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Klaus J. Zink (Ed.)

Corporate Sustainability as a Challenge for Comprehensive Management

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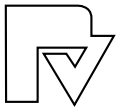

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Preface

Since the Rio Declaration of the United Nations in 1992 sustainability has become a topic of global economic and societal relevance. Generalized sustainability means a reasonable i.e. conservative use of available resources including economic, social and environmental goals.

This point of view implies that corporate activities should not concentrate on short-term improvements of a single dimension but strive for a middle to long-term balance between all three dimensions.

Corporations and other economically acting organizations need to realize economic, environmental and social objectives with a long-term perspective for the benefit of all stakeholders in order to survive.

Referring to corporate sustainability therefore two aspects are of specific relevance:

- to realize comprehensive management concepts
- based on a comprehensive change management

Comprehensive management concepts are understood as systems approach including the interests of all relevant stakeholders with a mid- or long-term time perspective. As seen before these definition elements are very much related to sustainability. Such concepts can be found e.g. in international excellence models mainly based on a TQM thinking.

Many examples in the past showed, that only one third of the companies trying to realize such a holistic approach have been successful. The cause of these failures can be found in the field of human factors in organizational design and management. A comprehensive change management has to involve people and needs to change corporate culture instead of “only” changing structures and processes. There is a challenge for integration!

This topic has been discussed during a symposium organized by the Chair of Human Factors and Industrial Management and the Research Institute for Work and Technology at the University of Kaiserslautern in March 2007. Internationally leading scientists from nearly all parts of the world discussed the item of sustainability from their perspective. Some of them focused mainly on the time perspective, describing the preconditions for a long lasting success e.g. of change projects. Others took the broader

perspective based on a stakeholder approach and addressed more than one pillar of the sustainability concept.

For a better understanding it might be helpful to explain some more definitions used very often in this book. When we talk about ergonomics we have a broad understanding based on the definition of the International Ergonomics Association, focusing on human-systems interface design with at least two objectives: contributing to the wellbeing of people and enhancing the performance of the system. The term human factors has internationally the same meaning and is here used mainly as human factors in organizational design and management (or human factors in ODAM). For human factors in ODAM during the last years also the term macroergonomics is used. The basis for organizational or business excellence is total quality management (TQM). TQM is mostly understood as the process to reach excellence. Excellence in this context is based on a broad, stakeholder-oriented assessment concept, used by international excellence awards.

I am very thankful to all those, who – not only came to Kaiserslautern – but also took the time to transfer their presentation into a scientific paper for this book. Special thanks go to my associates Dr. Ulrich Steimle and Dipl.-Wirtsch.-Ing. Klaus Fischer, who contributed to the "opening paper" describing the field of sustainability. Klaus Fischer was the project manager for this publication – and he really did an excellent job. Stefanie Holtz and Jens Köhler were responsible for the layout of texts and figures, Sabine Owens helped us to realize a "readable" English version of this book. Thank you to all of them! My final acknowledgements go to the Springer Publishing Company, which accepted to publish this reader, and Dr. Niels Peter Thomas who supported us in doing so.

Kaiserslautern, January 2008

Klaus J. Zink

Contents

Part 1

Corporate Sustainability as a Challenge for Comprehensive Management

Human Factors, Business Excellence and Corporate Sustainability: Differing Perspectives, Joint Objectives

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The papers in this book deal with an understanding of sustainability both in the sense of obtaining long-term success and thus survivability of a corporation and in the sense of the normative idea "sustainable development", which has gained substantial relevance since the early 1970s. These understandings are represented by different approaches which can be seen as exemplary for a (more) comprehensive management, namely human factors on the one hand, and total quality management and business excellence on the other. They all comprise a stakeholder orientation coupled with a time horizon which exceeds the perspective of short-term earnings.

Reflecting the title of this book, this paper intends to show how these understandings are linked together and why realizing corporate sustainability can be seen as a challenge for those comprehensive management approaches.

In the first section, the term "sustainability" is presented in its original context of an economic principle as well as in the sense of the more recent normative concept sustainable development. Starting with these considerations, it is argued that the mentioned approaches are linked by concurring objectives, though differing in time focus and scope. Especially these differences can be seen as a challenge to broaden the perspectives but also to benefit from already existing synergies.

1 Sustainability as an Economic Principle

The current discussion on sustainable development, which is presented in more detail in Chap. 2, is mainly based on the contributions of the Club of Rome in 1972, the World Commission on Environment and Development (WCED) in 1987 followed by the United Nations Conference in Rio de Janeiro in 1992.

The principle of sustainability though is much older and originally – in contrast to the modern concept – not based on normative, but on economic considerations. It dates back to forestry in the Last Middle Ages (Nutzinger 1995) when timber served as main source for several economic processes, e.g. as energy source and building or raw material. Significant growth of population led to excessive overuse and clearings causing an economic and ecologic crisis and finally the collapse of the population in Central Europe in the 14th century. Starting from this crisis mainly German forestry anchored different regulations of felling and systematic afforestation allowing to balance resource accruement and use.

The example of sustainable forestry shows that sustainability can be seen as primal economic principle. Without clear economic interests it would not have emerged. The same occurs when the focus lies on the long-term economic success of a company, e.g. within approaches of business excellence. The often argued conflicts between social, economic and ecological objectives are thus not originally caused by a contradiction between these dimensions but by conflicts between short-term and long-term objectives. Safeguarding all kinds of capital – social, economic as well as natural – finally builds the basis for durable economic success. If we enlarge our perspective from a couple of years to decades and centuries corporate sustainability can be seen as primary objective for our economy.

Naturally the problem of forestry in the Last Middle Ages is characterized by much less complexity than the current debate on sustainability. Time span and geographic scope of the problem were at that time clearly set, its originators directly identifiable and the measures to overcome the problem relatively simple.

Our modern understanding of sustainability is characterized by a much higher complexity, the relevant time span and interrelations are significantly broader. “Sustainability” thus extended its focus from a regionally and temporary limited challenge to a worldwide and long-term one. Consequently the “modern idea” of sustainability requires comprehensive approaches allowing to cope with this higher complexity.

2 Sustainable Development and Corporate Sustainability

2.1 The Idea of Sustainable Development

The Club of Rome's Report "The Limits to Growth" in 1972 presented a computer-based model predicting the consequences of exponential growth in world population and economy for the 21th century. In spite of all criticism regarding the modelling approach and its outcomes this report contributed significantly to our perception of systemic interrelations at a global level and can thus be seen as the starting point of a worldwide discussion on sustainable development.

In 1987 the WCED for the first time set a common definition of "sustainable development" creating an important basis for a further international deployment of the normative idea. On the one hand this definition allows a widespread identification and is thus accepted as a common denominator. On the other hand it is often criticized as too vague and not tangible enough to serve as an operational term for sustainable development.

The idea of sustainable development is based on different theoretical concepts. They all refer to normative aspects mainly expressed through questions on inter- and intra-generational justice and the long-term viability of our social and ecological systems.

The concept of sustainable development relies on three basic ideas:

- Sustainable development is focused on human needs (anthropocentric view) and thus not slanted toward environmental issues; according to the Principle 1 of the Rio Declaration on Environment and Development "Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature" (UNCED 1992).
- The idea of inter- and intra-generational equity is focused in the WCED definition of sustainable development, i.e. every generation should be able to benefit from the heritage of precedent generations and is obliged to hold it in trust regarding the needs of future generations.
- The so-called three pillars of sustainable development comprising social, economic and environmental objectives should be considered equally.

The normative idea of sustainable development is interpreted in different manners, several main aspects characterize the debate on "sustainability" in the public, politics and sciences. An important question is whether natu-

ral capital (e.g. natural resources or ecosystems as a whole) can be substituted by man-made capital (e.g. assets, technologies or knowledge). Proponents of the so-called concept of weak sustainability maintain that man-made capital stocks are substitutable[1]. This includes that the present exploitation of natural resources can be completely substituted by anthropogenic capital, leaving the whole capital stock constant. A complete exploitation of non-renewable resources is not critical here.

The concept of "strong sustainability" emphasizes, that man-made capital cannot substitute natural one. This seems to be particularly obvious in the case of natural functions being essential for (human) life. The consequence on this assumption is that every use of non-renewable resources would not be sustainable as it reduces the potential capabilities of future generations (Pearce et al. 1990).

Both concepts represent extreme positions and cannot be seen as directly applicable for our present way to sustainable development. Thus sustainable development will never be a detailed and fixed plan of action, but will be continuously concretized through a discussion process setting the normative basis for a common approach to shift towards a more sustainable path. Several further concepts could influence this debate like the concept of "critical sustainability" claiming for a conservation of natural capital which is seen as essential for the viability of our social and ecological systems without neglecting positive effects of a substitution of capital (Endres and Radke 1998).

The discussion on a possible (future) substitution of natural resources by man-made capital is highly linked with the question on intergenerational justice referring to the allocation of resources and development potentials between present and future generations. At this point we have to consider that our present design of products, working systems and society as a whole might have long-term impacts on our societal and environmental systems – emphasizing the need for a combination of preventive measures with a long-term view. As the effects of current systems design cannot be completely foreseen, sustainable development policies should be oriented on the precautionary principle, meaning to avoid possible negative impacts and in particular irreversible damages at the best while allowing future adjustments.

Besides the focus on future generations sustainable development calls for intra-generational justice referring to the allocation of resources and development potentials within our present generation. Following the often-cited definition of sustainable development given by the WCED a devel-

[1] The concept of "weak sustainability" is mainly based on Solow and Hartwick (see e.g. Solow 1974).

opment is sustainable when both aspects, meeting the needs of the present generation without comprising the ability of future generations to meet their own needs, are considered equivalently.

A further issue to be discussed while finding a normative agreement can be seen in the different interpretations of the three-pillar concept. The debate often mainly focuses on environmental aspects. As the social, economic and ecological spheres are highly interdependent all dimensions have to be considered in a systemic manner. Systems thinking and knowledge about the interconnections between environment, economy and society are thus important preconditions and require the cooperation of experts in different disciplines.

2.2 Corporate Sustainability

Corporate Sustainability can be seen as a transfer of the overall idea of sustainable development to business level. It can thus be defined analogously to the definition of the WCED "as meeting the needs of a firm's direct and indirect stakeholders […] without compromising its ability to meet the needs of future stakeholders as well" (Dyllick and Hockerts 2002, p. 131).

This definition implicitly comprises several assumptions, showing the interpretation of a corporation's role in its social system from the perspective of corporate sustainability:

- Satisfying human needs is the objective of all business activities and thus a superior "raison d'être" of each company. This points out the close link between the overall idea of sustainable development and accordant actions at business level. Corporations are important actors in realizing a path to sustainable development. They do not only satisfy human needs – coupled with a certain use of resources and production of waste materials – they also create needs and thus influence our consumption behavior and lifestyle. This aspect is crucial regarding the relevance of sufficiency strategies for sustainable development.
- The basis of a company's economic success is to meet its (relevant) stakeholders' needs as best as possible. A corporation which is not able to obtain a "license to operate" will not survive. This is not only the case regarding the compensation of familiar resource suppliers such as employees, shareholders or customers. Several examples show that it could be of major importance for a corporation that also legitimacy of its business is recognized, even by stakeholders with whom it is not (yet) in touch (e.g. non-governmental interest groups).

- Economic systems are built on a continuing basis which can be seen as a broader understanding of the "going concern principle". Without this assumption a corporation could theoretically act "sustainable" following the mentioned definition of corporate sustainability (meeting the needs of present and future stakeholders) without being sustainable in the sense of the overall normative idea, which would be the case if the time horizon of its business would not comprise future generations.

Summing up the previous considerations, three key elements of corporate sustainability can be identified (Dyllick and Hockerts 2002):

1. Based on the three-dimensional concept a sustainable corporation considers not only economic but also social and environmental prerequisites and impacts of its actions as well as the interdependencies between them.
2. As mentioned above, corporate sustainability requires a long-term business orientation as a basis for satisfying stakeholders' needs currently and in the future. At the present time earning short-term profits is outranking a long-term value creation which takes account of positive as well as negative external effects of business activities in the long run.
3. A sustainable corporation follows the rule to live on the income from capital not the capital itself – not solely regarding financial assets. Coupled with a necessarily broader interpretation of the term "capital" this rule is applied to all financial, natural, human as well as social capital stocks.

Corporate sustainability thus means to add environmental and social aspects to the set of common business objectives. This requires to overcome conflicts of goals between economic, environmental and social issues in the long rung, thus combining economic success with conserving the biophysical environment and social responsible actions. As argued in Chap. 1 where the primal economic character of the sustainability principle is shown, these objectives are not originally contrary but currently conflicting due to a short-term orientation in business activities. When goal conflicts are changed into goal congruencies a win-win situation between the dimensions of sustainability is realized. Then the overall performance of a corporation is not only determined by financial results but also by its environmental and social performance (Steimle and Zink 2006).

3 Satisfaction of Human Needs – Joint Objective though Differing Perspectives

The definition of sustainable development of the WCED emphasizes on meeting human needs (especially focusing the essential needs of the world's poor) thus implying an anthropocentric view (WCED 1987). Though the discussion often mainly refers to environmental aspects, safeguarding nature is not an end in itself but a necessary prerequisite for a durable satisfaction of human needs.

The comparison of several definitions in Table 2 shows that human needs also take center stage in excellence approaches based on the principles of TQM as well as in ergonomics/human factors and the concept of corporate sustainability although these concepts have different perspectives and vary in their foci regarding time and scope. As mentioned above the definition of corporate sustainability of Dyllick and Hockerts (2002) is analog to that of the WCED and consequently also emphasizes on the satisfaction of human needs. Even the first definition of ergonomics by Jastrzebowski in 1857 already comprises this focus based on a normative understanding of work (see Table 2).

While excellence approaches are mainly targeted on economic sustainability human factors is highly linked to topics of social sustainability (Steimle and Zink 2006). Both approaches refer to the needs of the present generation while corporate sustainability also refers to future generations and emphasizes on economic, environmental and social sustainability (see Table 1). Of course this differentiation is becoming more and more indistinct as the different approaches get broader perspectives. An example is using new ways of lifecycle-oriented product management aiming to design ergonomically and ecologically optimized products and working systems (Zink and Eberhard 2006).

Table 1. Differences in scope and time focus of excellence approaches, human factors and corporate sustainability

	Business excellence/TQM	Ergonomics/human factors	Corporate sustainability
(Traditional) scope	Economic sustainability	Social sustainability	Economic, social and environmental sustainability
Time focus	Present generation	Present generation	Present and future generations

Table 2. Satisfaction of human needs as a joint objective

Business excellence/ TQM	Ergonomics/human factors	Corporate sustainability
Management approach of an organisation, centred on quality, based on the participation of all its members and aiming at long-term success through *customer satisfaction,* as well as *benefits for all members of the organisation and for society*.[2] (DIN EN ISO 8402)	The exertion of our vital forces for the common good, which is called work […] by which we and our fellow creatures *attain to all that is good for ourself and the common welfare*. The Science of Work […] we shall venture to call Ergonomics. (Jastrzebowski 1857, pp. 14, 15) Ergonomics (or human factors) is the scientific discipline concerned with the understanding of the interactions among human and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to *optimise human well-being and overall system performance.* (IEA 2000)	*Meeting the needs* of a firm's *direct and indirect stakeholders* (such as shareholders, employees, clients, pressure groups, communities etc), without comprising its ability *to meet the needs of future stakeholders* as well. (Dyllick and Hockerts 2002, p. 131)
Joint objective: Satisfaction of human needs		

[2] As it is exemplary, the (old) ISO definition of TQM in 1992 was chosen here. The term "quality" is not used in current excellence models because it was often interpreted in a rather narrow sense of product quality assurance than as a companywide change of culture; thus the principles of TQM are now represented by models of business or performance excellence (see the paper of Zink in this book).

4 Corporate Sustainability – Synergies and Challenges for Comprehensive Management

Satisfying needs while maintaining social, economic and natural capital requires an efficient use of resources but also considering the absolute impacts of (economic) activities to society and nature. Regarding a corporation's activities these requirements can be formulated as criteria of socio- or eco-efficiency as well as socio- or eco-effectiveness which need to be fulfilled for realizing corporate sustainability (Dyllick and Hockerts 2002).

Socio- and eco-efficiency can be mathematically expressed as quotient of the value added and the positive external effects of business activities over their aggregated negative social or ecological impact which is shown in the following equation based on the definition of eco-efficiency by Schaltegger and Sturm (1990):

$$\text{Socio-/ Eco-efficiency} = \frac{\Sigma \text{ Value added + positive external effects}}{\Sigma \text{ Aggregated negative impacts on society / nature}}$$

The concept of eco-efficiency was popularized by the Business Council of Sustainable Development in the 1990s (later WBSCD) as the increasing production of goods coupled with a constant decrease of input of natural resources (Schmidheiny 1999). This interpretation can be seen critically as dematerialization has its physical limits. But efficiency-quotients also neglect absolute impacts, thus an increase of efficiency only leads to relative improvements while absolute burden on nature or society might increase – a crucial effect especially regarding complex eco-systems or cumulative damages.

Consequently realizing corporate sustainability also requires considering the socio- and eco-effectiveness of business activities as a whole, therefore – in an aggregated view – "doing the right things".

Besides the already mentioned criteria of efficiency and effectiveness Dyllick and Hockerts (2002) stress sufficiency as a fundamental change of (consumer) behavior as well as ecological equity to be necessarily fulfilled (see Fig. 1).

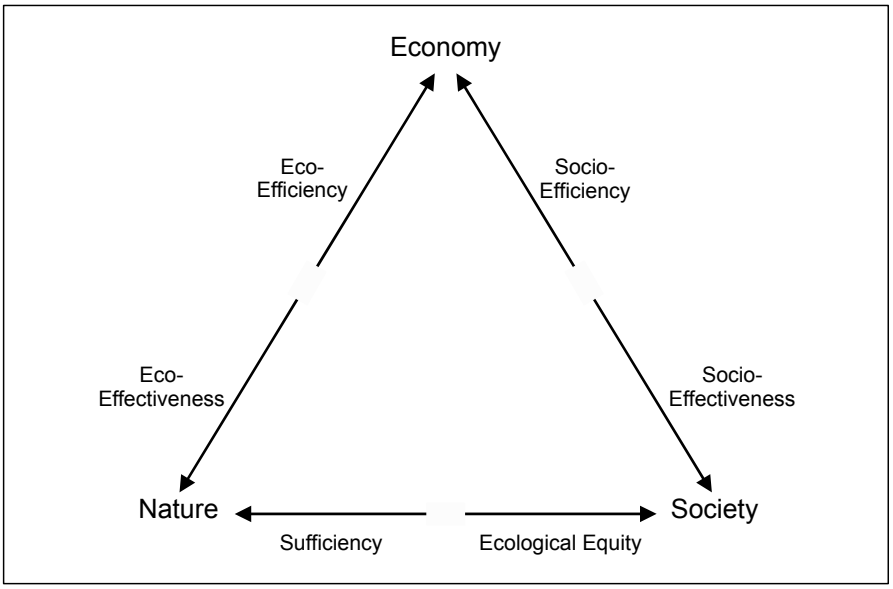

Fig. 1. The six criteria of corporate sustainability (Dyllick and Hockerts 2002, p. 138)

The challenge regarding corporate sustainability for comprehensive management can be seen as twofold: on the one hand to broaden the scope and time focus of business excellence and human factors, e.g. regarding the satisfaction of the needs of people in all parts of the world and of future generations, on the other hand to realize synergies between different approaches and disciplines. Actually there are already approaches in human factors and in TQM with a broad scope integrating two – or even all three – dimensions of sustainability and/or a long-term perspective. Organizational design and development approaches that widen the scope from a workplace level to a macro perspective gained significance in human factors research (Hendricks and Kleiner 2002). Therefore the variety of stakeholder interests, i.e. environmental, social and economic requirements which have to be considered in ergonomic analysis and design increases (see e.g. Zink 2002). In the field of TQM and business excellence there are promising approaches for promoting corporate sustainability through the integration of social and environmental aspects in established methods and frameworks (see e.g. EFQM 2004 – CSR framework).

Starting with the above mentioned six criteria of corporate sustainability, we try to delineate in Fig. 2 how current principles, tools and methods of business excellence and human factors already contribute to corporate sustainability. As can be seen the synergies are widespread and solely

apart from "pure" ecologic issues both approaches are highly linked with corporate sustainability.

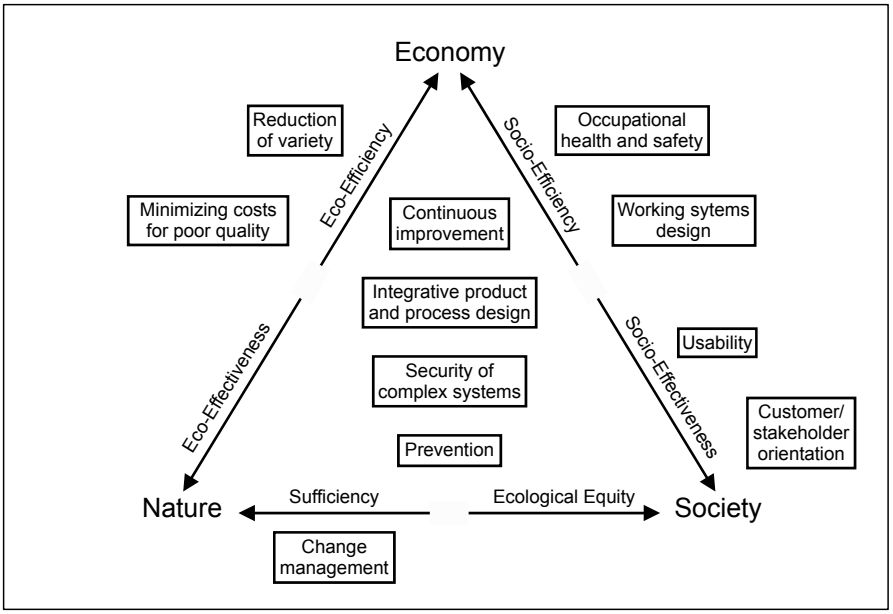

Fig. 2. Principles, tools and methods of business excellence and human factors in corporate sustainability

The examples in Fig. 2 reveal that in various respects human factors and TQM already contribute to sustainability by improving the environmental and social performance of corporations:

- The substantial precautionary principle of prevention in human factors is highly complementary with the requirements of sustainable development, thus avoiding negative impacts as best as possible – primarily irreversible damages. For instance ergonomic approaches for occupational health and safety help to make workplaces compatible with people's needs, abilities, and limitations, thus minimizing harmful impacts on employees. The principle of prevention is also included in innovative approaches of integrated product and process design (Zink and Eberhard 2006) that improve environmental and social compatibility of products and work systems.
- The papers of Scott and Kogi in this book impressively show how human factors' interactions in microsystems can lead to promising effects in related macrosystems, thus to "reverse the negative spiral" in

industrially developing countries through minor corrections at workplace level.

- Technological changes respectively the introduction of new technological solutions may further corporate sustainability (as can be seen in the paper of Carayon et al. referring to the improvement of patient safety and health care). Those changes are promoted through a macroergonomic change management focusing necessary socio-technical interventions.
- The application of ergonomic principles can enhance the security of complex systems such as traffic, power plants and chemical production processes and, therefore, prevents environmental and human harm.
- Participation of employees in continuous improvement approaches may lead to reductions of waste, higher resource efficiency and decreasing costs of poor quality while at the same time strengthen employees' satisfaction and motivation. This can be shown in the context of quality circles or high involvement teams (see e.g. O'Toole and Lawler III 2006) and has been described as a macroergonomics method by Brown (2002).
- Customer and stakeholder orientation of business excellence and TQM are promoting socio-effectiveness, thus to gear a company's output and activities to the needs of its customers, further stakeholders and the society as a whole. This is not only relevant in industrialized countries with highly saturated markets but also and – as Prahalad (2005) shows in various examples – particularly in the developing world taking center stage in the concerns about sustainable development. Customer orientation is an important precondition for positive business results – and in this sense for the possibility to invest in the improvement of working conditions. Therefore the necessity of a sustainable economic success (as it is dealt with in the papers of Dervitsiotis, Kanji and Tort-Martorell et al.) should not be lost as sometimes done by "only" including environmental aspects in the discussion of sustainability.
- Integrating environmental management into total quality management was discussed already in the 1990s (Rau and Zink 1996). In more recent publications authors have transferred principles from quality management to corporate social responsibility, leading to an approach of "Total Responsibility Management" (Waddock and Bodwell 2007; Waddock et al. 2002). Others have analyzed corporate social responsibility in general business excellence frameworks and developed an audit instrument for assessing an organization's position regarding social responsibility (Kok et al. 2001). Such innovative approaches are gaining increasing importance: As Hermel shows in this book, the basic requirements of

corporate social responsibility are not really new but their international dissemination and relevance increased significantly in the last 25 years.

- The discussion on corporate responsibility and sustainability also has been influencing the development of international business excellence models. As Cesarotti and Spada point out in their contribution to this book the EFQM Excellence Model may provide a basis on which a company can build its way to sustainability. Looking at the criteria of this model we can see a much stronger emphasis on social and environmental issues than in the past. In the current EFQM Model sustainability is defined as a so-called "Red Thread", i.e. as a concept that is of relevance for the entire model. Since the revision in 2002 all model criteria include guidance points that are closely related to the concept of sustainable development. The model also comprises the idea of economic sustainability because it is based on a managerial long-term perspective – even the needs and rights of future generations are mentioned within some of the criteria (Zink and Steimle 2007; Steimle 2007).
- Realizing sustainability on a global as well as on a corporate level requires adaptation to environmental and social changes such as resource scarcity and demographic development (see e.g. Drury in this book). Facing those critical trends long-term survival will depend on the ability to fundamentally change behaviors, structures and technologies to achieve higher eco- and socio-efficiency and -effectiveness but also to strengthen a culture of sufficiency. Imada demonstrates in this book that human factors in organizational design and management (also described as macroergonomics) has a lot to offer for supporting those change processes in a system based solution. On an organizational level a socio-technical systems approach could also be applied for the effective implementation of a business excellence framework (Zink 1995) that integrates sustainability issues as described above.
- Another basis for synergies is given by showing the relationship between stakeholders' interests and human factors in organizational design and management. As sustainability and corporate social responsibility are also based on a stakeholder approach the connections to human factors are obvious and can be shown easily (see e.g. Zink 2002).

5 Conclusions

In a more and more complex world only comprehensive management concepts will be able to realize sustainable success. At first glance – and as some of the following contributions may show – sustainability "only" re-

fers to the time dimension. But especially in the context of globalization it becomes obvious that sustainable success has to be built on the three pillar definition too. Without a strong effort in including social and environmental aspects in economic objectives there will be no lasting success. As shown in this introductory paper there are chances for synergies between different approaches (see e.g. also the paper of Dahlgaard and Dahlgaard in this book). In this sense corporate sustainability is a challenge for human factors in organizational design and management as well as for TQM approaches with the objective of business excellence to broaden their perspectives in scope (as shown in the paper of Karwowski in this book) and in time focus.

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Part 2

Comprehensive Management Concepts and Sustainable Excellence

Performance Excellence: Path to Integrated Management and Sustainable Success

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Performance measurement traditionally focuses on financial measures, such as sales turnover, profit, debt and return on investment. However, traditional financial measures do not match entirely with the competencies and skills companies required to face today's business environment. The complexity of managing an organization today requires "integrated management" that means managers being able to view performance in several areas simultaneously. Rather than analyzing performance from an historical perspective, it is important to understand organizational excellence, which potentially leads to success of a business in the future.

The first condition to improve, and ultimately to achieve organizational excellence, is to develop and implement a system of performance measurement criteria that goes beyond the presentation of financial figures and incorporates other non-financial success factors.

This paper provides with a performance measurement system built upon what many researchers and practitioners believe are the critical success factors for organizational excellence. By exploring the potentialities of a sound methodology, based on structural equation modeling and the system for performance measurement, the author in this paper will guide the reader the impact of different performance dimensions on the organization and its excellence. Such a performance measurement system goes beyond simple internal measurements and assessments of performance from external stakeholders. In reality it provides a solid base for an integrated management of the organization.

1 Business Excellence

The most important role of quality in the 21st century is to achieve excellence in all aspects of the business. The complexity of present day business is manifested in low cost opportunities, quickly expanding global markets, the boosting of operating efficiencies and the delivery of better and more personalized customer service, thus we can already see that business excellence is transforming the way we work.

Business excellence has no boundaries. Our challenge for the 21st century is to turn the organizational vision into reality. In a nutshell, it is the best window for the reality of corporate life, setting before us with the following visions:

1. Leaders must achieve and adhere to their highest quality standards in order to motivate by example their workforce; encourage them to embrace quality culture with enthusiasm and pride, not unreflected;
2. Develop a quality culture because it is a way of life, a lifetime business commitment; it is not a pastime;
3. Excellence in business is not by chance it is by choice;
4. Total quality culture and business excellence must denounce the evils of "sloppy organization cultures";
5. A successful business will not lower its standard; it will build on its success;
6. Business excellence and humility are not incompatible with one other; on the contrary they complement each other;
7. Systems approaches in business excellence must demonstrate how the organization's vision can be turned into reality;
8. Never to let continuous improvement rest till good business is better and better business is best;
9. In following the above vision you must also realize that the quality culture of an organization is committed to customer satisfaction through continuous improvement. Although this culture varies from country to country and industry to industry there are certain common principles which can be implemented to secure a greater market share, increased profits and reduced costs.

Hence, to fulfill the vision and achieve high customer satisfaction levels (delight the customer), the organization must improve continually all aspects of its operation (continuous improvement); this can be achieved through leadership making decision on objective evidence of what is actually happening (management by fact) and by involving all employees in

quality improvement activities (people based management). The ultimate outcome will be business excellence.

Our task is, therefore, to help to build a highly well integrated business excellence culture utilizing its critical success factors for achieving the vision of reality.

In general, organizations that have achieved higher levels of business excellence have demonstrated very high growth in their customer base, thus improving overall profitability and stakeholders' values.

To follow the real path of quality improvement and ultimately to achieve business excellence, organizations must choose the performance measurement system, which provides a holistic, and a systematic approach.

By knowing the real path of excellence and following the systems approach of performance measurement an organization will be able to know where to improve and how limited resources can be more effectively used for the improvement.

Performance measurement thus requires not only a systems approach but also a systematic assessment of the organization against a set of criteria that should relate to its critical success factors.

However, designing and operating such a system is not without difficulties and requires proper skill and investment. Thus it is important to identify and implement a good performance measurement system in order to achieve meaningful interpretation of business activities.

A performance measurement system must incorporate all the quality principles and integrate all the quality concepts in order to measure and evaluate business processes. Hence, the requisites for a good performance measurement system are as follows:

1. Provision of a holistic and systemic approach
2. Provision of multipurpose and interrelated activities
3. Links to the organizational values and strategy
4. Links to the organizational critical success factors and quality principles
5. Provision of valid, reliable and easy to use models and methodologies
6. Comparison of results and monitoring of progress
7. Improvement opportunities and improvement strategy

It is also important to understand that whatever the size of the organization, whether you want to start small and add capability incrementally, 21st century quality culture and business excellence have come to help you to make real sense of your business.

In reality, your approach to quality culture will depend on your competitive landscape, strategy, objective and resources. Whatever you choose,

make sure that you follow a systems approach of business excellence that provides a reliable and valid method.

Such an approach for business excellence can be found in Kanji's Business Excellence Measurement System (KBEMS), which is based on critical success factors and provides a reliable and valid method with the help of a systems approach.

2 Systems Approach

It is fruitless to discuss how to measure an organization unless you define what an organization is. In my opinion any organization is best described and viewed as a system. In other words, we are about to measure a system, or more precisely, the performance of the system. A basic principle of measuring business excellence is to view the organization as a system, then model the organization and finally define the kind of information needed and how to collect it.

The first argument to use a systems approach as the prime foundation of the new approach to performance measurement comes from the tendency to regard organizations as organisms (Jackson 1991), which in order to operate effectively need to have a purpose. Accordingly, organizations are made of highly interdependent parts that must work together to achieve the system's overall aim.

Broadly, a system is "a set of objects together with relationships between the objects and their attributes related to each other and to their environment so as to form a whole" (Schoderbeck et al. 1990).

Similarly, TQM conceives the organization as a system that interacts with its customers, suppliers and to some extent also with society (Kanji 2002).

As social systems, organizations are complex. More than technology people individually and collectively play the major roles. Given that individuals and groups have their own purposes, social systems' alignment and aim congruency is more difficult to achieve.

Thus, the holistic view of TQM is an important consequence of adopting a systems perspective. It calls attention to the importance of implementing TQM on an organization-wide basis and to the need of establishing coordination mechanisms. This view is strongly emphasized in Deming's works when he argues that:

"A system is a network of interdependent components that work together to try to accomplish the aim of a system. A system must have an aim. Without an aim, there is no system" (Deming 1994).

Senge (1993) emphasizes, "the art of systems thinking lies in seeing through complexity to the underlying structures generating change. System thinking does not mean ignoring complexity. Rather, it means organizing complexity into a coherent story that illuminates the causes of problems and how they can be remedied in enduring ways".

Adopting a systems approach is also regarded as essential to pursue the best solutions to most organizational problems. In fact, traditional performance measurement systems promote local optimization at the expense of a systemic view of the organization. As Jackson (1995) highlights, "focusing upon the maximization of a performance target at the expense of others can result in the sub optimization of the system as a whole".

3 Critical Success Factors Approach

Conceiving a performance measurement system based on the identification of the critical factors affecting performance and then analyzing and quantifying the relationships among them finds support in the literature (Bititci et al. 2001).

The main purpose of this work is to present a new system to measure organizational excellence that is, as much as possible, multidimensional, comprehensive, integrated and reliable.

Such a system is based on the critical success factors (CSFs), which, according to Leidecker and Bruno (1984), are the limited number of areas in which results, if satisfactory, will ensure successful performance for the organization. CSFs can also be described as "those variables that management can influence through its decisions that can affect significantly the overall competitive positions of the various firms in an industry" (Kanji 2002).

Conceptually, a business excellence model should thus be based on the key TQM elements, using a CSFs approach.

When identifying the critical factors of quality management, most authors have reviewed the works of the quality gurus, in particular the writings of Deming, Juran and Crosby.

Looking at the CSFs as a whole, it is possible to conclude that there is a substantial agreement among the most prominent quality researchers about the main TQM constructs. Overall, the models presented in the next section and that serve as a baseline for the new performance measurement system – Kanji's Business Excellence Model (KBEM) and Kanji's Business Scorecard (KBS) – adequately cover the CSFs proposed in the literature.

In KBEMS the key performance indicators derive from the CSFs identified. Therefore, a key step in applying the new performance measurement system is to identify and validate the CSFs for the organization.

A model of TQM capable of effectively promoting organizational excellence (OE) must be based on the CSFs and comprise a measurement approach able to evaluate the real contribution of each dimension to OE, suggest improvement strategies and track progress over time. The Structural Equation Modeling (SEM) approach described next aims to provide such a measurement approach.

In our approach, SEM is used to test the postulated causal relationships that form KBEMS.

SEM is a multivariate technique combining aspects of multiple regression and factor analysis to estimate a series of interrelated dependence relationships simultaneously (Hair et al. 1998). Structural equation models include one or more linear regression equations that describe how the endogenous constructs depend upon the exogenous constructs. Their coefficients are called path coefficients, or sometimes regression weights.

Most SEM applications deal with research problems related to the study of causal relationships among latent variables.

For the requirements of performance evaluation it is necessary for the system to deliver meaningful results in terms of causal (cause-effect-oriented) relationship and a structural approach (meaning that the analysis shall be model-based). SEM provides a means by which theoretical relationships can be tested.

The principles and concepts embedded in KBEMS cannot be directly measured. Rather they need to be translated into a set of manifest variables (indicators). These indicators not only have to adequately cover the domain of the latent constructs, but also need to meet requirements of measurement validity and reliability.

It is also concluded that a simultaneous systems approach rather than a partial model approach is required for this analysis in order to estimate the entire set of relationships at once. Hence KBEMS derives from a structural model, based on a probabilistic approach using simultaneous equation estimation techniques for the measurement of performance.

4 Kanji's Business Excellence Measurement System and Kanji's Business Scorecard

In this section the models that make up KBEMS (see Fig. 1) are described in some detail.

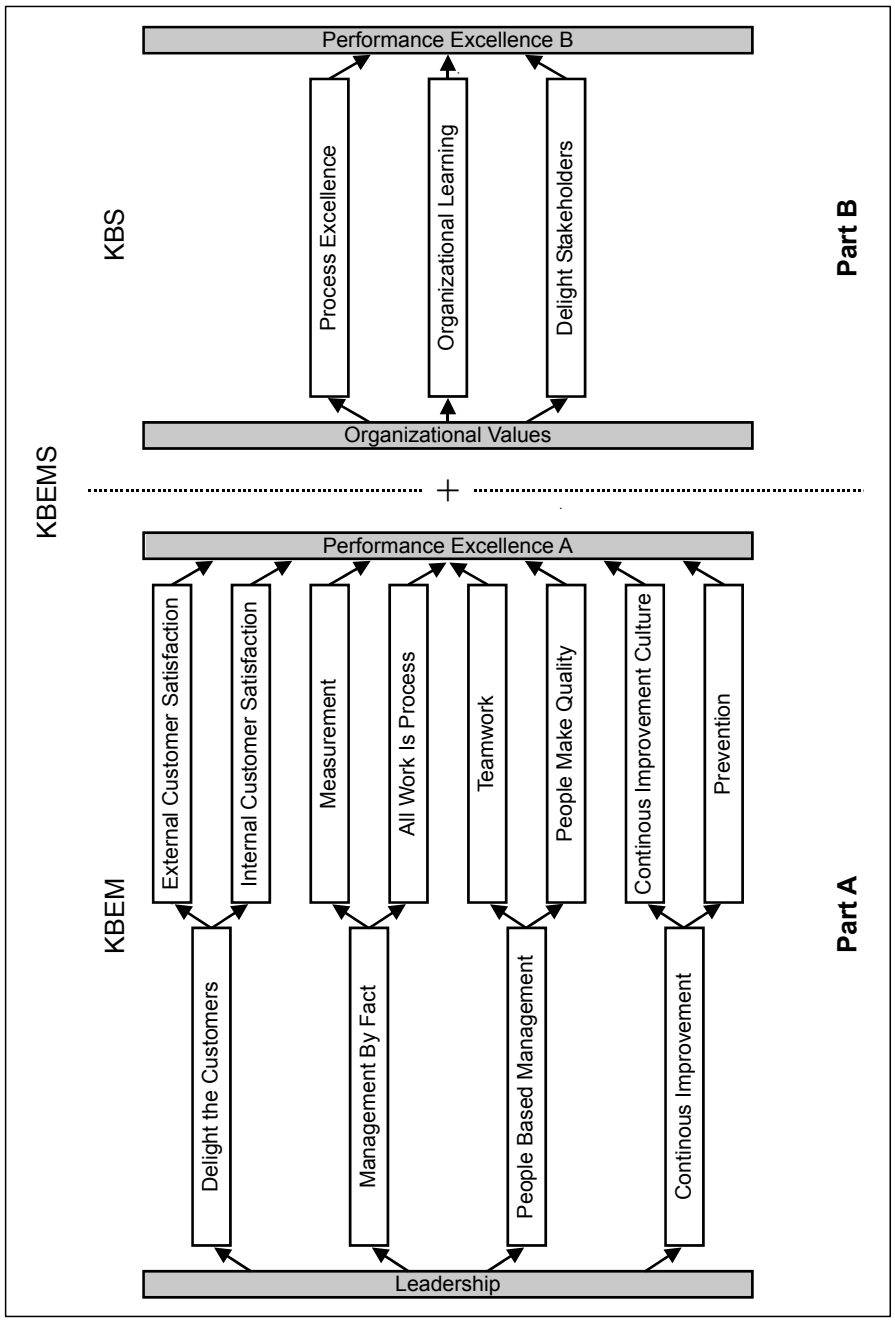

Fig. 1. Kanji's Business Excellence Measurement System (KBEMS) (Kanji and Sá 2001, p. 31)

KBEMS is based on KBEM and KBS. These are made up of several criteria that correspond to the CSFs, i.e. the areas that must perform well if an organization is to succeed. They form respectively Part A and Part B of the performance measurement system and should be applied simultaneously, since they form a single and complementary view of organizational performance.

"Leadership" is the prime of Part A, meaning that leaders are the most important driving force for quality improvement and business excellence. Their attitude must promote four principles: "Delight the Customers", "Management by Fact", "People Based Management" and "Continuous Improvement". Each principle operates in two core concepts, namely "External Customer Satisfaction", "Internal Customer Satisfaction", "Measurement", "All Work Is Process", "Teamwork", "People Make Quality", "Continuous Improvement Culture" and "Prevention".

In Part B, "Organizational Values" are the prime for "Process Excellence", "Organizational Learning" and "Delight Stakeholders". Effective management of these CSFs will lead to a high "Performance Excellence" in Part B.

As described in this paper, Part A is essentially directed towards the measurement of performance internally, according to the views of managers and employees. Part B requires performance measurement to be assessed from the perspective of external stakeholders, such as customers, suppliers, government, financial institutions and the society in general.

5 Empirical Evidence in Healthcare

A regional healthcare system is responsible for a considerable proportion of public expenses (see Hassan and Kanji 2006). Cowan et al. (2004) reported that 2002 expenditures for healthcare were $1.6 trillion in the United States – a 93 % increase from the previous year. Health costs are also escalating around the globe. 2003 data from the Organization for Economic Co-operation and Development (OECD), generated from a comparative analysis of 30 countries, shows that average healthcare expenditures in European countries were 8.4 % of their GDP in 2001. Cost management has become a primary topic in healthcare.

Improving the quality of healthcare and measuring the performance of care are major public and political issues challenging the healthcare organizations today. The literature indicates that the costs associated with adverse events are quite substantial. Perrone (1997) estimated the total costs associated with medical injury in the United States at as much as

$200 billion annually. Kohn et al. (1999) in their report found that 44,000 to 98,000 Americans die each year as a result of medical errors. The total national costs of preventable adverse events were estimated to be between $17 billion and $29 billion, of which healthcare costs represented over one-half.

In response to increasing concerns about quality and the rising need of accountability and improvement targets, a growing number of countries and healthcare institutions are implementing quality management programs and applying quality standards. Dranove et al. (1999) observed that nearly all hospitals in the United States were involved in quality improvement programs, noting that in 1997 almost all (98 %) of about 2,000 hospitals had adopted the continuous-quality-improvement policy.

Increasing amounts of resources are being devoted to these interventions. Measures on hospital spending on quality activities from a detailed study of 16 hospitals in the United States, performed by Dranove et al. (1999), revealed an expenditure of $56 per admission. The annual costs of quality-related activities by hospitals were from $300,000 to more than $4.5 million.

This issue is beginning to garner attention for government and private funding around the world. In coming years healthcare managers will be under greater pressure to demonstrate that quality interventions expenditures produce tangible benefits to their organizations. This increases their responsibility to evaluate these interventions and the contribution to the goals of the healthcare system.

Ovretveit and Gustafson (2002) have noted that existing research provides little evidence of the overall effectiveness of quality interventions and quality standards in healthcare. Suggested reasons for the lack of evaluation research include the methodological challenges of measuring performance and the complexity of the healthcare system.

Another gap in the literature is the absence of robust methodologies that use performance measurement systems to combine and integrate the perspectives of different stakeholders, and thereby present a holistic view of the level of performance of the healthcare system. The development of such methodologies will enable researchers to evaluate the effectiveness of quality interventions in enhancing organizational excellence.

The study uses the KBEMS model as a conceptual framework for measuring performance, which is grounded in the TQM approach and classical systems theory (Kanji 2000). KBEMS was developed from two structural models: KBEM, which is dedicated to the measurement of performance from an internal stakeholders' perspective, and KBS, which assesses performance from an external stakeholders' point of view. Both KBEM and KBS measures are based on CSFs. They form a complementary view of

organizational performance. The model has the ability to measure each of the components of the system and their relationships to each other.

6 Methodology

The research used a longitudinal quantitative design, and was conducted in a public 400-bed maternity and paediatric hospital in Dubai, United Arab Emirates (see Hassan and Kanji 2006). To achieve a holistic measurement of quality performance, several different populations were targeted reflecting a variety of stakeholders' perspectives, both internal and external. The targeted population for the internal stakeholders was hospital staff. High levels of heterogeneity characterized the staff population. Only 18 % were Dubai nationals, while 82 % were expatriates of 42 different nationalities. The functional language of the hospital was English. Many hospital services were either outsourced or centralized in the headquarters of the Department of Health and Medical Services. The staff categories were limited to the following: managers, doctors, nurses, technicians, and clerks. These categories constituted the targeted population of internal stakeholders.

The target population of patients and families was limited to inpatients admitted to the hospital wards during a period of two weeks (excluding intensive care patients and newborns). The population consisted of all the adult patients as well as families escorting paediatric patients. Data collection from the government authorities' perspective, conducted by clinical auditors from the Department of Health and Medical Services headquarters, targeted the patients' medical records excluding newborns.

Four sets of structured questionnaires, developed against a set of criteria based on Joint Commission International (JCI) standards and quality principles, were used in the study. They involved the use of standardized questions that were presented to the respondents with pre-coded response choices measured on a Likert scale with ten ordinals scaled options. A reliable and validated questionnaire that was tested in many countries, Kanji's instrument, was adopted in measuring performance from an internal stakeholders (staff) perspective. In consultation with Kanji, the lead author developed the other three sets of questionnaires. They were based on pre-set criteria and statements representing key performance indicators, extracted from the latest version of JCI standards, and validated by a panel of experts and JCI officials. Cronbach's coefficient alpha was used to provide scale reliability.

Preliminary tests including pilot testing of the measures and data collection methods were conducted prior to the collection of the baseline data.

Guidelines were prepared for each questionnaire to explain the concepts and avoid interpretation of the questions by the interviewers. Minor revisions were made to the instrument based on the results of the pilot studies, the interview method proved to be the best approach for data collection from staff and patients and families, and the use of guidelines to explain the concepts in the questionnaires proved to be useful.

Four university students who spoke four languages: Arabic, English, Urdu, and Farsi, were trained to conduct the interviews with patients and families. When possible, interviewers were matched with participants in relation to socio-demographic characteristics to reduce respondent bias. Ten quality coordinators performed the interviews with staff. To avoid social desirability in staff's responses self-administered responses were encouraged whenever possible; however this practice was very limited because most of the staff preferred to fill the questionnaire in the presence of an interviewer to provide explanation when required. Sixty hospital employees were stratified, randomly selected, and trained to perform the self-assessment survey based on the JCI accreditation approach. Three clinical auditors from the Department of Health and Medical Services conducted clinical review on patients' medical records.

The sample of staff chosen for the study was different than the baseline sample to avoid sample attrition (drop-out of respondents) and respondents' exposure bias (the Hawthorne Effect). Both samples had common characteristics, and were drawn from the same population. Different samples of patients and their families were chosen for the pre- and post-intervention studies. A panel design was not feasible because patients who were admitted to the hospital at the baseline measurement were not the same ones admitted after 15 months during the study survey. However, both samples had common characteristics, and were drawn from the same population. The characteristics of the population did not have major demographic variations during the period of study. The hospital is also specialized in maternity and paediatrics, which also limited the variation.

To trace changes overtime, clinical auditors studied a sample of medical records of patients discharged in the year 2003 for the pre-intervention study and a sample of records of patients discharged during May and June 2005 for the post-intervention study. For the self-assessment surveys, surveyors chose a different sample of patients' medical records from the one used in the baseline study. Their surveillance also involved opportunistic sampling when interviewing the staff, patients, and families for needed relevant information.

The data analysis employed a dedicated software package ("Kanji Quality Culture Management Software"), developed by Kanji and used to calculate internal and external stakeholders' scores, which were combined to

calculate the final organizational performance index (OPI). Positive changes detected in the OPIs indicated improvement in the hospital performance due to the intervention (implementation of JCI standards). The application of the software in different sectors, banking, supply chain management, hotel industry, and higher education (Kanji and Wong 2002; Kanji and Tambi 2002; Kanji and Liu 2003; Kanji and Lan 2003; Kanji and Sá 2006; Hassan and Kanji 2006) has validated its use.

To evaluate the effect of the intervention (JCI standards) on improvement of the hospital quality performance, business excellence indexes (BEIs) were calculated before the implementation of the standards and then 15 months after implementation.

The total OPI, which is a single number, was compared for the two intervals. This enabled the researcher to detect any positive change in the index score. An increase in the value after the implementation of JCI standards suggests improvement in the hospital performance.

To measure the impact of JCI standards on each of the stakeholders' perception (staff, patients and families, accreditation bodies, and government authorities), their BEIs were calculated at each measurement level and compared to detect any change in the perceived performance.

To identify strengths and limitations of the JCI standards, the mean scores of the individual components (CSFs) were compared and t-tests were performed to detect significant improvements. The calculations allowed us to identify the areas where the JCI standards were effective, and the areas they failed to improve.

Stakeholders' assessment varied widely, ranging from 24 % for accreditation bodies to 78 % for patients and families, as reflected in Fig. 2.

The implementation of the JCI standards led to a significant impact on stakeholders' assessments. Improvement in the hospital's quality performance was evident in the assessment of all four stakeholders, as demonstrated in Fig. 3.

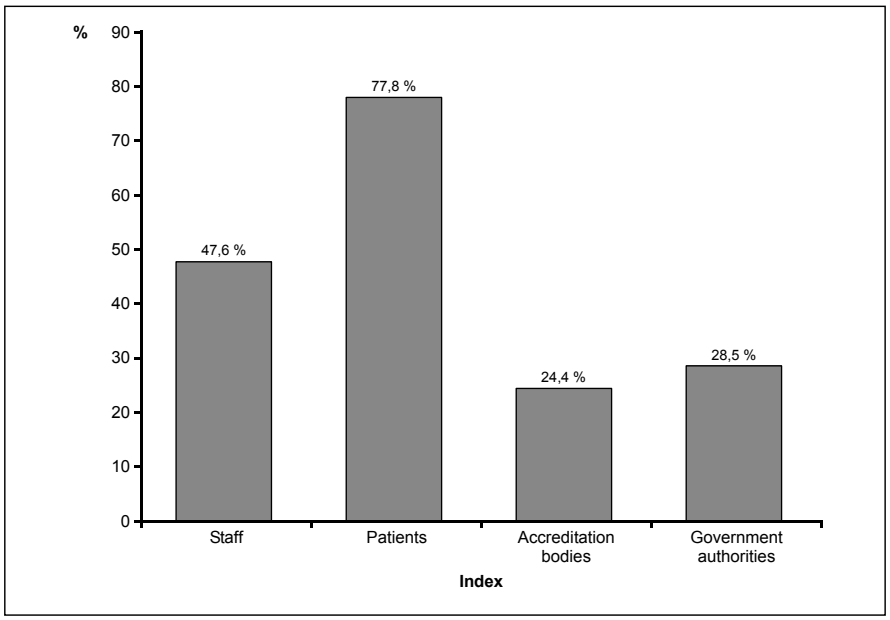

Fig. 2. Pre-intervention indexes of stakeholders' assessments of hospital's performance

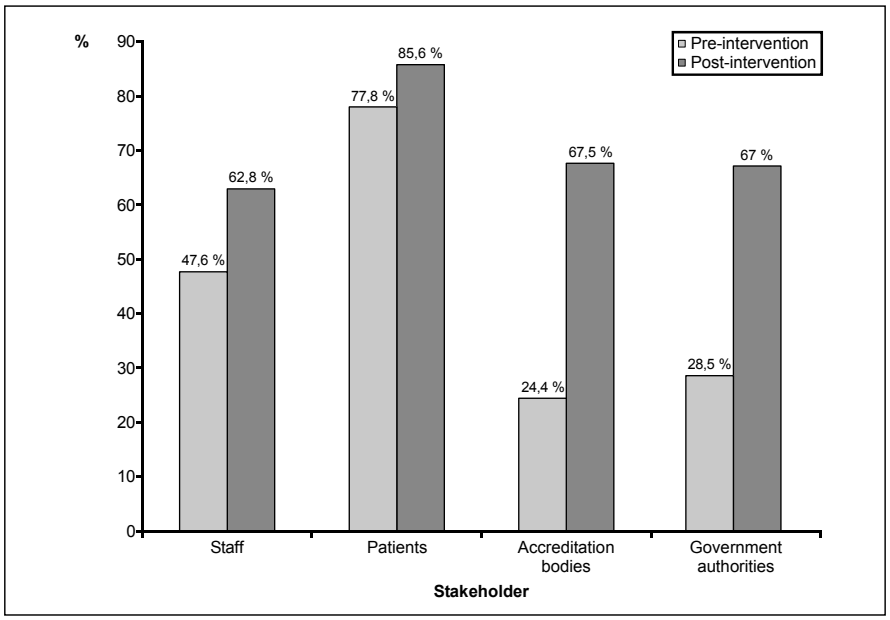

Fig. 3. Pre- and post-intervention indexes of organization's performance as perceived by different stakeholders

The first research question was: "To what extent does the application of the JCI standards improve perceived quality performance in a hospital?" The study provided empirical evidence on the significant improvement in the perceived quality performance of the hospital 15 months after the implementation of the JCI standards. A post-intervention OPI showed 49 % improvement in quality performance. The results are reflected in Fig. 4.

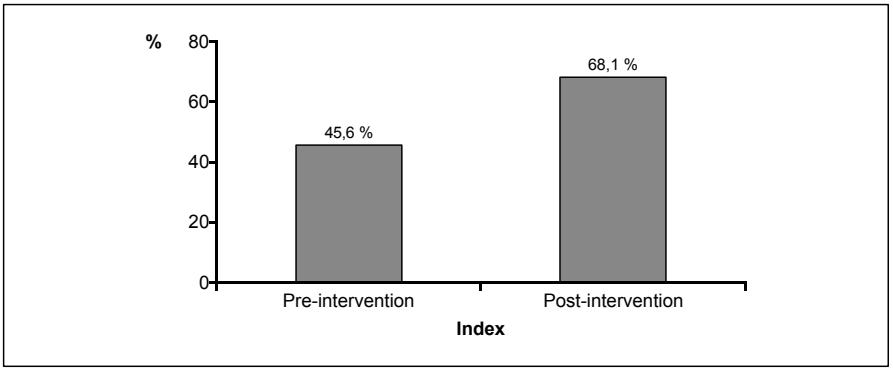

Fig. 4. Overall pre- and post-intervention performance indexes

7 Conclusion

The findings of the study supported KBEM for measuring performance. Kanji (2002) argued that researchers should view the organization as a system and accordingly apply systems theory when measuring it. His model embraces a holistic approach including as many stakeholders as possible and not focusing on one stakeholder alone. His model actively involves internal and external stakeholders in the assessment process. It measures performance from a multi- and interrelated perspective. The baseline study's findings revealed a big difference in stakeholders' assessments (Fig. 2). Kanji's model combined different stakeholders' measurements (internal and external) to calculate a final performance excellence index. The study findings empirically proved that it is a realistic view to performance measurement.

As a holistic approach to viewing performance, KBEMS permits all of a system's parameters to be measured simultaneously. The findings showed that this holistic approach used for a complex system such as a hospital provides a better understanding of organizational change. Kanji's use of CSFs to measure a wide variety of quality concepts enabled a comprehen-

sive and detailed assessment of the critical areas to be performed, comparisons to be made, and progress to be monitored. It highlighted performance gaps and problems and pinpointed areas where improvement is required, while providing a methodology to evaluate progress toward organizational excellence.

The results also provided empirical support to the TQM philosophy and the notion that applying quality initiatives that are grounded in TQM, such as the JCI standards, leads to improvement in perceived organizational performance. The findings showed that 15 months after the implementation of JCI standards, the perceived OPI of the hospital improved by 49 %.

In the healthcare field, it is difficult to isolate business excellence matters from healthcare outcomes. Kanji's model isolates specific kinds of benefits by focusing on TQM's effect. In a sense they are management benefits in general, while JCI's international standards are quite different, since they are either directly or indirectly linked with patient care, patient safety, the effective treatment of patients, and the requirements of services by healthcare organizations.

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Developing Sustainable Competitive Advantage through Operational Excellence and Adaptation Excellence with Value-Innovations

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In a relatively stable environment most organizations can develop a strategic plan with a clear focus and direction. Its successful execution can achieve strategic goals mainly through operational excellence. However, when change in the external environment is rapid and outcomes cannot be anticipated, leadership must shift its priority to the exploration of new value opportunities and systematically experiment to see what works and what does not. Under such conditions what matters most is the capability to experiment efficiently, to test and to adapt to an environmental context undergoing significant change.

Leadership under these conditions must pursue a balance between the need for short-term earnings with an effective exploration of new opportunities and threats, as changes in customer preferences rearrange the competitive landscape. The quality of the value-innovation process will be determined by the creativity, talent and (tacit) knowledge of an organization's employees, rather than the effectiveness and efficiency of the conventional supply chain which delivers its products and services.

1 Environmental Changes and Systemic Thinking

During the post-war era we witnessed the development of a powerful arsenal of management methods and tools for performance improvement which served most organizations well. During the 70s and 80s a remarkable confluence of significant developments in technology, government policies about industry deregulation and the spread of global trade in-

creased at a rapid rate the number and frequency of interactions among domestic and global players, creating a new unfamiliar set of prevailing conditions. As a result, the environmental context became more and more complex and uncertain. For a long time highly successful companies (IBM, GM, US Steel and many others) found themselves unable to cope with emerging smaller competitors.

This paper examines how systemic thinking guided by inspired leadership can enhance an organization's capability to explore emerging business landscapes that cause value to migrate to different sectors of the economy as a result of shifting customer preferences (Slywotzky 1996). The approach for doing so requires sensing when there is a dramatic environmental change under way and then introducing and testing multiple value-innovations.

2 The Character of a Value-Innovation

Rather than seeking continually to introduce something simply new, business firms that want to develop a strong competitive advantage seek to focus on the kinds of innovations that aim to improve both the value offered to potential customers and to reduce the cost for its purchase and use. This is depicted in Fig. 1.

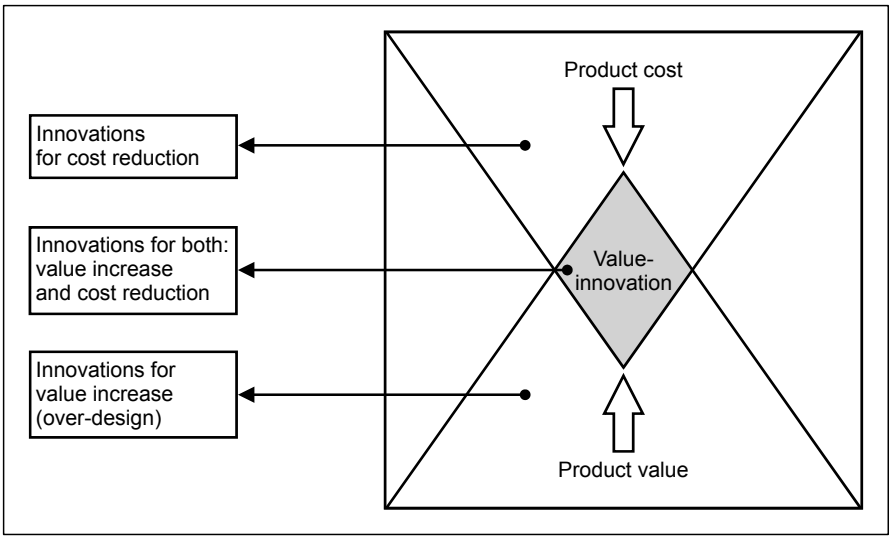

Fig. 1. Value-innovations aim simultaneously to increase value and reduce cost (adapted from Kim and Mauborne 2005, p. 16)

Focusing on innovations that increase only a product's value might make products or services most attractive to the demanding customers that always seek the best there is. These customers are not especially sensitive to price and will pay for maximum performance or other quality attribute, especially in consumer goods. The result is often one of over-design, in that its features go beyond what most buyers can make effective use of, be that a personal computer, a stereo system or a super luxurious automobile. The problem here is that these customers are only a small segment of the total market which can accommodate only a few competitors. In terms of the potential for a large sustained revenue stream, their prospects are limited and the risks of a new competitor overtaking them especially in high-tech industries are considerable.

3 The Development of Sustainable Competitive Advantage

An organization in a free-market economy, especially one that is becoming increasingly global, aims to achieve its strategic goals on the basis of a competitive advantage. Barney states that "A sustainable competitive advantage is one in which the company implements a value-creating strategy that remains unique despite attempts at imitation by current and future competitors" (Barney 1991). This means that the organization is capable of offering greater value to buyers in its industry that have a choice from several alternatives.

We must emphasize that the *value offered to customers* by products or services is determined by the customers themselves. As such it may include:

- Better quality, i.e. increased functionality, reliability, safety, etc.
- Lower price for comparable quality level
- Faster delivery when quality and cost are the same
- Easier use
- Greater customer satisfaction
- Provision of good after sale support

The cost of products or services from the producer's supply chain is determined by:

1. The *direct cost* for materials, parts, labor, overhead, etc.
2. The *indirect cost* of conducting all the *transactions* related to communications and coordination of all the necessary activities among the internal and external parties involved.

The most recurrent mistake made by successful organizations is the failure to assess the impact of ongoing changes on their customers and stay with the same strategy assuming continuity in environmental conditions. In what seems the rational thing to do, considering the cost structure with big overheads imposed by their large size, they keep making products that offer, albeit temporarily, the most attractive profit margins, by investing in incremental improvements that satisfy their most demanding customers. As a result they often pay little or no attention to the moves made by new competitors operating with a new strategy based on some disruptive innovation that gradually eats away their market share (Christensen 1998).

The impressive reduction of a firm's transactions costs since 1980, as a result of the rapid advancements in computers and telecommunications has created the foundation for the outsourcing of business activities. Outsourcing in 2004 reached $382.5 billion, increasing at annual rate of 11 %, thus expected to account for $641.2 billion of outsourcing business to countries of East Asia and East Europe by 2009 (Kutschera et al. 2006).

In periods of rapid change the focus for most business firms must shift from meeting profitability targets to the need for survival in the face of intense competition at a global scale. The conventional approach of cutting costs through extensive employee layoffs, plant closures, outsourcing to low-cost countries or increasing productivity with new technologies, does not address the fundamental challenges posed in the era of globalization through networked economies. What is primarily needed is the development of new capabilities that enhance the continual development of innovations that offer maximum value to customers and other stakeholders. Such a new strategic response demands the significant improvement of the quality of an organization's value-innovation process.

New innovations are most often introduced and visible in new products or services. To attain higher levels of quality and productivity the above lead to new innovations related the processes used. However, as environmental conditions change, the need for survival and adaptation increases the pressure for new innovations in an organization's business design in the form of new structure, interconnection of functions, processes and how an organization conducts its business, i.e. its business model (see Fig. 2).

For an organization to survive in an environment with rapid change, leadership must shift from a conventional (top-down) strategy which was formerly successful to an emerging (periphery-to-centre) strategy, by attempting to sense the potential impacts of changes manifested as new threats and opportunities, and interpret how these will affect its present structure and mode of operation. *Those working at an organization's boundary or edge usually function as the "value-sensors" that first detect*

how customer preferences shift based on changes in customer needs and the appealing novel offerings by new or existing competitors.

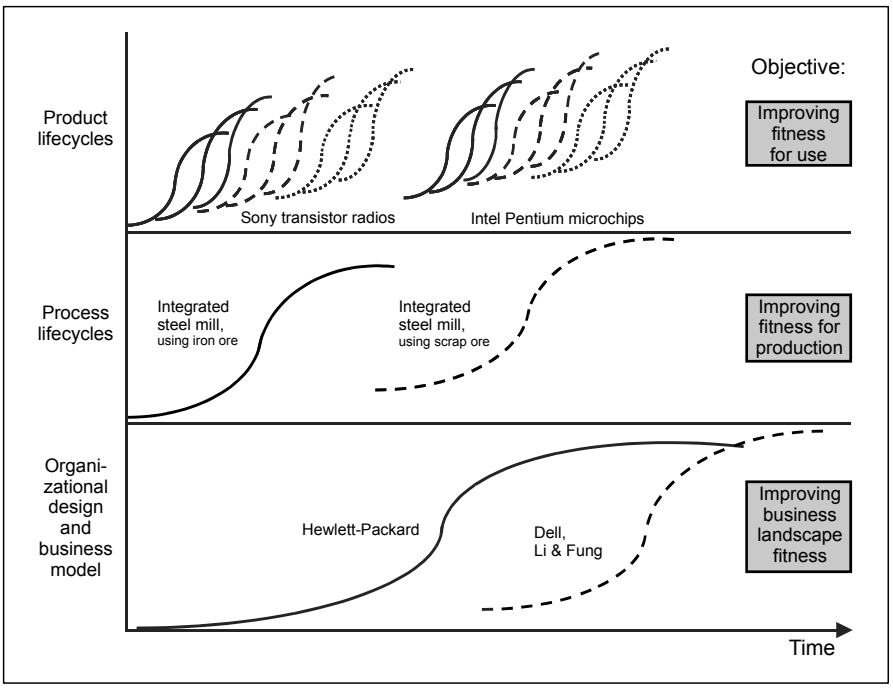

Fig. 2. Value-innovations for products, processes and organizational design (including business models)

Under conditions of rapid change, the conventional previously strong capabilities for developing and holding on to a unique competitive advantage, based on quality, productivity, or rapid response (time-based competition) for operational excellence are no longer sufficient because the key to survival and success now depends on the quality of an organization's value-innovation process (see Fig. 3). The only way to explore what will work or not as customer preferences change is a systematic way to experiment with innovations carried out in parallel with the execution of the current strategy that must provide the short-term earnings to keep a firm afloat.

Depending on how well the initiatives for experimental "actions-on-the-margin" succeed, leadership can then proceed with staged-investments for the more promising ones, while dropping those that have no impact in the new business landscape.

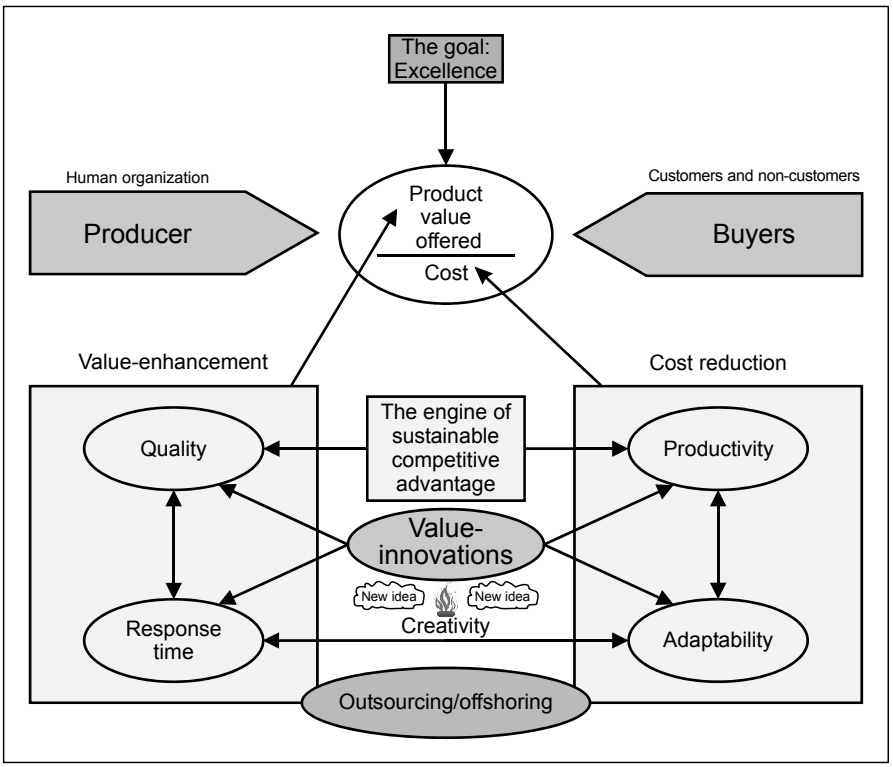

Fig. 3. The value-innovation process as the engine for developing competitive advantage

4 Analyzing the Value-Innovation Process

To address the challenges posed by rapid changes in the environment, effective organizations have understood the critical contribution made by developing a high quality value innovation process. This must be understood as an organic feature of the way an organization functions, rather than as something assigned to a group of specialists. Our understanding of the value-innovation process is best understood by examining innovation as a system described by its basic components, i.e. its desired outputs, necessary inputs, the process that converts inputs to outputs and the metrics we generally employ to evaluate its contribution (see Fig. 4).

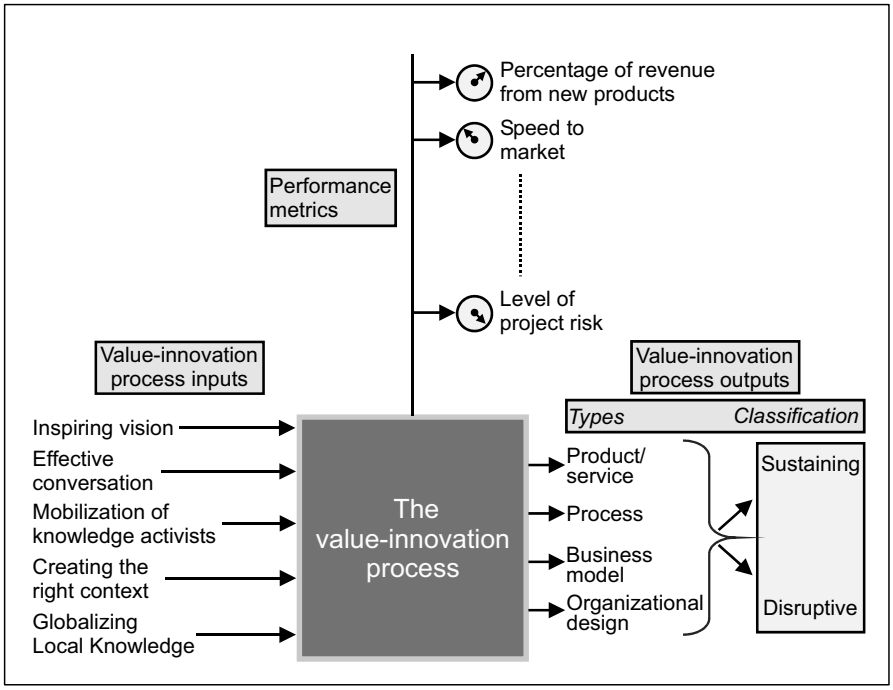

Fig. 4. The key-aspects of a value-innovations system

4.1 Desired Innovation-Process Outputs

The outputs of a value-innovation process refer to whatever specific tangible or intangible items that will enable an organization to develop a competitive advantage in order to benefit its key stakeholders and adapt to ongoing changes in its environment.

The most visible outputs refer to new products or services that offer new functionality or other attributes that enhance customer perceptions of the value they receive for the price they pay. Apple's iPod is an example of an outstanding product-related value-innovation for customers of portable music players, widely acclaimed for its ease of use, quality of sound reproduction and memory capacity. Having sold over 50 million units in a few years and contributing significantly to Apple's revenues and profits, along with raising the company's stock is indicative of how well it satisfied all key stakeholders.

Sometimes the value-innovation output of a firm may be related to an organization's production or other processes. This was the case with the development of mini-mills that made it possible to produce steel from

scrap iron and by improving with time product quality they managed to grab an enormous market share from most major integrated steel producers, such as US Steel, most of which went out of business.

In periods of rapid change one of the most important types of value-innovation for long-term impact is related to an organization's business design, i.e. its architecture and business model. A good example of this type is the business design developed by DELL for making computers to customer specifications and direct delivery using as the key customer interface initially the postal system and later the internet. Another one is that of amazon.com that changed worldwide how people select and buy books, DVDs, etc. using the web.

4.2 Necessary Value-Innovation Process Inputs

For a value-innovation process to generate the desired outputs described previously, it must have the following set of inputs as the critical enablers for new knowledge creation:

1. *Inspiring Vision:* This refers to a road map that describes (a) an organization's present circumstances, i.e. the present reality or the world its members live in now, (b) the desired future circumstances its members would want to live in and (c) their assessment of the knowledge they must seek and create to make the transition from the present to the future possible.
   Specifying parts (b) and (c) often require new language to probe new concepts and methods not available in the organization's current vocabulary. The need to develop such a vision for the future is essential not only to stimulate concerted efforts for new innovations, but also as the guiding light or "North Star" in the process of strategy formulation.
2. *Effective Conversations:* The process of developing value-innovations requires seeking or creating new knowledge. Doing so must engage an organization's members in conversations within project teams that facilitate exchanging their individual knowledge, some of which is explicit in some recorded form easily available to others, but most of which is tacit, i.e. deeply personal derived from one's own learning and experience over a long period of time.
   As seen in Fig. 5 conversations play a vital role in organizational life (1) to build personal relationships that foster trust, (2) to resolve conflicts and (3) to coordinate the activities in implementing a strategy and related action plans. However, their importance is even greater in periods of rapid change when the development of value innovations

becomes critical for survival and adaptation (Cohen and Prusak 2001).

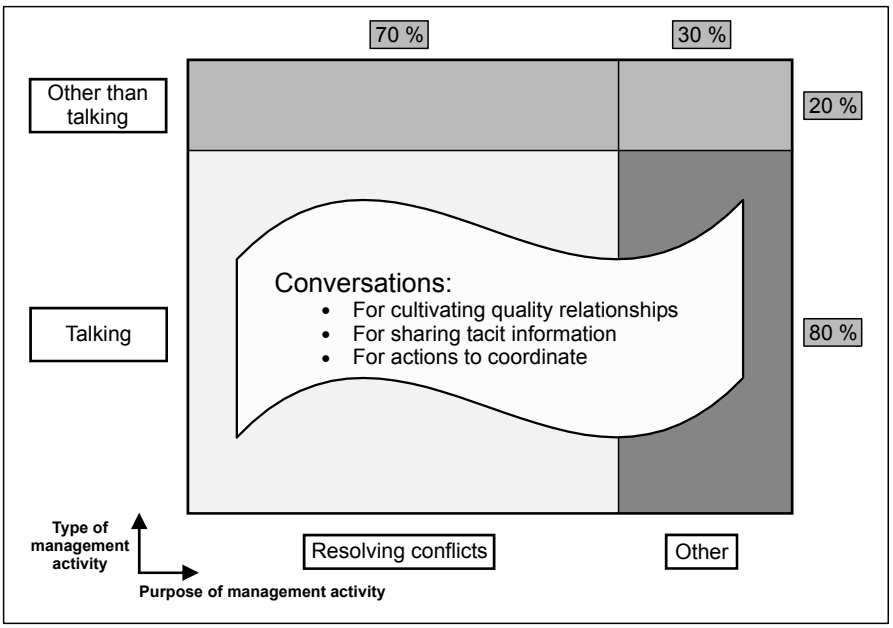

Fig. 5. How leaders and managers spend their time at work (Mintzberg 1973)

3. *Knowledge Activists:* To be successful in developing value-innovations, an organization needs to have people assigned with the role of facilitating the five essential steps in new knowledge creation, described in the next section. Knowledge activists are the knowledge evangelists and proselytizers in the system and they may reside at any level with sufficient authority to engage others in knowledge creation.
4. *Creating the Right Context:* The right context for value-innovations is the one that enables knowledge creation. Considering that unlocking tacit personal information is at the heart of enabling the development of new innovations, creating the right context involves setting up the common shared physical or virtual space that allows members of a project team to exchange their personal knowledge which is relevant to their project objectives.
5. *Globalizing Local Knowledge:* This is the task of making the knowledge developed by smaller specialized groups available to the members of the organization at large. This must be done in ways that allow knowledge to cross functional or departmental boundaries, organizational levels and thus provide all project teams within a firm

the means to develop more knowledge, pushing the envelop for the capability of future value-innovations.

5 The Process Steps for Knowledge Creation Leading to Value-Innovations

Having secured the necessary inputs for enabling value-innovation, the process requires completing the following set of steps presented in Fig. 6 (Krogh et al. 2000).

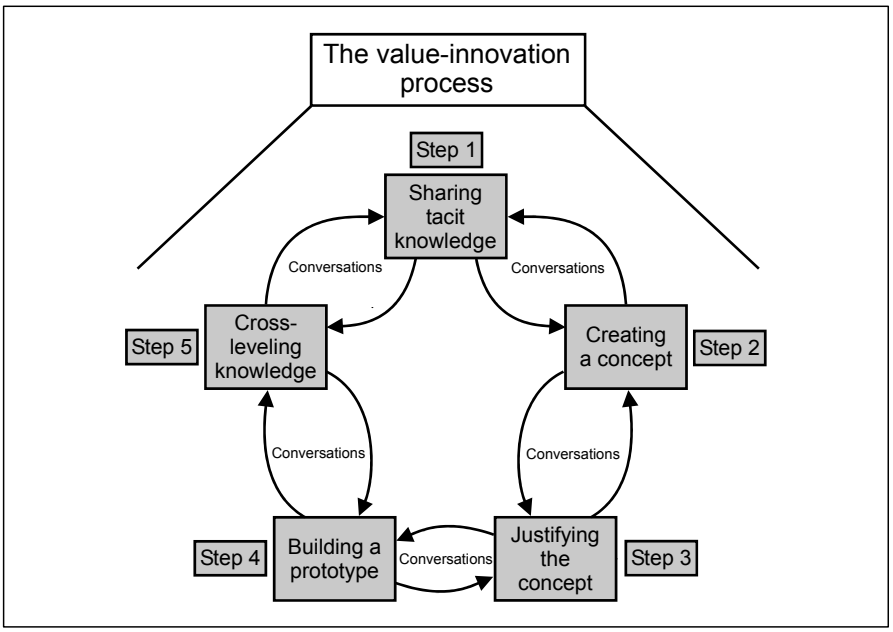

Fig. 6. The process steps for knowledge creation leading to value-innovations (adapted from Krogh et al. 2000, p. 9)

5.1 Step 1: Sharing Tacit Knowledge

Recognizing that knowledge is more than data placed in context or a set of tools, but something that has meaning to each one of us as a human being implies that knowledge encompasses our beliefs as individuals or groups and is intimately related to action. As stated elsewhere, a carpenter's

knowledge is more than a toolbox, but the capability from personal learning and experience to use it properly for the task at hand.

To enable all parts of an organization to engage effectively in developing value-innovations the most crucial step is making it possible for individuals in the project teams set up for this purpose to share their tacit knowledge with others. Unlike explicit knowledge in forms that can be easily stored or communicated as documents, drawings, video files, etc. tacit knowledge is deeply personal reflecting an individual's cumulative personal study, and learning, closely tied to one's senses, bodily movements and experiences.

Sharing tacit knowledge of complex tasks and concepts is the most critical component in stimulating creativity to develop new ideas that lead to value-innovations. It can be accomplished through the socialization of the members of a team which forms a "microcommunity" of knowledge (Wenger et al. 2002). It can be shared through direct observation, observation and narration, imitation, experimentation and comparison and joint execution (Krogh et al. 2000). It is like being asked to teach someone how to ride a bicycle. It requires physical proximity and time, a high degree of interdependence among a team's members and an enabling environment that cultivates shared values and trust. The lack of such conditions that create an "enabling organization" has been perhaps the main reason that most firms cannot assume a leadership role in their industry, as imitation is much easier than genuine value-innovation.

5.2 Step 2: Creating a New Concept

Developing a value-innovation requires the previous development of a new concept in response to an existing or emerging new human need. The process of concept creation is the response to such a need by an individual or a team whose members have appropriate tacit knowledge and expertise. Through their constructive interaction these members manage to externalize their shared experiences, shared practices and knowledge to express a new concept from existing ideas that promises to address the need identified in earlier stages. Examples of such concept formation include the one related to the innovations for the iPod, or that for Sony's Walkman, whose president Akio Morita wanted while traveling by plane to listen to his favorite music without disturbing fellow passengers near him.

The success of the highly creative concept formation phase depends heavily on the skills already developed within a firm for using figurative language, relying on metaphors and analogies to describe something that does not yet exist.

5.3 Step 3: Justifying the New Concept

Once a new concept has been expressed, it must be evaluated by all those that will be affected by its realization. This evaluation step needed to justify the new concept initially begins by those in the organization that will assume the responsibility to make it happen, using both qualitative and quantitative criteria to assess its future appeal, by asking whether it addresses effectively the stated needs that triggered its articulation. The criteria invoked relate to the new concept's fit with an organization's values, vision and strategy and the extent to which it addresses the needs of stakeholders, i.e. customers, employees, suppliers and shareholders. It is preferable to avoid evaluating a new concept on the basis of its contribution to the firm's current strategy, as this might lead to its early dismissal for lack of fit to the existing competitive landscape, even though it might open up new opportunities and enable the firm to assume a leading role in a new competitive arena.

A new concept representing new knowledge, which is always a social construction tied intimately to people's emotions and experiences, must be also evaluated and justified to account for such emotions and experiences of those affected by it. In general, *the justification of a new concept always requires rich and diverse language skills to support the opinions expressed for or against*. In this sense, it is helpful to visualize and express as clearly as possible in what ways the market or society will change as a result of introducing a new concept. Quite a few important innovations are developed for use in one area and later on thrive when applied to a different field. The invention of the microprocessor was initially intended for use with complex machine-tools, before realizing its potential for computers and other products.

5.4 Step 4: Building a Prototype

Once a new concept has been justified, the team proceeds with the construction of a prototype which is the physical embodiment of the new knowledge it represents. A prototype can assume various forms, from simple drawings or clay models to more sophisticated CAD-CAM representations that enable desirable changes on its initial proposed features. This not only allows for its visualization by all concerned but it also creates quick feedback loops among the departments and employees that will be called upon to make it available for commercial use. Furthermore, building and improving the prototype for a new concept helps point out possible design flaws that should be removed before proceeding to large scale production.

The availability of new technologies that enable fast e-mail exchanges, videoconferencing and online feedback, say from test-groups of potentially future customers, as Toyota did with Lexus in the 1990's, make it possible to test and refine sufficiently proposed prototypes, so as to minimize undesirable design flaws or concept limitations by returning to previous design phases.

5.5 Step 5: Cross-leveling the New Knowledge

As new knowledge is developed and embodied in a prototype and the finalized product specifications for a new concept, it is important to make it available and useful to other parts of the organization. This process of cross-leveling the acquired new knowledge is the engine of developing *organizational capital* that will enable a firm to develop and maintain a sustainable competitive advantage. It is this kind of knowledge which represents a firm's collective intelligence which cannot be imitated by its competitors.

To build and grow a firm's organizational capital, management must ensure that:

1. The time between creating such knowledge and making it available to other parts of the organization is shortened as much as possible
2. The new knowledge created is properly documented and saved
3. The members of the organization are encouraged to apply the new knowledge to other activities and initiatives leading to value-innovations

An essential requirement for all the above is the existence and continual updating of appropriate data banks that can be easily accessed by all members engaged in the value-innovation process.

6 Assessment of Proposed Value-Innovations for the Exploration of Emerging Opportunities with Staged Investments

For organizations operating in environments with rapid change the need to explore emerging new opportunities and threats with experiments that involve *"actions-on-the-margin"*, concurrently with its presently ongoing activities, requires a structured process of staged investments. Leadership's objective in this situation is to assign priorities to selected initiatives for new products or processes, based on the expected level of risk and the

amount of investment required to proceed in successive stages of development. The matrix in Figure 7 can be used to position each proposal on the basis of (1) the expected reward from its full implementation, which can be immediate, medium- (2–3 years), or long-term (more than 3 years) and (2) the risk level of the project based on an assessment of the degree of familiarity or uncertainty of the undertaking.

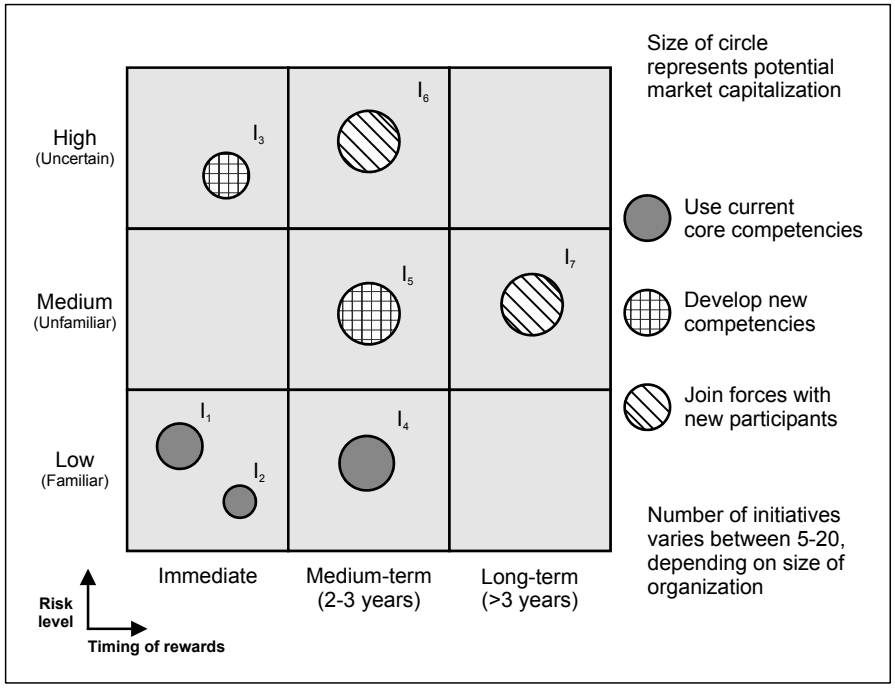

Fig. 7. Assessment of initiatives for the exploration of emerging opportunities (adapted from Bryan 2002, p. 25)

A new project has a low risk of failure when the existing distinctive knowledge residing in the organization is superior to that of competitors. In this case management must make the needed investments in the ongoing or new initiatives. A project's risk level is medium when competitors possess distinctive knowledge superior to our own, in which case the proper action is to initiate a small- to medium-size investment to gain sufficient familiarity. The risk level is considered high when the probability of success is difficult to estimate and the proper action for management is to make only a small investment to develop enough familiarity for further evaluation later on.

7 Key Metrics to Assess the Quality of the Value-Innovation Process

Like any other process expected to contribute to an organization's strategic goals, in periods of rapid change the vital process of developing value-innovations must be periodically assessed with an appropriate set of criteria. Among the most widely used criteria we have:

1. The speed to market in introducing a new product or service
2. The percentage of revenue from new products
3. The level of project risk
4. The project milestone progress
5. The project kill rate
6. Others

Depending on the environmental context, the above are weighted according to their expected contribution to competitive advantage. Sustaining innovations which involve small improvements can be introduced at a faster rate, especially for high-tech consumers goods, such as laptops, digital cameras, etc. because they do not require big changes in the current business model. However, disruptive innovations like the PC or the cell phone which create new markets, or the mini-mills for existing markets, require longer periods to take hold and be accepted as viable more attractive options.

At one extreme we have innovations based on over-design introduced to offer only greater value to "under-served" customers. However, these customers represent only a small segment of the total market which can accommodate very few competitors. In terms of the potential for large sustainable revenue stream, the prospects are limited and the risks of a new competitor overtaking them, especially in high-tech industries are considerable. At the other extreme of seeking to develop innovations mainly for the reduction of product cost, there is the risk of placing the product in a different quality segment of the market by stripping away features that change customer perceptions of the value offered.

The impact of a significant value-innovation can be portrayed in a *"strategy canvass"* which highlights the differences between business models for low-cost producers (LC's) and differentiators (DF's) that create distinctive customer-value perceptions (Kim and Mauborne 2005). A strategy-canvass representation can show the comparisons of a proposed value-innovation on key performance attributes versus those of the low-cost and high-price differentiator strategies of the main competitors (see Fig. 8).

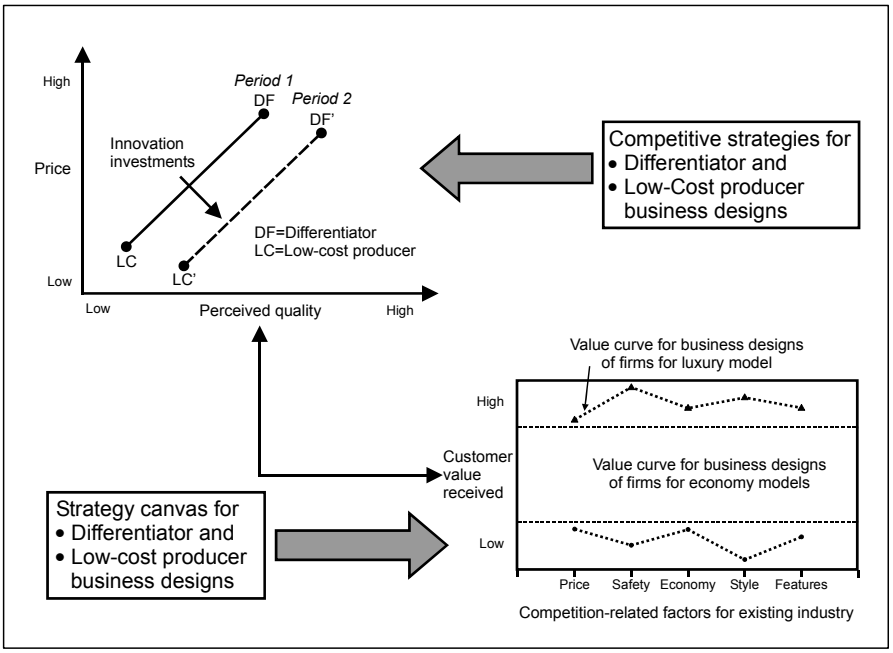

Fig. 8. Connecting strategy with value-generating capacity of business design (adapted from Kim and Mauborne 2005, p. 38)

8 Leadership Aiming for a Balance Between Short- and Long-term Goals

In the industrial era operational excellence as a strategic goal reigned supreme. It was in this period that most performance improvement approaches, such as TQM, reengineering and others were introduced, refined and adopted by organizations worldwide. However, in today's environment of rapid change leadership must continually try to balance the need for (1) operational excellence (the conventional component) that enables effective strategy execution to ensure short-term earnings with (2) excellence in adaptation (adaptive component) to new conditions that ensure an organization's survival and success.

In engaging leadership's conventional component, when the environment is stable and reasonably predictable, the focus is mainly on line-management activities to meet short-term earnings expectations. This includes mainly *transformational* and *transactional* activities for processing materials and routine information**.** The dominant issue in this case is *cost*

minimization and is addressed by increasing the efficiencies of scale, scope and skills, as in organizations of the traditional economy. Standardization, uniform procedures, substitution of humans by machines, and outsourcing (or offshoring) can be used to minimize costs. The most important requirement for effective strategy execution is the need for *variation in infrastructure processes to be minimized.* A basic principle in TQM is that no process can be improved unless it operates in a stable condition (Deming 1986).

When the environment is changing rapidly and demand and customer preferences are not predictable, engaging the leadership adaptive component shifts the focus to creative professionals, rather than line management personnel, for the development of value-innovations that are likely to lead to long-term creation of wealth. Under these conditions distinctive knowledge becomes the new competitive weapon and *tacit human interaction activities* which ensure the effective exchange of tacit knowledge take priority over transformational and transactional activities. The latter can now be more easily outsourced globally to reduce the cost of new products and services. In this manner the organization gradually becomes a part of the larger interdependent and often global in scope "network economy".

The key objectives in periods of rapid change become the survival and success of the organization through effective adaptation. This is achieved by optimizing rather than minimizing the variation in all processes in order to exploit diversity in developing value-innovations. One of the most powerful sources of innovation has been the study of an unexpected process result (Drucker 1985). By improving the quality and quantity of tacit human interactions, which determine the sharing of common values and vision in a climate of high trust, it becomes easier for members of work teams to exchange their valuable tacit knowledge in projects set up to develop value-adding innovations (Dervitsiotis 2006). Rather than emphasizing profitability the key criterion of performance in periods of rapid change is the achievement of landscape fitness which provides the flexibility to adapt as needed to emerging conditions.

The complementarity of the conventional and the adaptive components in the way an organization and its leadership seek to achieve key objectives resembles that of the "Yang" and the "Yin" in the Tao philosophy.

9 Conclusions

As the pace of change in today's environment accelerates, operational excellence in executing well a firm's current strategy is necessary but no

longer sufficient for survival and success. The speedy introduction by competitors of new innovations for better products and services continually transforms the competitive landscape. The only way to develop a sustainable competitive advantage depends on the capability of an organization's to explore new opportunities by developing a high quality value-innovation process. In this way a firm can satisfy changing customer preferences that demand products and services that offer more value for less cost. The advances in technology have made it possible for small and large competitors to enter established markets in a global economy. As a result, the introduction of both sustaining and disruptive innovations assisted internally by the use of advanced software for seeking and exchanging new knowledge and with the internet for the conduct of e-commerce, has forced many previously successful large organizations to lose their market share and yield their leading positions to smaller, faster and more innovative competitors.

Value-innovations as a source of competitive advantage are not restricted to the visible forms we see in new products and services, but extend to the multiple processes of global value networks and to new organizational designs that make an organization more flexible and robust in the face of rapid change. For such conditions, a sustainable competitive advantage is achievable primarily through an organization's capability to innovate effectively and efficiently developing new knowledge and the skills required to do so on a continual basis.

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Sustainable Improvement: Six Sigma – Lessons Learned after Five Years of Training and Consulting

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A fundamental element for the sustainable long-term success of any organization is an effective improvement program. Six sigma is a powerful improvement methodology that, if correctly implemented, can be an important component of a management system aimed at sustainability. However, a successful implementation of six sigma is not an easy task, in this paper we share our experience after five years of extensive six sigma training and consulting in Spain and South America. We are responsible for a Black Belt open enrollment training and deployment course offered by the Technical University of Catalonia (UPC) in Barcelona, San Sebastian and Santiago de Chile. In addition to presenting some of the lessons learned throughout this experience, we comment on two aspects of the use of the methodology that we believe may affect the future of six sigma: the extent to which statistics must be included in a Black Belt training course and the amount of guidance that needs to be built into both the tools to be used and the DMAIC (define, measure, analyze, improve, control) methodology, in order to obtain the maximum possible benefit with the least possible effort from the six sigma process. We finish with some conclusions.

1 Sustainable Improvement

According to Juran's well known definition, improvement is a systematic and organized activity aimed to correct all types of deficiencies created in our processes, products and services because we have not been capable to plan them perfectly (Juran 1989). It is then clear that sustainable success of

an organization depends heavily on the rate of improvement that it is able to maintain. This has been widely recognized and in consequence improvement has been an important part of all holistic approaches to management.

Since the 1970s, many different improvement methodologies have been used, and all of them share Juran's old idea that improvement takes place project by project and in no other way. To carry out improvement projects three elements are needed: an organization able to identify projects, assign them to teams and support them throughout the process; a method (roadmap) to be followed by teams – it has always been some adaptation of the scientific method, frequently called PDCA (plan, do, check, act) – and a toolbox – sometimes bigger, sometimes smaller but that at a minimum including the so called "seven tools" (as known from KAIZEN) – to be used along the process.

The results of this variety of somewhat similar improvement methodologies have been diverse. A compendium of lessons learned, good practices and new elements has been evolving into the six sigma business improvement strategy (a good reference for six sigma is Pande et al. 2000). It was introduced by Motorola in the 1980s and adopted (and adapted) very successfully by General Electric and other large corporations in the 1990s. Since then it has gained great popularity.

At the organizational level, six sigma advocates for establishing a group of top executives and upper managers in charge of improvement. Their responsibility is to launch, coordinate and institutionalize improvement goals and plans. They are in charge of: establishing a project nomination and selection process, establishing a team selection process, providing resources – including training –, assuring implementation, establishing a progress review process and assigning a sponsor (usually called champion) and a Black Belt (BB) to each project. The champion is an upper manager responsible to follow closely the project assuring its success, and the BB is a person in charge of leading and facilitating the team that has been especially trained in the six sigma improvement process and the extensive six sigma toolkit (Hoerl 2001; Pande et al. 2000). Six sigma theory advocates for BBs being full time dedicated to the program, however in most companies it is a part time job. People with a shorter training are called Green Belts (GB), they may be team members of projects led by a BB, or leading simpler projects following the same process.

At the improvement process level six sigma is well known for the acronym DMAIC that stands for "define, measure, analyze, improve and control". The aim of the define phase is to review that the chosen project is important and define the objective in view of the voice of the customer and the impact on the business. The measure phase includes the tracking of key

process output variables quantifying the process capability of these variables, gaining insight into the process behavior and assuring the effectiveness of measurement systems. The analyze phase's objective is to establish clear and scientific relationships between the process controllable variables (Xs) and the process critical outputs (Ys). The improvement phase's aim is to develop a remedy – in view of all things learned about the process at hand during the measure and analyze phases – and verify its effectiveness. Finally the control phase is aimed at institutionalizing controls to hold the gains and making a balance of the project.

The BB's toolbox has a lot of tools, many of them statistical. One of the characteristics of six sigma is that it includes a lot of guidance on which tools to use at each phase. It will be argued in this article that in general the toolbox contains too many and too sophisticated tools and that in some programs guidance has been converted into a closed prescription.

The key focus of all six sigma programs is to optimize overall business results and thus, in some instances six sigma has been seen as a substitute from the holistic approach to management represented first by TQM and later by the excellence models (Bisgaard and De Mast 2006). In our view six sigma is not more and not less than a very powerful improvement methodology that has inherited a lot of good practices – especially the ones related to the management and organizational aspects needed to make it work – from its predecessors. Thus, six sigma cannot be seen as a substitute for the much needed holistic approach to management (Zink 2007) – not only because it is too much related with a narrow understanding of "quality" (Zink 1997).

2 UPC's[1] Open Enrollment Course

In the late 90s we were giving talks, making presentations and writing articles in Spanish industrial magazines about six sigma, while managers looked at six sigma with reservation and a half smile asking: "Are you seriously telling us that these Americans are playing karate belt games and getting results? This will never work here." Meanwhile some companies, GE Spanish divisions, Alstom Transport and Sony among them, had seriously started implementing six sigma. Even though overall figures have not been publicized, they assured that they have attained excellent bottom line results.

[1] UPC: Technical University of Catalonia

In July 2000, Sony, who was using our Industrial Statistics book to train their BBs, invited us to give a talk at a BB recognition session. Many of their local suppliers, in general small companies, were present and they asked us to start an open enrollment BB training course. Sony was using an American consultant; however, their suppliers could not afford this! This was the start of our open enrollment BB course (already ten editions with almost 200 attendees, delivered in two Spanish cities and in Chile).

2.1 Starting Points

The following starting points were identified as the main characteristics of the UPC six sigma course:

- Rigorous training but with a somewhat lower statistical content than the "standard Black Belt" courses in the US
- Projects, preserving confidentiality when required, form an integral part of the course; these are not, however, compulsory, although only those presenting a successful project will be UPC Certified Black Belts
- Mixing people of various backgrounds and interests
- A certain emphasis on SMEs, since this is a Spanish market need. In this respect, Snee's and Parikh's presentations at the ASQ (American Society for Quality) Six Sigma Conference were both inspiring and reassuring for us (Snee and Parikh 2001)
- To train BBs to meet the organizational challenges of six sigma implementation by themselves (they will often have nobody else in the company supporting them), while providing the skills necessary in order to lead a DMAIC project
- Presentations and experiences from experienced BBs from different companies
- One session for top managers of the companies sending BB candidates.

This last point was discontinued after the third edition of the course. The idea to give sessions for top managers seemed to be very good "a priori" but reality was that attendance was scarce; they always had last minute important issues which prevented them to attend. Only two, respectively one top manager showed up in the three editions in which this activity was included. Feedback was in all five cases very good.

2.2 The Elements of the Program

We have tried different (though relatively similar) schemes and sort of stabilized on a total of 120 hours divided into ten twelve-hour sessions (Friday and Saturday morning) over four or five months. The idea is to seek a compromise between working time and free time dedicated to the training, so that the program is attractive to both management and employees. The four/five month period (usually from February/March to June/July) is, of course, to allow time to develop the improvement project that is presented at a special session in late September.

The reduction in classroom hours with respect to what may be considered a "standard BB training course" (Hahn et al. 2001 and Hoerl 2001) is accomplished both by a reduction in content and by some extra homework. The topics omitted are: designs at more than two levels, response surface methodology and advanced analysis of variance. Other topics are slightly shortened. From the very beginning we incorporated two topics: four hours on how six sigma should be implemented (roles and tasks, possible pitfalls, what to do at the beginning, how to select projects, etc.) and some attention to lean concepts and tools, mainly the emphasis on streamlining processes[2].

2.3 Attendance

The average attendance of the course was between 15 and 20 people coming from a variety of sectors (Fig. 1), almost 70 % from SMEs, and of course with very different backgrounds.

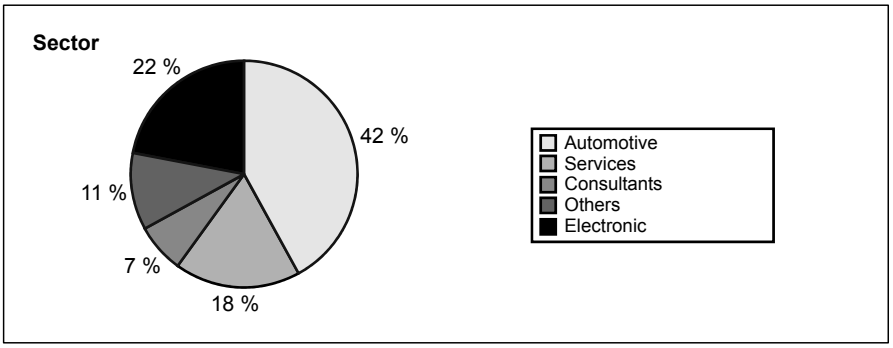

Fig. 1. Students per sector attending our six sigma courses

[2] Detailed information about content and structure can be found at http://www.upcq.net (in Spanish)

This mixture, which in many ways is beneficial and enriching to all participants (given the high degree of business cross-fertilization), also causes some problems, mainly related to different background levels, various positions and responsibilities in their companies and different degrees of top management involvement.

3 Lessons Learned from Black Belt Training in Open Enrollment Courses

The fact of mixing people from different companies, situations and interests must be taken into account in deciding how to effectively "produce" people able to act as a BB. The following are the main points we have learned in this respect.

3.1 Guides and Guidance

On many occasions the person attending the course is going to be the six sigma "expert" at his company. She or he will therefore be confronted with all future questions without further assistance, and this causes in many occasions some degree of insecurity.

The six sigma training process is a unique opportunity to teach useful techniques to interested people who will have the immediate opportunity to try them out in their jobs. In this sense, they are looking for clear guidance on the steps to be followed. They would like to have a very clear list of "what" to use (which tools) and a very detailed step-by-step procedure describing how to use them at each stage of the DMAIC sequence. In addition they would like to have "perfectly" defined frontiers between the steps.

Satisfying this need is crucial, more than we originally thought. We therefore recommend:

- Clearly establishing the steps of the methodology by giving clear definitions, frontiers, and "this step is finalized when…" lists
- Giving clear instructions on statistical tools; in other words: when to use them, how to use them, the software to be used and how to interpret the output
- In this context it is of course a very good practice – and one that we followed with insufficient emphasis in the first edition of the course – to name and define the content of the course after each of the five steps of the methodology, and set the completion of this step in a real project as

homework; in our courses, the students' projects tend to take longer than the course, probably because many of them are not "full time" Black Belts

The problem is that guidance – if excessive, as it is often the case in BB courses – can convert the methodology into a closed prescription and an oversimplification of real world problems. The line between roadmaps, guides and step-by-step procedures and closed prescriptions is thin. We have seen BB candidates trained by famous US consultants desperately applying tools that they know are not appropriate for the project at hand, but that were needed to qualify for the BB certification. When roadmaps contemplate a unique, must-follow road they can not only lead to an inefficient use of resources, and reduce the scope for ingenuity, but they can also undermine the credibility of the program.

The real aim of this unique training opportunity – in terms of time, effort and resources devoted – should be to provide a framework and a methodology to encourage human ingenuity and increase the capacity to learn and improve.

Of course, the solution is to give clear concepts (make sure that people understand the whys behind the method and the tools) and give as many examples as possible. In addition it is important to offer plenty of exercises for the participants to feel comfortable with the process and see that it works in practice by achieving good and motivating results. In this respect, class exercises such as catapults[3] and helicopters[4] are fundamental for teaching the statistical tools and concepts (an excellent example of this can be found in the paper of Box and Liu 1999), and also partly for practicing the steps of the DMAIC methodology. Interiorizing and gaining confidence with these steps, together with the skills for conducting and facilitating working groups is, in our opinion, so important that we have developed a specific game for this purpose.

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[3] It is an "almost standard" in six sigma courses to have teams improving a process of throwing balls with a catapult, where the ball distance is the critical output (Y in six sigma language). This exercise allows to practice several concepts (data driven decisions, variability, clear responsibilities etc.) and tools (obtaining a reliable measurement system, brainstorming, cause and effect as well as statistical tools including design of experiments and process control).

[4] The idea of this exercise is similar to the "catapult", but is realized by constructing paper helicopters. The critical process output is the time the helicopter takes for falling from a given height. The article of Box and Liu (see references) includes a drawing of the helicopter and a description of the methods and tools which are used to improve it.

Therefore, the exercises should be simple, challenging and tailored to the steps described in the theory, while leaving room for the participants' ingenuity. In some of the exercises we used in the first courses we were guilty of providing both a lack and an excess of guidance; even today we are not sure of having found the right balance. Obviously this is not easy, and the thin line that divides "required guidance" from "closed prescription" is different not only in different cultures but also regarding different people. When buying a new appliance some will carefully read and follow the instructions, while others will just try and make it work out of the box.

3.2 Linking Theory and Practice – Beyond Exercises and Games

It is also relevant to stress the importance for both, the learning process and the involvement of top management, of developing a project of value to the company the participant is working for (Bisgaard 1999; Snee 2001). In our courses not all companies sending candidates are launching a serious six sigma program. Some are just considering the possibility and gaining knowledge in order to make a better and more informed decision, while others are running some type of pilot scheme. Knowing the situation, we tried to gain a better support from the management of our BB candidates by dedicating a special free session to them, as mentioned above we stopped the practice for lack of top management attendance even though we still think that this is a useful idea. This was a four hour session, dedicated to explain the basic aspects of six sigma organization and the aims and roles of top management. We enjoyed the help of the general manager of GE Capital Bank[5] Spanish division.

In our course, which is made up of both people from companies starting to implement six sigma and people interested in learning about it for mainly personal reasons, it was difficult to establish a project follow-up system that took into account the added value of sharing experiences and the need for individual counselling. We tried to provide support to all those who needed it in order to continue their projects, without boring those not developing a project and without taking too much time out of the regular course hours.

We dedicated time to follow up project-homework on an individual basis. There are several reasons for this: some aspects of the projects may be secret and participants would prefer not to discuss them in public; other times it may be difficult for them to recognize in public that their project is

[5] The division changed its name and is now called GE Financial Services.

not going very well or that they have made mistakes. This type of personal support, that is a time consuming activity, is much appreciated by our students. A warning here is that the line between giving BB candidates advise for their project and acting as a consultant is also thin, and some people are extremely skillful at making you cross it!

The inclusion of a few sessions (two hours, one hour presentation and one hour discussion, in which participants were able to talk face-to-face with an experienced BB working in a large company) with BBs from GE, Samsung, Alstom, Sony or Ford was much appreciated and a good complement to the learning process. Many of the questions addressed to them were related to the every day life of a BB, his role, his relationships with other people and so on.

3.3 Assessment, Exams and Accreditation

Should exams be held, and if so, at what level of difficulty? As we know that in Spain managers dislike being examined, especially in front of their peers, we decided against holding exams. However, we think that some way to check that the BB candidate has understood and learned at a reasonably simple and conceptual level is needed. Preferable alternatives, like a close personal follow up, to test type examinations certainly exist. Furthermore, a serious review of the project, and the role of the candidate within it, was the final check to accredit the candidate as a BB.

We have discussed this topic with several people running six sigma trainings in Europe, and this approach seems to be becoming a normal practice here, see Sörqvist (2001) for details of the approach in Sweden.

4 In Company Black Belt Training and Coaching

As said before we have collaborated with several companies in their six sigma implementation efforts. We would refer briefly here to two of them: BBVA – a large Spanish bank with almost 90,000 employees and branches all over the world (especially in Latin America) – and Alstom Transporte. BBVA was selected because we worked very close with their managers to design and implement the program. And, Alstom Transporte because during our coaching – in close collaboration with their Quality Manager – we carefully gathered data to conduct a study on the profitability of their program.

4.1 Case Study of BBVA

4.1.1 Brief Summary of Starting Point and Activities

In May 2004, when the six sigma program started, BBVA was already leader in efficiency (costs/income) in the Euro zone. So the starting point was very positive, not only regarding results but also culture and knowledge as well as the use of some tools and methods. In addition the president of the bank had the vision of becoming "the Toyota of the banks". To accomplish this he decided to center the efforts in two areas: innovation and productivity. And this last one, centered in process management and improvement. The first step was the creation of a corporate "productivity improvement office". We worked very close with them to design and deploy the program. A more detailed explanation of the activities developed can be found at Tort-Martorell et al. (2005).

We can summarize the departure requirements and conditions as:

- Involvement of all departments
- Support infrastructure (productivity office)
- Adaptation of the methodology and tools
- Training designed especially for them
- External support at the beginning (UPC chosen partner)
- No paraphernalia (internal and external noise)
- Link with processes
- Lean elements

It was part of the deal that in spite of the existing support, the initiative had to compete with other initiatives and show its value, otherwise it will die. Therefore, a big problem was to convince the division managers (second layer of top management) of the value of the program, and for that purpose we only had four hours of their time! This has been one of the problems because now some BBs or BB candidates still lack the support of their division managers who, even after having seen many successful projects, remain reluctant.

The training, done in eleven days (88 hours, so it can be argued that they are sort of Brown Belts, in between Green and Black Belts), covers methodological aspects and tools, both statistical with Minitab[6] and process ori-

[6] Minitab is a statistical software that has become almost a standard in six sigma programs. It is a registered trademark.

ented with iGrafx[7]. It emphasizes the concepts and the use of the tools and is delivered through many examples, games and practical team work. An outline of the content for each month can be found in the Appendix. Figure 2 reflects the way the training was delivered. After 88 hours of training, participants were delivered a GB and if in addition they developed a successful project presented to a jury composed by one UPC professor and several BBVA managers, they got the BB certificate.

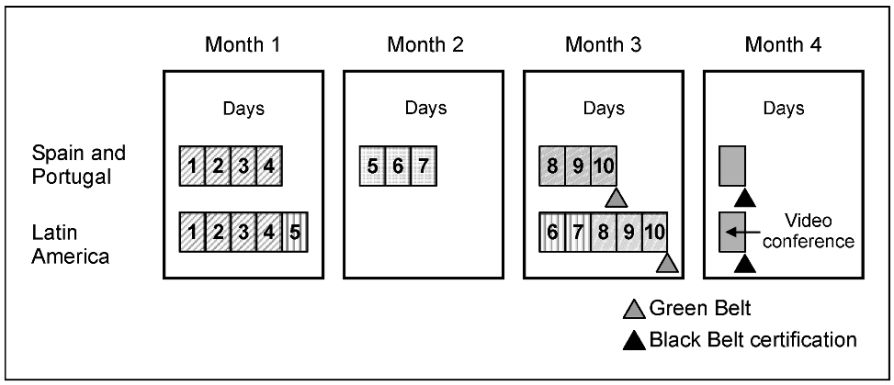

Fig. 2. Details of the BB training schedule at BBVA

In total 237 people have been trained and so far 182 BBs have been certified (this includes of course a successful project). The average saving per project is around €160,000. The type and size of projects vary a lot, Fig. 3 shows that the majority of them were in general aimed at business processes which focus on time (both average and variability) and cost reduction.

An analysis of the tools used in the projects gives some interesting information:

- All projects have benefited from the DMAIC (DMAS[8] in BBVA case) approach, although almost 40 % of them could have done a better job in following the DMAIC framework.
- Almost all projects have benefited from the use of data.
- Only 15 % of the projects have used tools beyond the seven basic tools[9]. Very few would have benefited from the use of more sophisticated tools

[7] iGrafx is a process simulation software used in many six sigma programs. It is a registered trademark.

[8] DMAIC was changed to DMAS that stands for define, measure, analyze and "superar" (Spanish for "get and maintain a superior performance").

[9] These basic tools comply with the seven tools of KAIZEN.

than the ones used. Therefore, training should concentrate on collecting and using good data (not much need for statistical inference).
- Almost all projects have flowcharted the process, but very few have used lean tools to reduce time or analyze non-value adding activities. Only four have used the simulation capabilities of iGrafx.

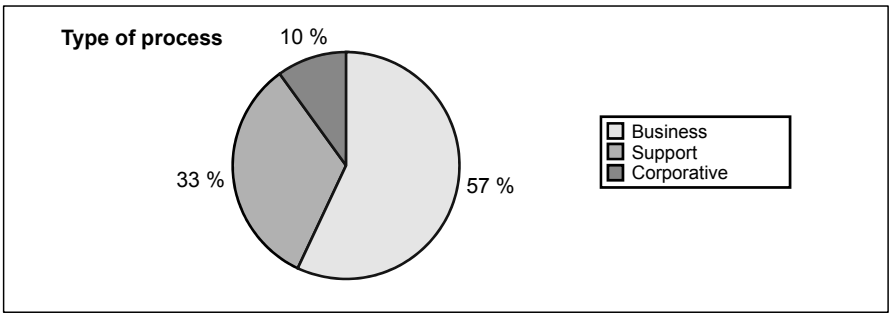

Fig. 3. Processes impacted by six sigma projects

4.1.2 Lessons Learned

Organization Lessons

- The immediate superior of the BB has a very important role (providing time and support);
- Importance of the sponsor linked to the implantation of process management;
- Importance of project and BB selection;
- Need to have more levels (Yellow and Green Belts);

Methodology Lessons

- Strong tendency to join the measure and analyze phases;
- Many improvements need software developments and this takes time;
- It is very important to stress the need to establish a follow up (control) system of the Ys;
- It is very useful to classify the projects in three types (something that we agreed with the productivity office): “just do it”, “problem” and “opportunity”;

Training Lessons

- Finding the existing data (lots of data bases are not always easy to access) or collecting new data is difficult and time consuming and training must include information about company data bases and ways to access and get information from them.
- It is very useful to have lots of games (catapults[10], cards[11], team competitions, etc.).
- It is very useful to have a simulated project (to practice methodology and tools) to be worked by teams at the end of the training.
- In final project presentations a lot of candidates put more emphasis on showing that they have followed the methodology and used some tools than in showing good results (this is more so outside Spain). Training should stress the importance of learning the method but not too much!
- Many project presentations are closely "inspired" by the examples seen during the training. Developing a good data base of real projects, if possible with some comments from the didactical standpoint, is a good idea.

4.2 Case Study of ALSTOM Transporte

4.2.1 Brief Summary of Activities and Findings

Much has been said about the profitability of six sigma projects, usually without hard data to back up the conclusions. Here we present a brief summary of a study conducted at Alstom Transporte, a company dedicated to build train carriages. This implies short production runs, few repeat orders (almost always new designs) and a low degree of automation. The company employs around 1000 people and has annual sales of 220 million euro.

The study, carried during two years (2004 and 2005) included also a comparison between six sigma projects (important and difficult problems, concrete objectives, four to six months, led by a BB) and Kaizen projects (smaller projects, revision of a process, look for opportunities, four to six

[10] See explanation in Chap. 3.

[11] Card games are used to practice lean concepts, value and non-value adding activities, streamlining process flows etc. The cards are thrown from a given height and are supposed to fall on a piece of paper. All cards falling completely on the paper are "ok", the others are handled as defects. The game is implemented in several steps and uses red and blue cards.

days, facilitators). Here we will only comment on six sigma projects, more information on the study can be found at Robert and Tort-Martorell (2006). The improvement program that included both types of projects was coordinated by a small organizational unit (Improvement Office), the problems and processes were chosen by top management and especial attention was given to training and the role of Black Belts. All costs and benefits were validated by the financial department.

The costs included:

- The man-hours of the people working in the Improvement Office attributable to six sigma
- Improvement Office's training costs
- Investments required to implement improvements
- Man-hours spent by the team members
- Other costs attributable to the teams: organizing meetings, meals, travel, etc.
- Costs of external advisers
- Costs of training the team members

The benefits were calculated as:

- Difference between the starting situation and the ending situation, valued in money
- Total impact of the action until production project completion
- If the improvement affects general processes: savings obtained in the two years following implementation of the improvements

The financial results after twelve six sigma projects are summarized in Table 1. Of course there was quite a lot of variability between the projects, savings ranged from €15,400 to €384,600. Costs showed a smaller variability surely because their main component is team time that we show in Fig. 4.

Table 1. Financial results of twelve six sigma projects

Cost of teams	€461,700
Gross savings	€1,935,800
CBR (Cost-Benefit Ratio)	4.17
IRR (Internal Rate of Return)	184 %

4.2.2 Lessons Learned

- Six sigma projects achieved a high rate of return.

- The main difficulty was to measure the savings.
- The profitability of six sigma projects will depend very much on the nature of the company's business. In particular the length of production runs is a parameter that greatly influences profitability.
- Although the savings were validated by the finance department, a significant number of people still refuse to accept these results.
- There is a conviction that without Black Belts and facilitators the results would have been significantly worse.

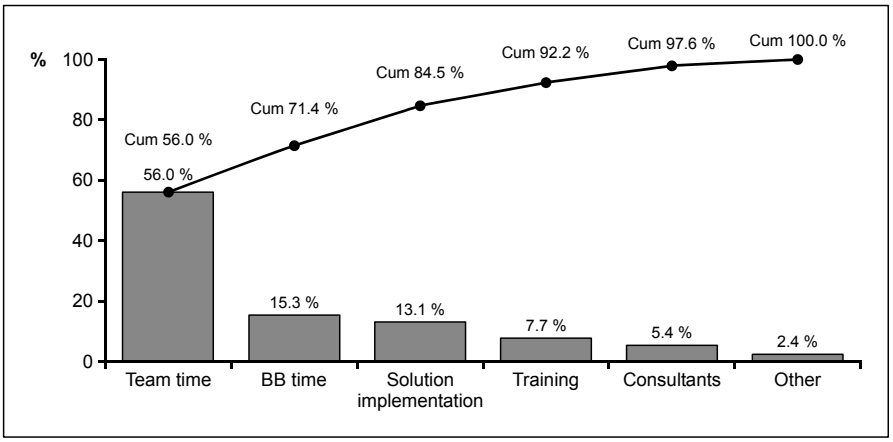

Fig. 4. Pareto chart of six sigma projects' cost components

An important lesson is that even though in general the time dedicated by team members is generally not included as a cost when calculating the profitability of six sigma projects (or improvement projects in general), we have found (Fig. 4) that it is by far the major cost component, in our case more than 50 %.

5 Two Questions Concerning the Survival of Six Sigma

We have seen that financial results of six sigma programs, when implemented with care and enough management support are really good. However, the survival of six sigma, not in a particular company but as a methodology is confronted with several threats. We do not want to make a throughout exploration of the subject but we want to focus on two of them: how much statistics must be included in a BB training course and how much guidance needs to be built into both the tools to be used and the DMAIC methodology. We believe that too much statistics and converting

the roadmap in a closed presentation are two of the most common mistakes in six sigma programs and that this can lead to the downfall of an excellent methodology.

5.1 Statistics

The statistics curricula to be included in the BB training courses have been discussed in detail by knowledgeable experts (Hoerl 2001) and some more recent but less comprehensive articles. In our opinion, there are two things to consider: Are BB candidates really assimilating all the topics covered in a "standard BB course"? More importantly, are these topics needed for the development of the projects? We believe that in fact some of the more advanced statistical tools and methods can be omitted, and that this would not hinder the capacity of BBs to carry on their projects in the vast majority of the cases. In fact, we think that quite the contrary is true: a better understanding of a shorter list of topics will give the BBs confidence and will also facilitate the task of giving the right amount of guidance, as mentioned below. What is the right amount of statistics and which topics are to be included in BB training? Again, the answer is not clear, but our opinion is that perhaps we have followed the pendulum law and gone from one extreme (just "the seven tools") to the other.

5.2 Guidance

In our opinion, one of the keys (there are of course others) to the success of six sigma is that it contains detailed roadmaps and procedures. Of course, people in industries (managers and technicians alike) feel much more secure and comfortable if they know that to finalize the project they must start at the define step and that to complete it they must do this and that, and the same for the measure step and so on. This is easier than having to decide on their own what to do next. It is also very clear that the world is a complex place with complex problems and that on top of this detailed guidance a lot of brain work, ingenuity and "common sense criteria" are needed to produce good solutions.

In our first open training course our students complained at one point that they were feeling a bit lost in their projects, that it was hard to know where they were in the DMAIC process, that their projects were too complicated and that it was very difficult for them to decide which tool to use. Then many things crossed our mind: Are we doing a lousy job when telling them the steps to follow? Have we failed to help them develop "common sense criteria" and ingenuity? Is it true that the only way to learn is by

trial and error? Is it good that they have these doubts when confronted with a real project for the first time? In the second course we went too far towards providing rigid guideline and we ended up with a closed prescription. We think that since then we have found a balance that is certainly more difficult to find in open courses than when the course is tailored for a particular company.

Guidance is given in form of guides, roadmaps and procedures both for the DMAIC steps and the statistical methods and tools. How much guidance must be given to BBs so they are not lost, without crossing the line and falling into a closed prescription? This is a delicate question that depends, as mentioned above, on many things.

6 Conclusions

Six sigma is a very powerful improvement methodology, arguable the most successful known so far. This success is mainly due to two things: first the fact that the DMAIC steps and the statistical tools are a very good adaptation of scientific methods to improve processes by learning from them, and second that these methodological aspects come together with a lot of good implementation and management practices.

An important part of six sigma programs is the attention and time dedicated to train the Black Belts. Our experience is that training programs should be tailored to the processes and needs of the particular company. And as a general principle our recommendation is to keep statistics at a relatively basic level and incorporate guides – both for the roadmap and the tools – without falling into the closed prescription, thus hindering human ingenuity. In open courses, where adaptation is not possible, it can be partly substituted by personalized attention to the projects developed by students and the benefits derived from business cross fertilization.

Our experience is that a good balancing of tools and roadmaps (guides) together with a good incarnation of the program in the management of the company can deliver excellent results – an internal rate of return of 184 % in the Alstom Transporte case. Of course, as noted by Bendell et al. (2001) cost reduction should not be the only aim of an improvement program, but it is a good measure of its success.

We have pointed to some dangers for six sigma continuity. Of course there are others and because of all of them, six sigma will almost surely fade away and be replaced by other fads. However, we believe – and so do others, see for example Folaron and Morgan (2003) – that many of its fundamental tenants will remain: process oriented thinking, learning – via sci-

entific methods – from processes, process control to maintain the gains, data driven analysis, statistically based decisions, etc. One example of this is that the use of six sigma methodology, especially Design for Six Sigma, is starting to play an important role in innovation programs and innovation management that are one of the current fads (Bisgaard and De Mast 2006).

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Appendix: Outline of the Black Belt Course for BBVA

Month 1

- Introduction to Six Sigma at BBVA (DMAS[12])
- Overview (Pizza delivery example) of DMAS methodology
- Define phase: Objectives, description (steps), must be clear and documented
- Project charter, voice of the customer, business case
- Teamwork
- Measure phase
- Get to know the process (Xs and Ys), ask questions, gather data (existing or new), characterize the start point
- Seven basic tools
- Catapult game and introduction to MINITAB
- Sampling concepts
- Review of BBVA existing databases
- Measure system analysis for services

Month 2

- Introduction to iGrafx and process simulation (I)
- Descriptive statistics (MINITAB)
- Probability distributions (Normal, Binomial, Poisson and Lognormal)
- Process simulation (II)
- Analyze phase: Objectives, description (steps), must be clear and be documented
- Project charter review, hypothesis generation, hypothesis confirmation
- Failure Mode and Effect Analysis
- Hypothesis testing (t-test, analysis of variance, chi-square test); examples and exercises

[12] DMAIC was changed to DMAS that stands for define, measure, analyze and superar (Spanish for "get and maintain a superior performance").

Month 3

- Correlation and regression analysis
- Superar[13] phase: Objectives, description (steps), must be clear and documented
- Improvement ideas, selection, validation, monitoring, evaluation of gains, closing
- Creativity tools
- Statistical Process Control
- Introduction to multivariate analysis (cluster, principal component, correspondences)
- DMAS interactive case

During the whole course there was time devoted to project coaching, presentations and discussions

Month 4

- Project presentations and discussions
- Projects must be at the improvement phase with the improvements approved for implantation (plan, responsibilities, and budget) and a clear business case

[13] "Superar" is the Spanish expression for "get and maintain a superior performance".

A Strategy for Building Sustainable Innovation Excellence – A Danish Study

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The purpose of this paper is to report on the development of a methodology and an associated measurement instrument for diagnosing innovation excellence, and to show how this methodology was applied in a case study. The conceptual model behind the measurement instrument has been developed based on the specific enabler criteria and criteria parts from the European Excellence Model adapted to the innovation area. The areas to address (= the key performance indicators) under each criterion is the result of a comprehensive study of innovation literature combined with the case company's experiences from a relatively new established technology center.

In the literature study and model building section (section 1) a strategic model for building sustainable innovation excellence will be developed by going through a simplification process. The starting point for this simplification process is a previous study where the European Excellence Model was adapted to innovation and new product development. The resulting model which is called the "4P" model will be discussed further in section 2, followed by a presentation and discussion on the epistemology and ontology in section 3. Then a simple approach for measuring and diagnosing innovation excellence will be presented in section 4 and the results by using this approach will be presented and discussed in section 5. The paper will then be finalized in section 6 with final discussions and validation of the "4P" model.

1 Literature Study, Model Building and Simplification

Based on extensive literature studies related to the EFQM Excellence Model a new *Innovation Excellence Model* was developed and tested (Martensen and Dahlgaard 1999a, 1999b; Dahlgaard et.al. 2006). The developed model consisted of seven enabler or driving factors and one result factor compared to the EFQM Excellence Model's five enabling factors and four result factors. A comparison between the two models can be seen in Table 1 below.

Table 1. Critical success factors (criterions) of the EFQM Model and the developed Innovation Excellence Model

EFQM Excellence Model	Innovation Excellence Model
Enablers:	Enablers:
1. Leadership	1. Leadership
	2. Customer Orientation
	3. Innovativeness
2. Strategies and Plans	4. Strategies and Plans
3. People	5. People
4. Partnership and Resources	6. Partnership and Resources
5. Processes	7. Innovation Processes
Results:	Results:
6. Customer Results	
7. Employee Results	
8. Society Results	
9. Key Performance Results	8. Innovation Results

One main difference between the two models is that the developed Innovation Excellence Model only had one result factor – "Innovation Results" – where the EFQM Model has four result criterions. Another difference is that the EFQM Model has five enabler factors while the developed innovation excellence model had seven enabling factors. We will discuss these differences in the following.

The reduction of the *results criterions* compared to the EFQM Model was done in order to simplify when adapting the EFQM Excellence Model to the context of innovation. In this section we will gradually try to simplify the model even further because our experience is that simplification is a necessity for understanding, communication and hence for acceptance of the model. Without understanding the model will be neglected and it will not help in attaining or building sustainable innovation excellence.

The types of results to be included under *innovation results* should always be flexible and be related to the context and the company's strategic goals which should be determined by balancing the different stakeholders'

needs and interests. Hence the *concept of sustainability* should be used here in order to assure both long-term and short-term customers' and other stakeholders' satisfaction meaning that the company in its new product development activities is building sustainable innovation excellence. By *sustainable innovation excellence* we mean that innovative new products or services are developed in a way which both in the short-term and in the long run satisfies the customers and other stakeholders, such as employees, suppliers and society, in a balanced way.

Regarding the *enabling factors* (criterions) of the two models it is obvious that the basis for developing new innovative products is a *customer culture*, which starts with the identification of the customers' problems and needs (latent as well as manifest needs) and ends with customer satisfaction and loyalty. Everyone involved in innovation should have an open, constructive, positive attitude towards its customers and make sure to understand customers' needs and problems.

The literature analysis showed that *customer orientation* together with *innovativeness* should have a special high importance in the context of innovation. These enablers should therefore have a high priority in order to assure sustainable innovation excellence, and they should have the same high focus as the other enablers even if we in this article will regard them as leadership sub-criterions.

Regarding the influence of *people* on the innovation process and hence on innovation results this aspect is supported by several studies (Cooper and Kleinschmidt 1988; Cooper and Kleinschmidt 1991; Cooper 1998). We believe that one of the primary tasks in the future for leaders and its people will be to integrate creativity and learning in the innovation processes, and motivate and manage knowledge, learning and creativity in relation to its people. *Learning* helps to increase the capacity of a person's creativity. *Creativity*, on the other hand, is the foundation for building a learning organization, and is the underlying driver behind improvements and innovation. To have success with that integration leadership is needed at the top level as well as at the department levels and at the team level. That is the reason why *innovativeness* in this article is regarded as a leadership sub-criterion.

It is a management responsibility – top management as well as middle management – to build an innovative culture, with norms and values, which supports innovation and new product development. Such a culture is not a coincidence. It is the result of intentional long-term activities. It is the result of careful thinking, reflection, planning, measurements and follow-up from top level to process level. The plans for building the right innovative culture should be a part of the yearly strategic planning and follow up process ("Strategies and Plans") where the deployment process follows the

Hoshin Planning methodology (see Dahlgaard-Park et al. 1998; Dahlgaard and Dahlgaard-Park 1999).

As *strategies and plans* (together with *innovativeness* and *customer orientation*) also can be regarded as belonging to *leadership* we now has simplified the two models into the "4P" model's enablers (Dahlgaard and Dahlgaard-Park 2004, 2007):

1. Leadership
2. People
3. Partnership and Resources
4. Processes
5. Products

The "4P" model's main message is that before companies try to improve their processes they must improve the areas of leadership, people and partnerships. The background of the "4P" model will be presented in the following section.

2 A People Oriented Quality Strategy for Building Sustainable Organizational Excellence

As there is an increasing recognition of employees as organizations' greatest asset, there seems to be a need to develop a people oriented quality strategy or model to be used as a guideline for strategic planning, implementation, measurement and follow up when companies are trying to build *organizational excellence*. Such a model should clearly signal that the first step in building organizational excellence is to build quality into people, and that "the people first policy" and "total development of people" are essentials for achieving organizational excellence (Dahlgaard-Park and Kondo 2000; Dahlgaard-Park and Dahlgaard 2007).

Dahlgaard and Dahlgaard-Park (2004) suggested a model of organizational excellence, called *the "4P" model*, in which the people dimension is recognized and emphasized as the primary enabler. According to the model building quality or excellence into the following 4Ps develops organizational excellence:

1. People
2. Partnership/Team
3. Processes of work
4. Products/service products

The "4P" model is suggested based on the recent awareness on human resources and their role in the organizational context as the basic unit for any organizational improvement activity. From this viewpoint it is argued that the first priority of any quality or excellence strategy should be to build quality into people as the essential foundation and catalyst for improving partnerships, processes and products. But what does that really mean? In order to answer that question we need to understand human nature, human needs, human psychology, environmental and contextual factors of human behavior because the project of "building quality into people" can only be carried out when we have a profound knowledge of people and psychology (Deming 1993).

The quality strategy should always be implemented multidirectional, i.e. through a top-down, middle-up-down and a bottom-up strategy (Dahlgaard et al. 1994,). The strategy should follow the Policy Deployment approach (Hoshin Kanri), which has both the top-down and the bottom-up strategy included. Such an approach provides a framework for building quality into the following three levels (Dahlgaard-Park et al. 1998):

1. Individual level
2. Team level and
3. Organizational level

An efficient quality strategy aiming at improving the "4P" can only be developed based on an understanding of the interrelationships and interactions between individuals, teams, and the organization and the critical contextual factors at each level.

Figure 1 below illustrates these interrelationships and the process of building these different levels. The figure indicates that building organizational excellence starts with *building leadership*, which means developing (educating/training) and/or recruiting leaders with the right values and competencies. The next step is to develop and/or recruit *people* with the right values and competencies. Especially on the value dimension leaders' behaviors determine if core values (as for example trust, respect, openness etc.) will be diffused and will become a part of the organizational culture (Dahlgaard and Dahlgaard-Park 1999). *Building partnership/teams* means that teams are established and developed, so that each team is able to practice the right and needed values and competencies, and *partnership* is established in all people relationships – within the team, between team members (intra-team), between teams (inter-team) and with other people or groups outside the team (suppliers, lead customers etc.). *Building processes* means that leaders, individuals and teams day by day try to practice the needed values and competencies based on the principle of continuous improvement and the company's mission, vision, goals and strategies.

Building products/services means building quality into tangible and intangible products/services through a constant focus on customers' needs and market potentials, and to practice the principles of continuous improvement parallel with innovativeness in new product development. The foundation (building leadership) supports the four other factors represented by "the 4P" and all together the five factors comprise a roadmap to the "result" called *organizational excellence*. It is assumed by the model, that all five factors are necessary for achieving organizational excellence.

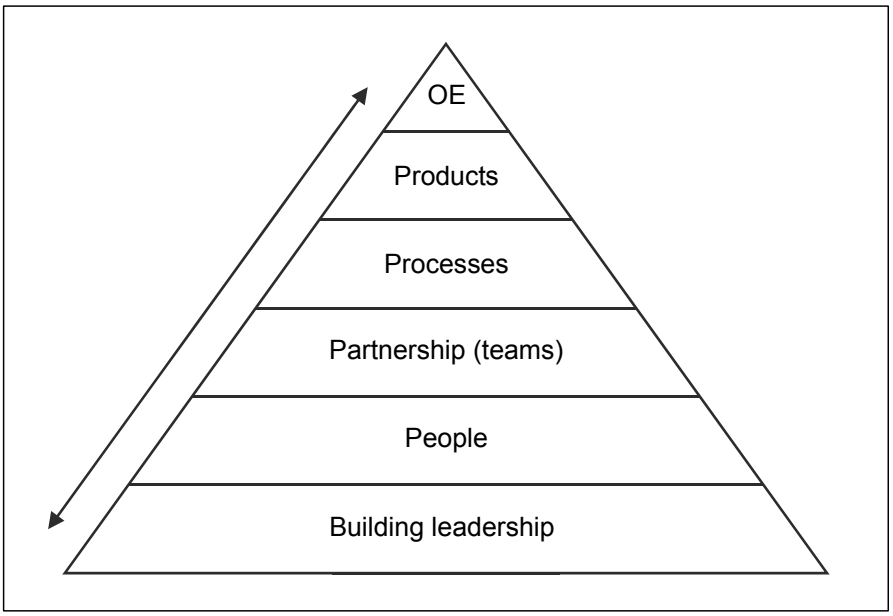

Fig. 1. Building organizational excellence through leadership and "the 4Ps"

Figure 1 is a general model which can be context related and adapted to innovation and new product development as shown in Fig. 2 below.

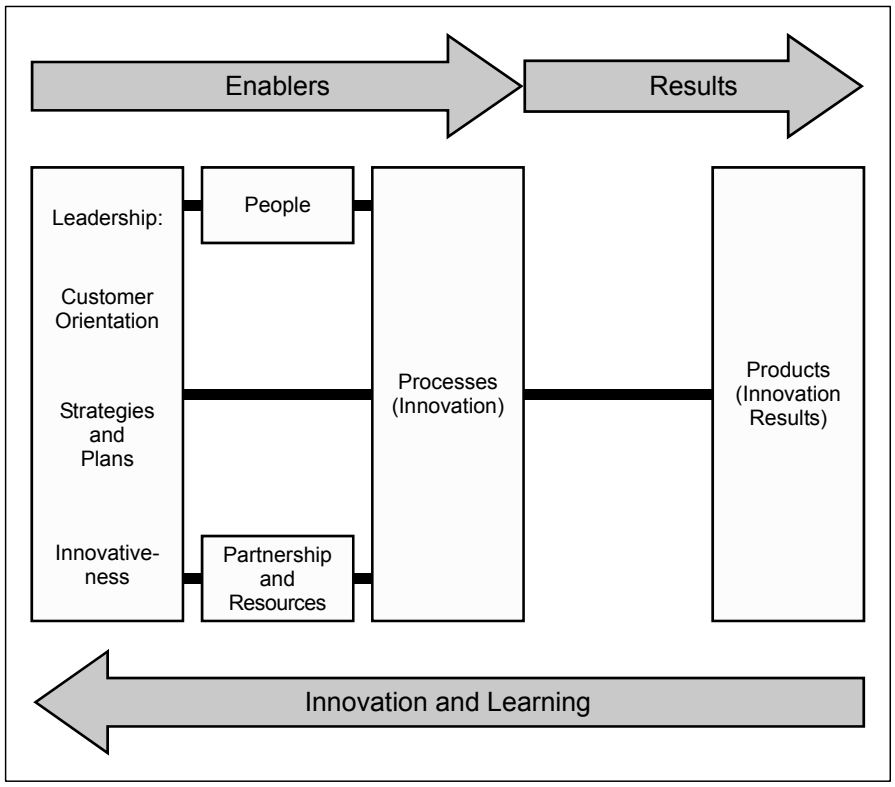

Fig. 2. The "4P" Excellence Model to be adapted for innovation and new product development

3 Epistemology and Ontology behind the "4P" Model

In this section of the article we will reflect on our paradigms and assumptions, which the "4P" model is based on.

One of the basic assumptions behind the "4P" model are *the principles of open systems theory* that recognize the importance of interrelationships, processes, contingency and integrative aspects between various parts of a system (Deming 1993; Luhmann 1995). More specifically we adopt the purposive and goal seeking socio-cultural system view (Buckley 1967) in which organizations are supposed to intentionally searching and receiving information and making efforts in order to keep moving toward their goals. The positioning of *building leadership* in the "4P" model should be understood from this point of view, as we recognize the decisive influence and

authority of leadership in shaping goals and designing the vision, mission and strategy for achieving the goals. Although we recognize the decisive role of leadership in shaping the vision, mission and organizational culture, the influence and interaction aspects of all levels and subcultures should not be underestimated. The multidirectional approaches of the "4P" model are based on this view.

Seen from this perspective all activities and interactions are information exchange activities, which organizations try to utilize in order to not only maintain their existing standards and processes (morphostasis), but also to improve and change (morphogenesis) (Buckley 1967, p. 58–62). Thus in order to continuously improving the system's capability and energy, information from the outside environment are utilized to restore, maintain and improve structures, processes and routines. In this way energy is "imported" from the outside and is being utilized for work which is valuable for the customers and other stakeholders – internal as well as external stakeholders. Without this continuous import of energy there is, according to the second law of thermodynamics, a risk that the system spontaneously will move towards a state of increasing *entropy* – a state of maximum disorder – a state where energy cannot be turned into value-added work.

Another assumption in relationship with the "4P" model is the aspect of organizational reality. The quality movement has often been explained and characterized as a quality evolution from a rather mechanical view with a focus on objective and rational elements to a more holistic and organic view with a focus on both subjective and objective elements of organizational reality (Dahlgaard-Park 1999). TQM can be explained as an ongoing process of fusion between western and eastern ways of seeing, thinking, interpreting, understanding, and doing. It is argued (Dahlgaard-Park 2006), that the rational and logical approach is a heritage from the western tradition mediated by pioneers such as Shewhart, Deming and Juran, and the more holistic and humanistic approach is a heritage of the eastern tradition, mostly transmitted by Japanese practices. As a result of this quality evolution, which also comprises the fusion between western and eastern traditions, TQM as well as the various business excellence models came to recognize this multifaceted reality (Dahlgaard-Park 2006). The multifaceted reality means here that the various aspects of organizations, e.g. subjective, irrational, objective, logical, rational, emotional, formal, and informal aspects are all recognized as representing organizational reality, and are thereby candidates for consideration (potential areas to address) in relationship with implementing TQM and building organizational excellence.

As many theoreticians still seem to misinterpret excellence models by seeing these models only from a one-sided "reductionist" view, we emphasize that *the "4P" model* should be viewed as an integrative model where

the distinctions between subjective/mental and objective/physical as well as between micro/individual and macro/collective aspects of reality are abandoned. Instead of dichotomies between these aspects we suggest an integrative approach where subjective and objective as well as micro and macro aspects are to be seen as a dynamic continuum of organizational reality, and thereby as parts of the reality.

As can be seen from Table 2 below the various elements of *the "4P" model* can be interpreted as parts of the dynamic continuum between the micro–macro and the subjective–objective pole of organizational realities. The micro/individual–macro/collective continuum is shown vertically and the subjective/intangible–objective/tangible continuum is shown horizontally. Because the table may be misinterpreted as four distinctive areas we emphasize the importance of interactions and interrelationships among and between the four areas. The micro/subjective area of organizational reality involves individual persons' mental processes of both emotional and intellectual cognitive aspects. Perceptions, reference frameworks/mental models, thoughts, intentions, beliefs, motives, willingness, desires etc. are some examples of the micro/subjective realities. These realities are often difficult to observe and take time to understand, as they are mostly intangible and are not revealed unless people have intimate relationships. The micro/objective area of organizational reality involves the more tangible aspects of individual processes such as behavior and interaction patterns. The macro/subjective area of organizational reality involves intangible collective processes e.g. norms, values, political interest of groups, departments and organizations. The macro/objective area involves tangible collective organizational realities such as vision, mission statements, the visible part of organizational cultures in terms of the way of celebrating success and failures, the way of using symbols, work processes, rules, routines, technology, manuals, structures, collective behavior patterns, communication channels, reward systems, products, profits etc. The most formalized parts of organization belong to the macro/objective area.

Seen from *the "4P" model*, large parts of "Building Leadership" and the first two Ps – "People" and "Partnership" building – belong to the micro areas, and large parts of the last two Ps – "Processes" and "Products" – belong to the macro areas of organizational realities. However, as is indicated in Table 2, most of the "4P" are relevant in each category of the organizational reality. Thus the most important point is that all four aspects of realities are important, and there are mutual interrelationships between all four areas.

Table 2. The "4P" and the four aspects of organizational realities

	Subjective/intangible	Objective/tangible
Micro/ individual	Individual feelings/emotions, perceptions, assumptions, values, thoughts, intentions and will, beliefs, motives, meaning creations, desires, motivation, commitment, loyalty *(Building leadership, people, partnership, processes and products)*	Individuals' patterns of behavior, leadership behavior and patterns, patterns of interactions, patterns of partnership, individual work processes, individual work performance, *(Building leadership, people, partnership and processes)*
Macro/ collective	Groups, departmental and organizational norms, values, believes, political interest, power relationships, informal power & communication structure, conflicts, interpersonal-, intergroup meaning creations *(Building leadership, people and partnership)*	Vision, mission statement, symbols, ceremony, traditions, patterns of intergroup /interdepartmental interaction and partnership, patterns of interorganizational partnership, groups, departmental and organizational work processes, training and education programs, rules, techniques, communication channel, structures, manuals, technology, routines, products *(Building leadership, people, partnership, processes and products)*

The micro/subjective realities will often be *key performance indicators* and input for micro/objective realities and vice versa. Similarly micro/subjective realities are also closely interrelated to macro/subjective realities. Individual persons can initiate an action (micro objective) driven by some personal motives, intentions and willingness (micro subjective), however those personal motives might have been shaped, modified and constrained by the organizational culture (macro subjective) or the existing hierarchical structure (macro objective). In other words, individuals' behaviors and actions are often constrained and shaped by the organizational environments. Thus interrelationships between them are multidirectional and not a clear linear cause-and-effect or enabler-results relationship. These relationships can be explained as an ongoing process of "becoming" (Sztompka 1991) or "emergence" (Wiley 1988) where feedback and feedforward flow constantly at all levels through interactions. Various processes identified in knowledge creation such as externalization, internalization, sympathy, socialization, combination, articulation (Nonaka and Takeuchi 1995) etc. are some main mechanisms in interactions that make this becoming or emergence possible.

Although we are careful and reluctant to make priorities at any level, we can observe from Table 2 that the impact of *leadership* is obvious within and between all four levels. This is the reason behind our argument of leadership to be considered as the foundation of the "4P" model indicating that *leadership* is the most critical and influential factor of the model.

4 Questionnaire Design and a Simple Approach for Measuring Innovation Excellence

During the spring of 2000 a questionnaire survey was run in a large Danish pump manufacturing company. The final version of the questionnaire comprised 80 questions related to innovation, which was a reduction from approximately 300 questions in the prototype questionnaire. The questionnaire was developed during a period of a year where the authors had a close co-operation with four managers from the innovation area. During this period a prototype of the questionnaire was developed and 15 people tested this prototype by filling out the questionnaire. Through simple data analyses, feedback and discussions with the managers the final version of the questionnaire was developed.

Respondents were asked to rank each question, formulized as statements, according to their perceived degree of *agreement* and *importance* using a Likert scale ranging from 1 to 5. On the "importance" scale, a "1" indicates that the statement according to him/her is of very minor importance, while statements that score "5" are perceived as having very high importance. On the agreement scale, a "1" indicates that the respondent fully disagrees with the statement, while a score of "5" means that the respondent fully agrees with it. To fully disagree with a statement means for the first seven critical success factors of the model (the enablers) that the respondent does not agree that the driver (activity) behind the question (statement) has been implemented into daily practice. To fully agree with a statement means for the first seven success factors of the model that the respondent totally agrees that the driver (activity) behind the question (statement) has been implemented into daily practice. Generally the importance measurements (= I) can be understood as indications of the respondents' needs and the agreement measurements (= P) as indications of the company's performance. Any negative difference between perceived indicated performance and perceived importance (P - I) can be regarded as a gap indicating an opportunity for improvement seen from the respondents' points of view.

260 employees involved within the innovation area were invited to participate in the survey and to fill out the developed questionnaire. 131 questionnaires were returned giving a response rate of approximately 50 %.

5 Using the Simple Approach to Prioritize Improvement Areas

By using the simple approach the gaps between importance and agreement were analyzed and the biggest gaps were regarded as most interesting to analyze. It is assumed that the biggest gaps are signals from the respondents about where to improve first. Therefore the first step in the simple approach is to rank the statements according to the size of the gaps. Table 3 shows the statements with the biggest gaps – first the enabler statements and then the result statements.

A quick overview tells us that according to the ranking in Table 3 the enabler factors should be prioritized for improvements in the following order: 1. "Leadership", 2. "Partnership and Resources", 3. "People", 4. "Processes", and 5. "Strategy". The message is very clear:

Improve first the "soft aspects of innovation" (= leadership, people and partnership), before you try to improve the "hard or logical aspects" (= processes, strategy).

This ranking is the same as suggested by Dahlgaard-Park and Dahlgaard in their "4P" model for building Organizational Excellence (1999, 2004, 2007). The suggested ranking is also supported by the biggest gap under *innovation results* which is "employees' motivation and commitment have increased during the last 4 years".

Table 3. Identification of statements with the biggest gaps

Criterion	Statements from Enablers	(Importance I, Agreement P)	Gap (P - I)
Leadership	The organization is characterized by an innovative culture (time to think freely and follow up on own ideas, learn of experiences, risk willingness etc.), entrepreneurship.	(4.51, 3.30)	1.21
Leadership	Important information is shared quickly and accurately to the right persons – up, down and sideways in the organization.	(4.47, 3.45)	1.02
Leadership	Creating, acquiring and transferring of new knowledge and skills are a part of the company culture.	(4.49, 3.52)	0.97
Partnership/ Resources	The resources necessary to accomplish the roles set up for the company's innovation programme are clearly mapped out.	(4.22, 3.33)	0.89
Partnership/ Resources	The company allocates consequently and visibly resources for the innovation.	(4.16, 3.28)	0.88
People	The reward system related to innovation is known by everybody and reviewed and improved collectively	(3.88, 3.03)	0.85
Leadership	The organization is always scanning the horizon and is proactively anticipating change.	(4.32, 3.48)	0.84
Partnership/ Resources	The employees participate in external innovation activities, creativity discussions, creativity teams etc.	(3.98, 3.18)	0.80
People	All people try to improve and develop themselves in order to cope with future challenges within the innovation area.	(4.38, 3.66)	0.72
People	Core team members use 80 % or more of their time on the innovation project.	(4.21, 3.52)	0.69
Processes	Bench marking data from "best practices" within innovation are used to set objectives for future improvements	(3.97, 3.30)	0.67
Processes	Faulty omission of key activities in the new product development process seldomly happens.	(4.33, 3.68)	0.65
People	The innovation team consists of committed employees from different departments which participate equally in the project.	(4.11, 3.48)	0.63

Table 3. (cont.)

Processes	Design errors, production errors, communication errors, marketing errors, etc. are continuously reduced or eliminated throughout the new product development process.	(4.39, 3.78)	0.61
People	Team members are empowered to make decisions about their innovation project and to participate in the planning and decision making for innovation.	(4.24, 3.67)	0.57
People	People in the organization possess a willingness to accept and adopt "external" ideas.	(4.10, 3.54)	0.56
Strategy	Visions, goals, and strategies for innovations are communicated clearly to everybody.	(4.26, 3.81)	0.45
Strategy	A Policy Deployment Process for innovation is established (develop 3–5 year plans, annual objectives, departmental plans, implementation, reviews, etc.).	(4.16, 3.74)	0.42
Strategy	Success criteria for the innovation programme have been formulated (guidelines, minimum standards, result benchmarks etc.).	(3.88, 3.49)	0.39
Criterion	Statements from Results	(Importance I, Agreement P)	Gap (P - I)
People	Employees' motivation and commitment have increased during the last four years.	(4.46, 3.70)	0.76
Products/ Sales	The percentage of sales provided by innovations that are less than four years old has increased.	(4.16, 3.50)	0.66
Products/ Sales	The number of innovations that provide the company with a sustainable competitive advantage has increased the last three years.	(4.36, 3.71)	0.65
Products/ ROI	Return on investment (ROI) of the company's innovation program has increased during the last four years.	(4.11, 3.60)	0.51

6 Discussion and Conclusions

An important finding by using *the simple approach* was that:

Improve first the "soft aspects of innovation" (= leadership, people and partnership), before you try to improve the "hard or logical aspects" (= processes, strategy).

This finding is supported by Peters and Austin (1985) who found *excellence* as being the result of the following four critical success factors:

1. *People*, who practice
2. Care of *costumers*,
3. Constant *innovation* and
4. *Leadership* which binds together the first three factors by using *MBWA* (Management by Wandering Around) at all levels of the organization.

The finding is also supported by the logic of the European Excellence Model and especially our research experiences with this model (e.g. Dahlgaard and Dahlgaard-Park 2004).

In case after case, when companies did their first self-assessment, we observed almost the same results: The biggest gaps were related to leadership and people oriented areas (the subjective/intangible part of Table 1). It seems as if top and middle managers too often ignore these factors and focus too much on logical factors such as technology and economy. But a focused self-assessment approach such as the approach used in this case will function as an "eye opener" and top management as well as middle management will easily come to a consensus about what to improve first. After having prioritized and worked with understanding (analyzing) and improving the soft areas then remarkable improvements in these areas will often be experienced and new priorities for improvements will be identified in the following self-assessments (see Dahlgaard and Dahlgaard-Park 2004). These new priorities may gradually be more focused on logical areas (the objective/tangible part of Table 2) without forgetting the learning points from the first self-assessment run. A new and sustainable company culture has gradually emerged – a culture, which is characterized by 1. Respect for People, and 2. Continuous Improvements, which is the same as the DNA of Toyota's Production System (Dahlgaard-Park and Dahlgaard 2007).

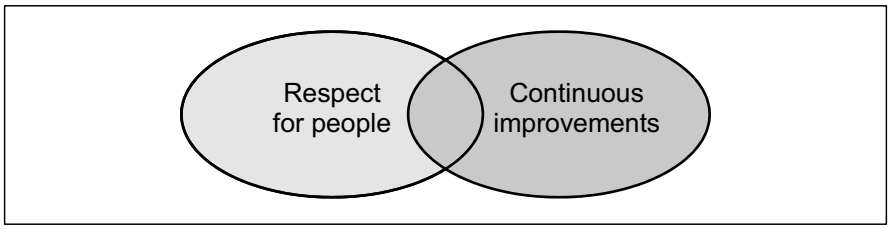

Fig. 3. Toyota's DNA (Dahlgaard-Park and Dahlgaard 2007, p. 388)

Our observations above may be understood simply by flaws in the existing managerial paradigms. Seen from a meta level, *TQM and the excellence approach* require a fundamentally different managerial paradigm and mental model compared to earlier quality approaches.

Earlier quality approaches were rooted in a positivistic and reductionist paradigm, which is well matching when focusing and understanding the formal and tangible aspects of organizations (Dahlgaard-Park 1999, 2006). One major problem with the various excellence models and the managerial practices of these models seems to be that people still interpret these models from a positivistic and mechanistic paradigm. The high failure rate with implementation of TQM and excellence models seems to be related to this problem (Dahlgaard-Park 2006). The phenomenon can be illustrated by an analogy of a doctor who tries to cure a mental sick person by carrying out a physical surgery. In order to understand the complex realities of organizations and its environments organizations need a new cure (framework), which can capture both depth (qualitative) and breadth (quantitative). The suggested "4P" model is our attempt to provide such a framework which may help to overcome organizations' current problems when trying to implement TQM and excellence by using existing excellence models.

With the "4P" model and its related principles we have tried to simplify the integration of tangible and intangible aspects (objective and subjective) as well as individual and organizational levels (micro and macro) into the framework. The "4P" model can be used as a guideline for implementing TQM and excellence by integrating the paradigm level with the methodological level. The successful transformation of Post Denmark's company culture in the period 1998 to 2004 from a bureaucratic commanding and control culture to a TQM and excellence culture was guided by an educational framework designed by the "4P" model and complemented by measurements of more than 500 managers' perceptions (mindsets) of selected critical success factors for excellence (key performance indicators) inspired by the European Excellence Model (Dahlgaard and Dahlgaard-Park 2004). Post Denmark received in 1999 the Danish Human Resource Prize, the Danish Quality Award in 2004 and the European Excellence Prize in 2006. Post Denmark is today regarded as one of the few innovative and best managed post companies in Europe.

By taking into account the discussion and arguments above combined with our theoretical discussion in sections 2 and 3 our final conclusion is that the validity of the "4P" model has been supported by this case. Combined with several other cases where we have used the simple approach for identifying and prioritizing improvement areas during the last 15 years we hence conclude that the "4P" model shows a valid structure or strategy for building sustainable organizational and innovation excellence.

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The Impact of Cultural Issues and Interpersonal Behavior on Sustainable Excellence and Competitiveness: An Analysis of the Italian Context

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The scope of this paper is to explore how cultural factors and behavioral preferences impact on organizational aspects facilitating or obstructing the ability of an organization to implement and succeed in its efforts towards sustainability, and how to take action on cultural factors in order to make the way to sustainability possible.

The paper first explores the need of management models for corporate sustainability, proposing the integration of sustainability within a pre-existing business excellence model (i.e. EFQM Excellence Model), in order to achieve what is here defined as sustainable excellence. The cultural advantages and the cultural obstacles on both business excellence and corporate sustainability will be explored, together with the ways through which the cultural obstacles can be faced and overtaken through cultural changes at corporate, sector o nationwide level. An example of this will be found in the Italian context.

1 Relevance of the Findings for Ergonomics Theory

In this paper the authors claim that corporate sustainability can be effectively supported by business excellence models, in an integrated approach, here referred to as sustainable excellence. The authors believe that today sustainable excellence is the new challenge both for ergonomics and for business management, in order to provide European businesses (and not

only them) with a new competitive advantage, assuring them growth and prosperity in a sustainable world.

2 Corporate Sustainability: Definitions and Models

Although it is probably incorrect to state that it is an established concept at this point in time, corporate sustainability is slowly getting to a common definition accepted by most specialists, identifying it as the capability of an organization to continue its activities indefinitely, having taken account of their impact on financial, social and environmental capitals.

An interesting definition that creates a strong link between corporate sustainability and shareholder value is given by the Dow Jones Sustainability Index (DJSI): Corporate sustainability is a business approach that creates long-term shareholder value by embracing opportunities and managing risks deriving from economic, environmental and social developments. That is further explored by the Sustainable Asset Management Group, stating that sustainable organizations integrate economic, environmental and social criteria into strategy and management, they pursue opportunities and manage risks that accompany sustainability trends, they create long-term shareholder value by leading their industry with a strong commitment and superior performance in all these dimensions.

Overall it is clear that sustainability grounds the development debate in a global framework, within which a continuous satisfaction of human needs constitute the ultimate goal (Brundtland Commission 1987). Transposing this concept to the business level, corporate sustainability can be defined as meeting the needs of a firm's direct and indirect stakeholders (such as shareholders, employees, clients, pressure groups, communities etc.), without compromising its ability to meet the needs of future stakeholders as well (Dyllick and Hockerts 2002).

Trying to go beyond definitions, into how to reach corporate sustainability, an interesting point of view is offered by Dyllick and Hockerts (2002), who focus on three major directions:

- Integrating the economic, ecological and social aspects in a "triple-bottom line"
- Integrating the short-term and long-term aspects
- Consuming the incomes and not the financial, natural and social capitals

Where next to the traditional concept of financial capital, the authors introduce the concepts of natural capital including both natural resources (generally substitutable) and ecosystems (generally non-substitutable), and

of social capital including both human capital (concerning primarily aspects such as skills, motivation and loyalty of employees and business partners) and societal capital (including the quality of public services, such as a good educational system, infrastructure or a culture supportive of entrepreneurship). But also the Dow Jones Sustainability Index (DJSI) offers a more in depth view of the concept, identifying the major areas in which leading sustainability companies should display higher levels of competence:

- Strategy: Integrating long-term economic, environmental and social aspects in their business strategies while maintaining global competitiveness and brand reputation
- Financial: Meeting shareholders' demands for sound financial returns, long-term economic growth, open communication and transparent financial accounting
- Customer and product: Fostering loyalty by investing in customer relationship management and product and service innovation that focuses on technologies and systems, which use financial, natural and social resources in an efficient, effective and economic manner over the long-term
- Governance and stakeholder: Setting the highest standards of corporate governance and stakeholder engagement, including corporate codes of conduct and public reporting
- Human: Managing human resources to maintain workforce capabilities and employee satisfaction through best-in-class organizational learning and knowledge management practices and remuneration and benefit programs

Since from these few definitions of the concept, it is clear that corporate sustainability surely needs a holistic approach, integrating sustainability issues with business issues. And to reach this goal we believe that, as for all the holistic management approaches, a model can give a fundamental help, it can help showing a roadmap, it can help highlighting the links between the (short- and long-term) results and what has been done to achieve them (enablers), it can help providing a measurement of all this.

In literature one can find several maturity models for corporate sustainability, some of them being extremely detailed and useful. However maturity models are good to measure the results and to show the way to improve, but only from a purely sustainability point of view, and not from an integrated management point of view, with the consequent risk of thinking and pursuing sustainability as something separate from the other strategic objectives and in someway apart from ordinary management decisions.

And this can heavily reduce the effectiveness of any strategy or action for sustainability.

3 A Management Model for Corporate Sustainability

Actually some management models for corporate sustainability do exist in literature. For example the European Corporate Sustainability Framework (ECSF 2004), that merges a phase-wise development (maturity) model with a more advanced management model. The development model identifies four levels: compliance driven, profit driven, care driven, innovation driven. While the management model, based on the European way to excellence (Hardjono et al. 1997) model (a 1996 EU/EFQM project to which one of the authors – Cesarotti – has contributed), has four main interrelated elements: constitution (identity and values), chemistry (flows and relationships), construct (actions and procedures) and control (monitoring and learning). Or the corporate sustainability management reference model, that identifies a core level (the theory) with a conceptual commitment to a core sustainability theory and model, a middle level (policy) introducing and integrating economic, social and environmental policies, and an external level (practice) made of stakeholder relations, program strategy and operations, R&D, measuring and control.

However these models have not had the wide application that could have been expected, given the importance of the topic nowadays. We believe that the reason behind this is that they are too specific and for the company willing to implement them they would be an additional model on top of the pre-existing management models the company most probably already refers to.

In this sense the best approach is to introduce corporate sustainability in an existing (and widespread) management model, reaching at the same time two goals: to facilitate the adoption of the model (since it would require just some integrations) and to show that sustainability is not something apart business strategy, but is and must be part of a business strategy and management system.

4 From Corporate Sustainability to Sustainable Excellence

To our opinion, one of the best candidates from this point of view is the EFQM Excellence Model (EFQM 2003). First of all because sustainability

is actually an element of an organization's excellence, secondly because the model is widely spread (not only in Europe), but also for some more specific reasons, and in particular because the EFQM Excellence Model, as corporate sustainability:

- encloses a management paradigm,
- presents a holistic approach,
- is strongly based on values,
- is based on the stakeholder theory,
- includes corporate social responsibility (CSR) as one of its fundamental concepts.

However, it must be mentioned that the EFQM model as it is, is not ready for being a corporate sustainability management model. In fact:

- it does not explore the concepts behind CSR, just mentioning environmental sustainability, but not going into details and pushing, for example, towards corporate accountability, or social justice, etc.;
- it substantially limits the impact of sustainability issues to only one criterion (8th society results), not explicitly considering them among the enabling factors;
- it limits the weight of society results to only six percent of the total;
- it does not consider long-term results, at least not long enough to capture sustainability results, limiting the trends analysis in the radar measuring system to three years.

Therefore it is clear that reaching business excellence does not necessarily mean to reach sustainability. But surely the Excellence Model offers an interesting basis on which a company can build its way to sustainability. We believe that corporate sustainability is a must for reaching excellence today at least for a European company. Having lost the cost competitive advantage and being at serious risk the technology and innovation competitive advantages, sustainability can be a strong (maybe the strongest) competitive advantage to let European companies and their products still be attractive.

In today's competitive environment, corporate sustainability can effectively help organizations to be attractive, to be competitive, to grow, to be scalable, in one word, to survive. The integration of corporate sustainability in a business excellence framework can provide that strong competitive advantage necessary today to exist on the global market. We will call this integration sustainable excellence.

5 Sustainable Excellence and Cultural Issues

No matter what has been written above is quite accepted today among the leaders of European businesses, no matter the results of using business excellence models has been demonstrated in more than one occasion (Hendricks and Singhal 1996; Boulter et al. 2005), no matter corporate sustainability is among the declared objectives of most companies, the examples of sustainable excellence in practice are still few.

Moreover, there are some regions or countries where even the attention to sustainability factors (without a management model) or the use of business excellence models is still very limited. We believe that an explanation to this difference can be given by cultural diversity.

"Culture is the collective programming of the human mind that distinguishes the members of one human group from those of another. Culture in this sense is a system of collectively held values." (Hofstede 1981)

Culture is "a pattern of shared basic assumptions that the group learned as it solved its problems of external adaptation and internal integration, that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way you perceive, think, and feel in relation to those problems." (Schein 1992)

This means that a culture is typical of a group and influences the behaviors of all the members of that group. In this sense it is possible to identify the culture of a nation, but also the culture of a company (corporate culture), as the culture of any other group that has links among the people belonging to the group strong enough to influence there behaviors.

According to Schein (1992), culture has three different levels at which culture influences people's and companies' products, actions and behaviors:

- Artefacts: they are on the surface and visible, easy to observe although sometimes difficult to decipher, they are in the language, in the look, in the outputs of what people do.
- Espoused values: reflected by groups' behaviors, first begin as shared values then become shared assumptions and then social validation, initially started by founder, then by leaders and then assimilated by all.
- Basic assumptions: they determine what people pay attention to, the meaning of what is said and done, emotional reactions, what actions to take and when.

Observing the location of the few companies who have developed an effective approach to sustainable excellence, or even just observing the number of companies implementing a serious approach to sustainability or

to business excellence, it is quite easy to notice that there are strong differences from country to country. We believe that one of the reasons behind this segmentation is the existence of cultural factors helping or discouraging approaches and investments for sustainable excellence. In order to be able to analyze this we will study the Italian case, where the number of companies using an excellence model is very small, where an excellence model (and an excellence award) exist only for SMEs and for the public sector (by the way without a great success in spreading the use of the model or the culture of excellence), where sustainability is still far from being perceived as a possible objective for a company and even less an asset to invest on.

But before analyzing the Italian case, we need a framework to identify a culture. In order to analyze and to understand a culture, under most of its points of view, and in order to find a reading key through which understand the behavior of people or of organizations, several authors have identified cultural dimensions. Identifying which of these dimensions a person or an organization (in case of corporate culture) has developed more, can help understanding and foreseeing their behavior.

Hofstede (2003) has defined five couples of cultural dimensions:

- High power distance versus low power distance
- Individualism versus collectivism
- Masculinity versus femininity
- Uncertainty avoidance versus risk inclination
- Long-term versus short-term

While Trompenaars (Trompenaars and Hampden-Turner 1997) has identified seven couples of cultural dimensions:

- Universalism versus particularism
- Individualism versus communitarianism
- Specific versus diffuse cultures
- Affective versus neutral cultures
- Achievement versus ascription
- Sequential versus synchronic cultures
- Internal versus external control

For the purpose of our study, we have selected a different set of cultural dimensions, that can better help us reach our goal of finding some kind of relationship between cultural factors and the attitude to implement and succeed in approaches to sustainable excellence. The selected dimensions are:

- Observance of rules versus adapting rules
- Wide vision versus focusing
- Competence versus personal contacts
- Results versus commitment
- Long-term orientation versus short-term orientation
- Cooperation versus individualism
- Proactivity versus reactivity
- Orientation to change versus orientation to stability

6 Sustainable Excellence and Cultural Issues: The Italian Case

In order to have a first response about a possible link between cultural factors and the attitude towards sustainable excellence, we have chosen to analyze the Italian case, where notably the approach towards sustainable excellence is still quite stuck, with the examples of organizations investing (and succeeding) in business excellence coming almost only from the area of small and medium enterprises (SMEs).

For this purpose we have used the results of a research developed by the Ambrosetti Research Institute (Ambrosetti 2005), that had researched the impact of cultural dimensions to analyze the pro-business attitude of a country. The Ambrosetti study started by analyzing and measuring several dimensions of culture, among which all dimensions we have selected above, comparing them among countries. The study has been performed using both indirect measurements (contextual dimensions, analyzing official indicators published by each country and other research findings) and direct measurements, based on a survey with specific questions aimed to evaluate the attitude of the respondent on each of the above dimensions. The questionnaire (assertions that the respondents were ask to assess between 1 = not important and 6 = very important) has been administered to a sample of 1800 people, equally distributed for age (between 18 and 65) and for gender. The results that follow have been obtained taking the percentage of "important" (5) and "very important" (6) answers for each dimension, and relating the dimensions in couples. The results are the following:

Competence versus Personal Contacts

Analyzing the importance given by people to the competence compared with the importance given to personal contacts for the success of any ini-

tiative, Italian culture gives an outstanding importance to personal contacts compared to an average importance given to competence (Fig. 1).

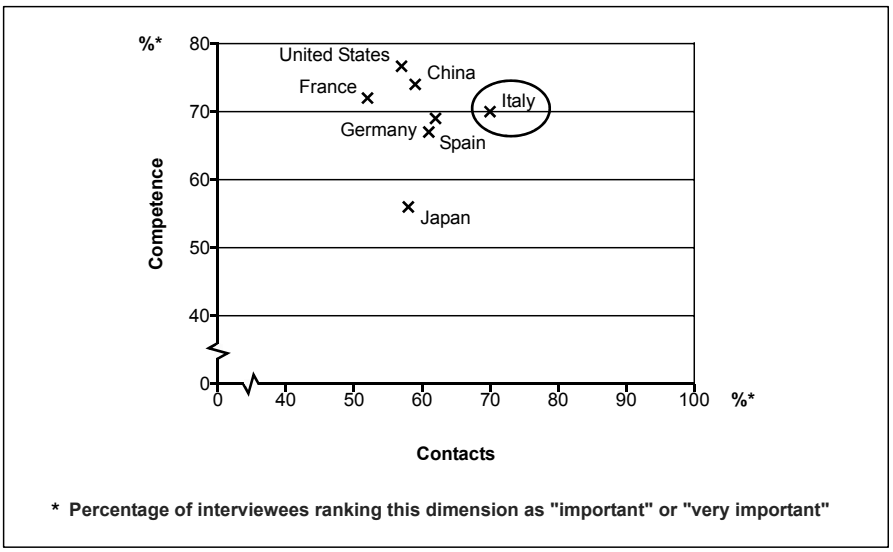

Fig. 1. The importance given to competence compared with the importance given to personal contacts

Rules Observance versus Rules Adapting

Analyzing the attitude of people to observe strictly the rules and comparing it with the attitude to adapt rules to specific situations, Italian culture appears to have a very limited tendency to observe the rules, while the tendency to adapt rules seems to be quite high (Fig. 2).

Wide Vision versus Focalization

Analyzing the preference of looking at things from a wide point of view compared with the attitude of focusing on details, Italian people seem to have a preference on the wide vision, although none of the two aspects are considered decisive (Fig. 3).

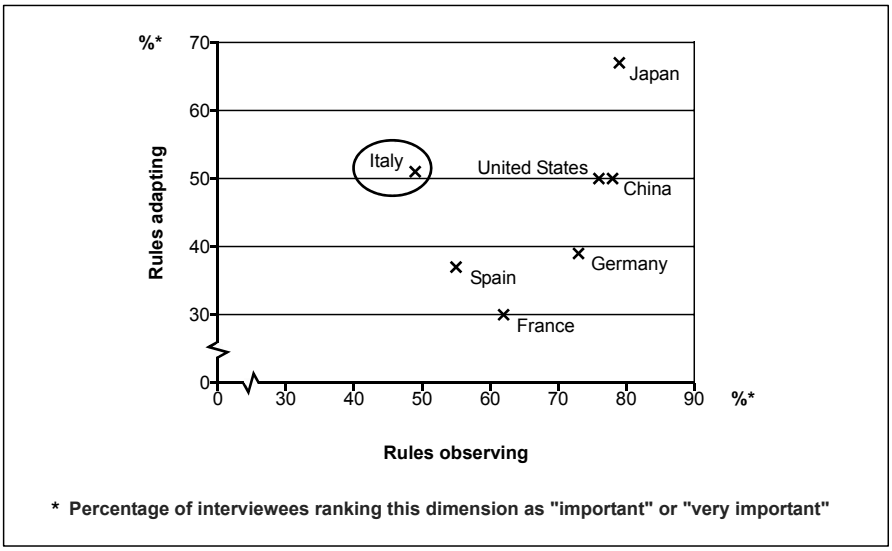

Fig. 2. The importance given to observing the rules compared with the importance given to adapting the rules to each situation

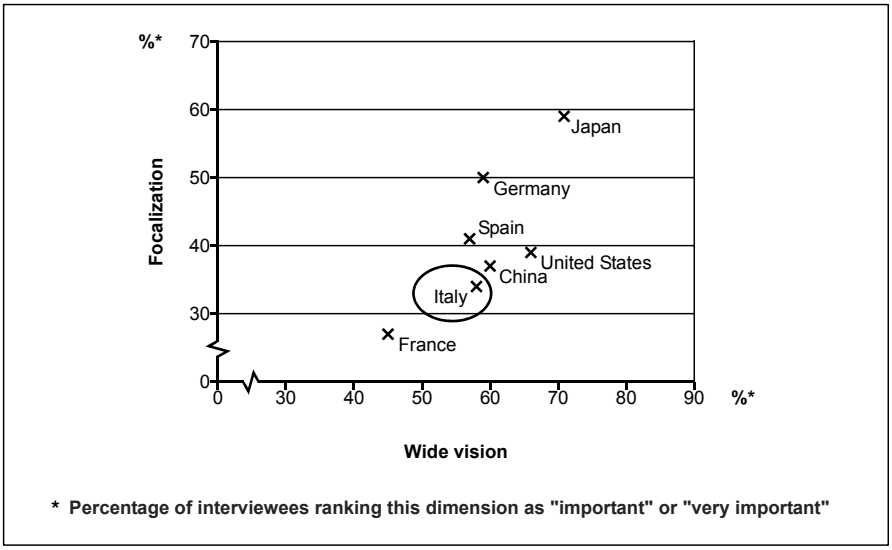

Fig. 3. The importance given to having a wide vision of facts compared with the importance given to being able to focalize

Result Orientation versus Commitment

Analyzing the attitude towards orientation to final results and comparing it with the attitude towards commitment on a task, Italians seem to be much more sensible to the result than to the task itself (Fig. 4).

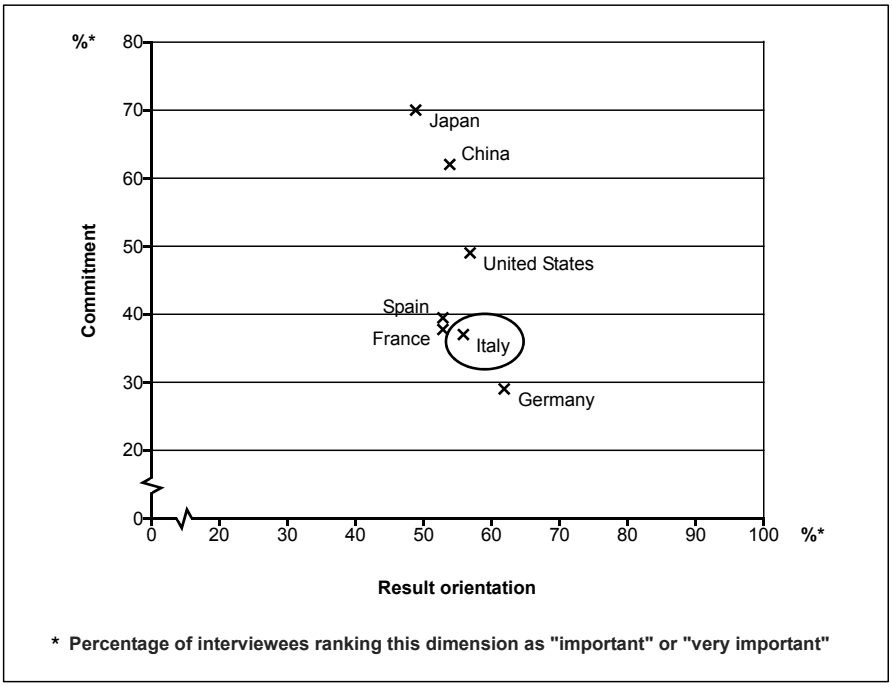

Fig. 4. The importance given to results compared with the importance given to commitment

Long-term versus Short-term

Analyzing the attention on long-term strategies compared to short-term tactics it seems that Italian culture is quite low on both, and this can be explained by preference to look at results rather than strategies or tactics (Fig. 5).

Cooperation versus Individualism

Analyzing the preference to cooperation rather than individualism (Fig. 6), it appears clearly that Italians are much more individualist than cooperation-oriented (interesting here is to notice at the position of the United States that presents very high levels on both factors, that we believe is one of the major strengths of that culture).

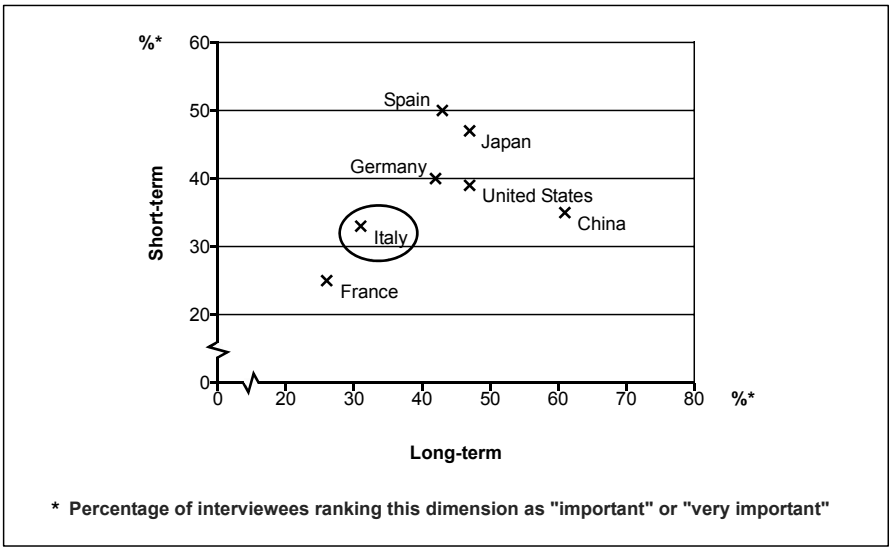

Fig. 5. The importance given to long-term orientation compared with the importance given to short-term orientation

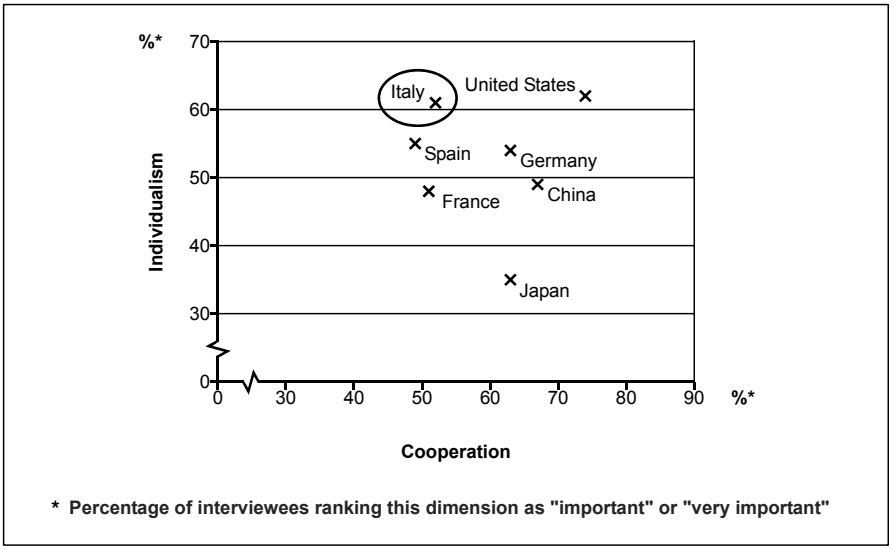

Fig. 6. The importance given to cooperation compared with the importance given to individualism

Proactivity versus Reactivity

Analyzing the attitude towards pro-active behaviors (anticipating events) compared with reactive behaviors (Fig. 7), Italian culture seems to be much more oriented to reactivity rather than to proactivity (interesting here is the Japanese culture that, as the USA in the previous case, is able to balance at the highest level both factors at the same time).

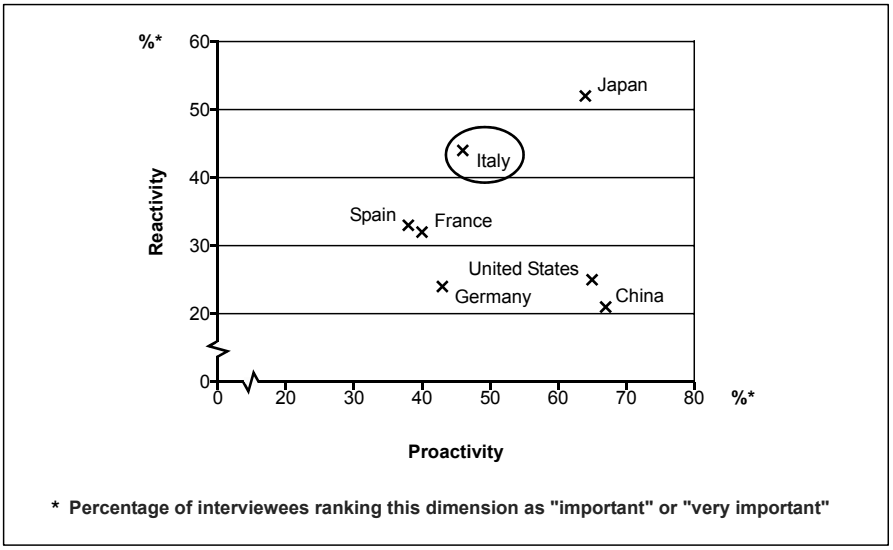

Fig. 7. The importance given to anticipate events (proactivity) compared with the importance of reactivity

Change versus Stability

Analyzing the attitude towards change compared with the preference towards stability, it is evident that Italians are relatively in the high area for stability, but they are also over average for attitude to change (Fig. 8). This is only apparently contradictory, since change and stability are two phases that alternate continuously, therefore feeling comfortable in both moments is a very interesting characteristic. In any case observing the absolute values, it is clear that – especially for the attitude to change – for a continuously changing world as today's the Italian attitude is still not adequate.

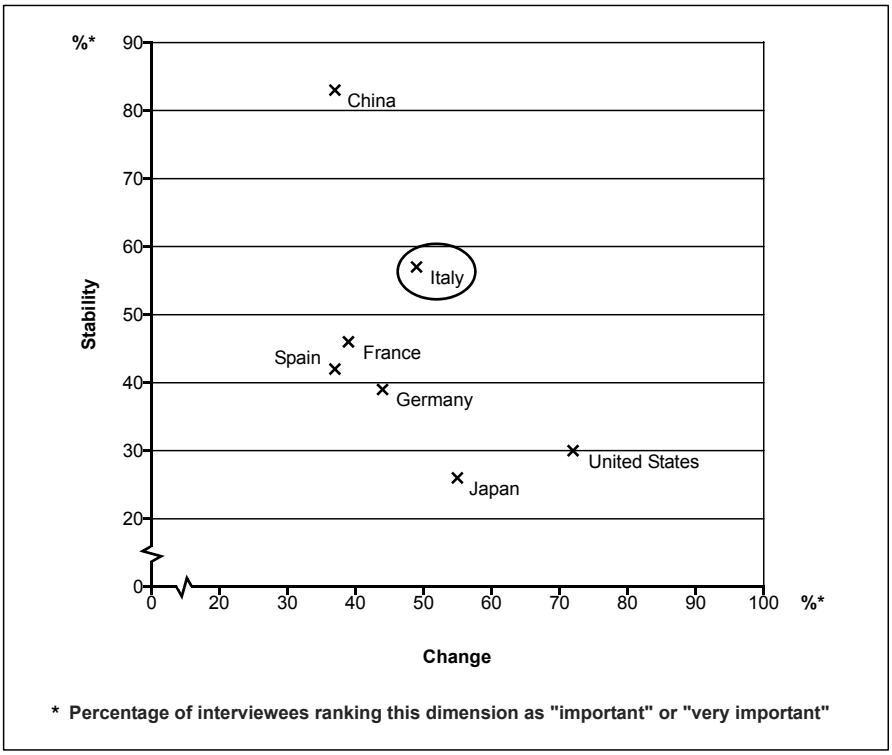

Fig. 8. The importance given to being able to adapt to changes compared with the importance given to perform in stable conditions

But how can this information be useful for the purpose of our study?

First of all we believe that excellence can be reached in several different cultural contexts. But for each cultural context a different model, or at least an adaptation of existing models, is needed, and also the success ratio (i.e. the level of excellence that can be reached) can be different. So the question is if there is a model for business excellence that adapts well to the cultural characteristics of Italian people and companies, and how effective this can be.

Secondly, we believe that the best way (maybe the only way) to reach a true sustainable excellence is to fire on all cylinders of all the above cultural dimensions. In order to reach excellence not only in terms of economic results, but also of environmental and social results, and in order to sustain these results in the long-term creating shareholder value and stakeholder satisfaction, an organization must be able to:

- create value from competence but also from contacts,
- observe the rules but also to adapt them when necessary,
- keep a wide vision but also to focus on details,
- orient its efforts to results but also to keep the commitment on tasks,
- have a long-term but also a short-term planning perspective,
- be proactive but also to be reactive,
- manage change but also to have the best from stability.

In this sense we can interpret the Italian situation. The limited number of Italian organizations using an excellence model can be explained by means of cultural factors, the lack of a wide vision (being excellence a holistic approach), of focalization, of orientation to results, of short-/medium-term orientation, of commitment to tasks, of cooperation.

However many Italian SMEs actually reach good or even high levels of excellence and have excellent approaches (although only few adopt a business excellence model), and this is probably explained by the importance of personal contacts (entrepreneurship), high individualism (owners' leadership), ability to adapt rules (agility), high reactivity (flexibility to customer).

In addition to what has been written for excellence, other factors influence negatively the approach to sustainable excellence. These are the lack of value of competence, of observing rules, of long-term orientation, of attitude to change of proactive attitude. All this together, together with the still quite low level of social and environmental awareness of people, can explain why Italy is still so far from perceiving sustainable excellence as a feasible objective for companies.

We believe that this can be only a first step to the understanding of the relationship of cultural dimensions and the attitude towards sustainable excellence and this is why further, specific studies will be developed to reach a deeper view on this topic. However, we believe that these first results give already a clear idea of the relationship and can suggest some actions to improve the development of sustainable excellence based on cultural leverages.

7 Working on the Cultural Leverages

If our society wants to survive, we need to reach sustainable excellence and this means that we need to deploy many challenging elements of our way of thinking and of behaving. This might contrast with our natural-cultural preference scheme, and this implies our readiness to change.

The Italian case shows this quite clearly. No effort to spread sustainable excellence can be successful if it does not work on changing the culture. The culture of people is reflected in the behaviors of leaders, of managers, of employees and of customers. Enabling that virtuous circle by means of which the market itself will support sustainable excellence, rewarding who has it, penalizing who has not.

So it is a matter of working on the cultural leverages, of changing the culture of people. This can happen at different levels, according to which group of people the change is directed to, who takes the lead of the change and how wide the change must be.

The first level is working at the company's level, where the strongest cultural leverage is corporate culture. Leaders have many ways to change a corporate culture, to embed a culture in an organization. These can be divided into two areas. The first (primary) way is through actions or behaviors of leaders directly aimed at modifying the corporate culture. The second (secondary) are meant to reinforce the primary actions through decisions that do not influence directly the culture but are able to support and to motivate the change.

The first of the primary ways to modify or embed a culture is the leader's role model, the way he/she behaves, acts, takes decisions. What the leader pays attention to, how he/she reacts to critical situations (moments of crisis are extremely important for the creation of a culture), how they allocate resources. But most of all the criteria through which leaders measure the performance and the way they reward people.

The secondary ways of embedding a culture are in the design of the organization, in systems and procedures implemented, in the physical appearance of workplaces and in all the formal statements expressed by the organization. These are all factors that can reinforce the primary actions.

It is of extreme importance that all the actions above are aligned on the same objective. Contradictions or conflicting objectives not only reduce the effectiveness of the action, but might cause some serious problems inside the organization. This must be carefully taken into account when a leader delegates some of the above actions to others within the organization.

But sustainable excellence is something that goes beyond the single company. The cultural factors determining its success or its failure are sometimes too firmly rooted to be modified at a company's level. Therefore two more levels of intervention on the cultural leverages are necessary.

The second level is working on the mechanisms of the industry, of the sector or of the market. The role of the leading companies of the sector, for example in case of the manufacturing industry of the big OEM's, is ex-

tremely important to guide a cultural change. They play a leading role and most of what has been written above for companies' leaders apply almost perfectly to them. But sectors (or markets) have also other ways of acting on the culture. The main one is the level of controls and inspections. A culture is a comfortable way of behaving, few people are willing to change their habits if not pushed to do so. If one wants this to happen, and positive behaviors to overcome negative ones, with a virtuous circle being activated, objective controls and inspections are extremely useful, at least at the beginning of the journey (in some cases, as the Italian one where there is a strong attitude to adapt rules, third party inspections are advisable). A focused measuring system linked to the inspection system can then reward actions that go in the direction of the new culture and discourage behaviors that do not.

Finally, the third level, that is the national (governmental) level. Here, who has to lead the way playing a role model are first of all the political leaders (who sometimes do not acknowledge this role). And the tools available to the leaders are the laws, but even more important the controls.

But also society leaders, media and education systems have a fundamental role. And once again, it is of primary importance that all these actions are aligned in the same direction, and sustained over a sufficient period of time to be able to actually modify the culture of people.

8 Conclusion

We strongly believe that we will see sensible actions and investments for sustainability from organizations only when sustainability will be considered among the main drivers to competitiveness and to overall business results. This includes at least adopting a wider stakeholder orientation strategy, increasing the weight of long-term results versus short-term, and considering seriously the impact on society as a fundamental driver for the image of the organization on the markets. All this can be achieved only if included within a wider strategic framework, and we believe that the business excellence framework fits perfectly to the scope. In this way the goal of global sustainability merges together with the goal of sustaining the organization's own business results over time, and the efforts to reach these goals will surely increase. This approach has here been called sustainable excellence.

However, there are several barriers to achieve and spread sustainable excellence, and many of these have cultural roots and need cultural changes.

Many people think (or prefer to think) that it is not possible to modify people's culture. There is so much evidence in literature but also in everyday life that this is not at all true. A culture can change. First starting from the artefacts, then the exposed values and finally the basic assumptions. They can all change. It needs a focused actions of leaders, it needs an aligned system supporting it, it needs a strong measuring and controlling system able to correctly reward behaviors that go in the direction of the new culture and discourage the others. It surely also needs time, but much less time than what we might think, if the actions are really focused and well sustained.

It is true that culture is a community's DNA, but also DNA can change. It is called Evolution of Species. And we strongly believe that if we want our species to survive, our next evolutionary step is called sustainable excellence.

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Part 3

Human Factors in Organizational Design and Management – Creating Sustainability

Building Sustainable Human-Centered Systems: A Grand Challenge for the Human Factors and Ergonomics Discipline in the Conceptual Age

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1 Sustainability in the World of Technology, Science, and Engineering

According to the *World Commission on Environment and Development* (1987), sustainable development can be defined as *development that meets the needs of the present without compromising the ability of future generations to meet their own needs.* Today, the sustainable economic growth and development pose serious challenges to both the developing and developed countries worldwide (Scott et al. 2001; Bieker 2005; Duderstadt 2008). One of the main questions in this regard is how can the technological and engineering solutions affect the long-term ecological, social and business resilience (Gunderson and Pritchard 2002; Stiglitz 2006). The general characteristics of the diversely resilient business systems (Fiskel 2003) are illustrated in Table 1 below.

Table 1. Characteristics of diversely resilient business systems (after Fiskel 2003, p. 5333)

Product system	Multiple product configurations and extensions
Enterprise system	Encouragement of diverse business strategies
Ecosystem	Biodiversity in terms of species variety
Socio-economic system	Ethnic, cultural, institutional, and political diversity

As discussed by National Academy of Engineering (NAE) (2004), technology is both a product and a process involving both science and engineering. Engineering, which seeks to shape the natural world to meet human needs and wants, is a body of knowledge of design and creation of human-made products and a process for solving problems (Wulf 1998). While there has been a relatively weak relationship between scientific advances and technology until the time of the *Second Industrial Revolution*, today the science, engineering, and technology are making significant contributions to global economic prosperity. For example, it is estimated that about 30–60 % of gross domestic product (GDP) in United States comes from 20–65 % return on investment in science, engineering and technology.

According to L. Creighton (2001) of the American Society of Engineering Education, contemporary society is becoming more technologically challenged and more environmentally sophisticated and industry leaders have to stay current in what is happening on all of those levels. In the not too distant future, the convergence of nanotechnology, biotechnology, and information technology will most likely impact every facet of society including medicine, health care, computer, information, communication, environment, and the economy, which will only increase the above outlook (National Research Council 2002; Roco and Bainbridge 2003; Sequeira et al. 2006). According to Henry T. Yang, Chancellor, University of California Santa Barbara, "*Nanotechnology will mandate a highly multidisciplinary approach in education and research, cutting across the boundaries of chemistry, biology, physics, materials, and all aspects of engineering*"[1].

Another important trend that will shape our future in the next 20–50 years is the advent of the conceptual age (Pink 2006), which is to follow the information age (Fig. 1) of today's *Flat World* and the "wired" global society (Friedman 2006). The conceptual age will be dominated by the "*creators and empathizers*", and specifically, the "right brain thinkers" whose abilities draw a line between those who get ahead in the competitive business world and those who do not (Fig. 2). There are several reasons why the *creators and empathizers* will rule in the coming conceptual age, including the importance of human creativity and a shift by the empathic society from consuming physical or virtual products to consuming human experiences (Fig. 3).

[1] see: http://www.nsf.gov/crssprgm/nano/reports/endorse.jsp

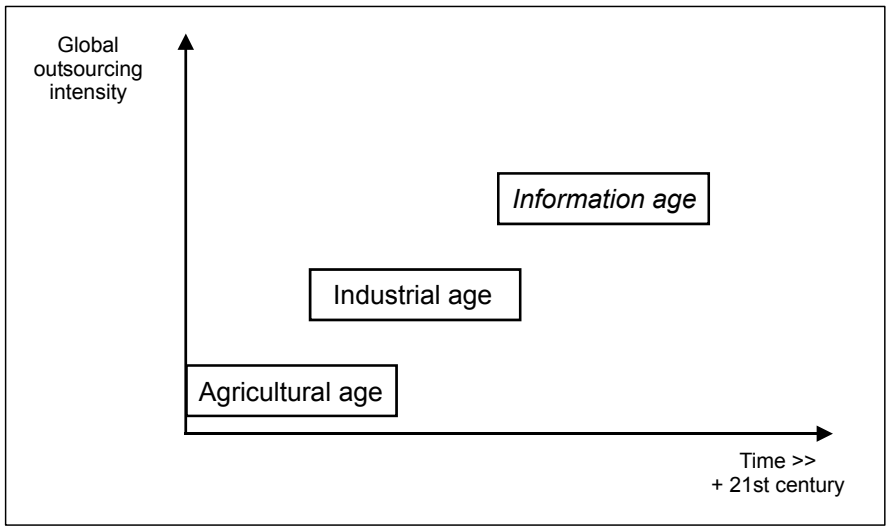

Fig. 1. The IT-based economy of the Flat World (Pink 2006) in the information age (after Karwowski 2007b)

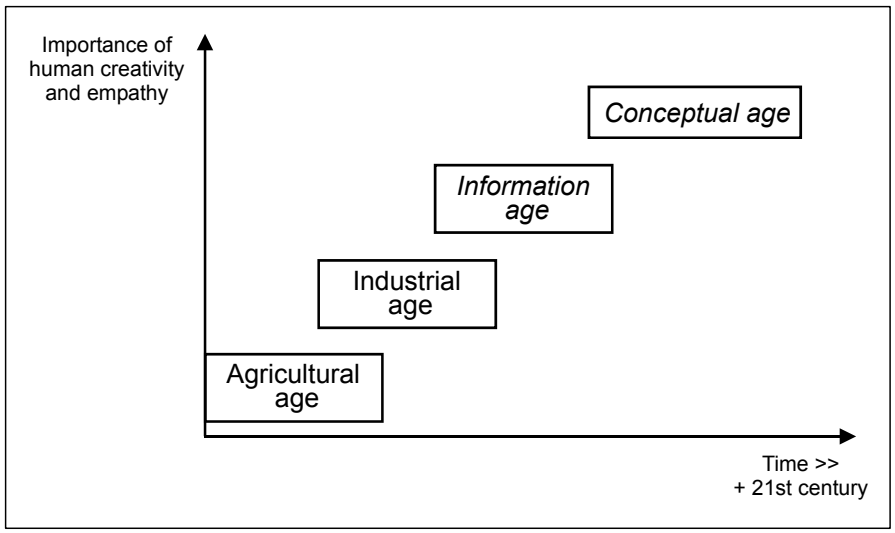

Fig. 2. Human creativity and empathy in the conceptual age (after Karwowski 2007b)

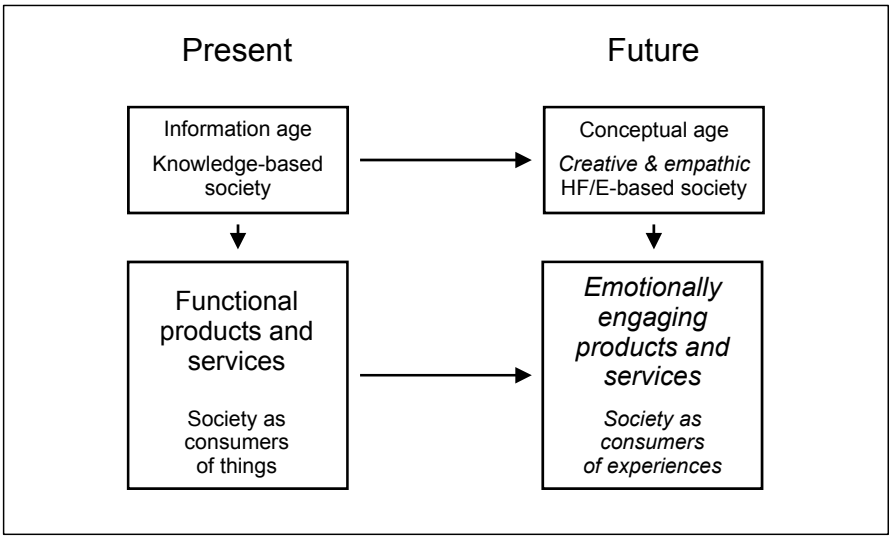

Fig. 3. Building the HF/E-based society in the conceptual age (after Karwowski 2007b)

The above discussion provides a context for exploring the nature of contemporary and future interactions between humans, technology and natural environments, which are in the heart of the field of human factors and ergonomics (HF/E). According to the International Ergonomics Association (IEA 2000), HF/E is the scientific discipline "*concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies, theory, principles, data and methods to design in order to optimize human well-being and overall system performance*". It should be noted here that the integration of science and technology in the 20th century has led to lifelong learning requirements, while the rapidly expanding body of knowledge has produced a need for both technological and HF/E literacy of the workforce. In articulating the benefits of technological literacy, the NAE (2004) pointed out that "*in the future, ongoing developments in engineering will expand toward tighter connections between technology and the human experience, including new products customized to the physical dimensions and capabilities of the user, and ergonomic design of engineered products*". A need for HF/E literacy, which prepares citizens to perform their roles in the workplace and outside of the working environment, was discussed by Karwowski (2007a).

2 Grand Challenges and Opportunities for Engineering

Recently, the NAE has initiated an open debate on the world's grand challenges and opportunities for engineering in the 21st century[2]. To date, a large number of ideas, desires and opinions have been proposed, including the following examples:

- clean nuclear energy
- eliminate pollution of the environment
- develop an efficient energy transformation system to utilize the solar energy
- develop an efficient greenhouse gases absorption system
- build a space elevator
- enable space travel out of the solar system
- create self-sustainable, extraterrestrial and extra-solar colonization
- assure control over climate and weather
- develop self-constructing materials
- develop an understanding of the human-level intelligence and consciousness
- develop artificial general intelligence (artificial brain)
- build an offsite backup system for humanity

Former President Jimmy Carter has synthesized many of the above challenges when he said: "*My own hope is that the engineering community will devote part of its effort to devise and apply technological advances to meet some of the rudimentary needs of water, fuel, housing, health, and information*"[3]. In view of the above, one should ask what are the greatest challenges for HF/E discipline and profession in the next 50 plus years. As the world around us is rapidly changing through profound technological, economical, social, environmental and cultural transformations, including the onset of a wired global society, globalization of consumer markets and outsourcing of manufacturing capabilities, but also experiencing the digital divide, increasing greenhouse gases pollution, and global climate changes, is the greatest challenge for HF/E discipline and profession to fundamentally redefine itself, or simply refine and polish what it does today?

[2] http://www.engineeringchallenges.com
[3] http://www.engineeringchallenges.org/cms/7125/Carter.aspx

3 Grand Challenges and Opportunities for the Human Factors and Ergonomics Discipline in the 21st Century

Over the last 50 years, human factors and ergonomics (HF/E) has been evolving as a unique and independent discipline that focuses on the nature of human-artifact interactions from the unified perspective of science, engineering, design, technology, and management of human-compatible systems, including a variety of natural and artificial products, processes, and living environments (Karwowski 2005). Today, the HF/E professionals worldwide contribute to the *design and evaluation of tasks, jobs, products, environments and systems in order to make them compatible with the needs, abilities and limitations of people* (IEA 2000).

However, given the unparallel in modern civilization's development throughout history, one must wonder if what we inspire as both a HF/E profession and as a discipline is sufficient. For example, the current mission statement by the Human Factors and Ergonomics Society reads, in relevant part, that we "promote the discovery and exchange of knowledge concerning the characteristics of human beings that are applicable to the design of systems and devices of all kinds", and that we "advocate systematic use of such knowledge to achieve compatibility in the design of interactive systems of people, machines, and environments to ensure their effectiveness, safety, and ease of performance"[4]. In the context of the above discussion, one should ask the question, is the "effectiveness, safety, and ease of performance" all that the HF/E discipline is about?

As discussed by Karwowski (2007b), one needs to contemplate whether the current mission of HF/E is fulfilled when helping to design cars that are effective, safe, and easy to perform (operate), but consume a lot of gas; or when we design power plants that generate energy by burning fossil fuels and also release a great amount of CO_2 into the atmosphere; or when we design effective, safe and easy to operate meat production facilities that utilize water-intensive cattle farming for beef production? Should we care that it takes on average 500–1,500 liters of water to produce one kilogram of potatoes, but to produce the same amount of beef we need between 15,000 and 70,000 liters of water? At the same time millions of people around the world do not have direct access to clean potable water.

Clearly, the problems of sustainable environments, greenhouse gas emission, and energy and clean water supply security for the entire human population on this earth important should prompt us to consider changing the focus of HF/E profession. Therefore, the key questions about the role

[4] www.HF/Es.org

of the HF/E discipline and profession in the modern society of the conceptual age are as follows (Karwowski 2007b):

- How can we be useful to society at large and what are our aspirations and opportunities to contribute in this regard?
- Should we be indifferent to the greater (i.e. socio-political) context in which we advocate the benefits of the theory and practice of the human-centered design?
- Is it enough to be user-friendly regardless of the socially and environmentally unsustainable systems we try to make compatible with humans?
- Should the focus of the human-centered design paradigm be redefined in order to reflect the fact that we do care about the above challenges of the 21st century, which seemingly only indirectly have anything to do with human-technology interactions?
- Should we advocate the systematic use of HF/E knowledge (and what HF/E knowledge should this be?) to achieve compatibility in the design of (environmentally sustainable?) interactive systems of people, machines, and environments to ensure their sustainability, economic and social effectiveness, safety, and ease of performance?
- How can we contribute in a meaningful way to the development of sustainable systems and technologies?

4 Business and Social Sustainability: Constraints and Opportunities

According to Fiskel (2003), sustainability needs to be considered at least at three levels, i.e. the society, enterprise and product. A sustainable society is one that continues to satisfy the current needs of its population without compromising quality of life for future generations. A sustainable enterprise is one that continues to grow and adapt in order to meet the needs and expectations of its shareholders and stakeholders. Finally, a sustainable product (or service) is one that continues, possibly with design modifications, to meet the needs of its producers, distributors, and customers. It is interesting to note here that a study of 160 companies indicated that the main determinants of superior financial performance were not technology-based, but rather organic system traits, an achievement-oriented culture, a flexible and responsive structure, a clear and focused strategy, and a flawless execution. Another study by Royal Dutch Shell (de Geus 1997) aimed to understand what drives corporate longevity. The average life expectancy

of large corporations worldwide was less than 50 years. There were several factors that distinguished long-lived companies, including the sensitivity and adaptability to business environment, cohesion and sense of identity, tolerance of diversity (decentralization), and conservative use of capital, but profitability was not among them (Fiskel 2003).

5 Building Sustainable Human-Centered Society

According to Francis Bacon, the purpose of science is "mastery over nature" (Bacon 1620). In this context, it can be proposed that the main purpose of human factors/ergonomics discipline is to optimize the beneficial affordances of the environment in order to ensure control of such environment by the society. Furthermore, sustainable HF/E design refers to (1) the design and management of affordances provided by the environment that are compatible with human social needs, abilities and requirements for sustainability and, (2) the design and management of affordances that are compatible with social needs and requirements for sustainability. In other words, sustainable HF/E design is one that maximizes desirable (positive) affordances of the environment and minimizes its undesirable (negative) affordances. Fiskel (2003) divided environmental performance indicators of sustainability into five different categories including material consumption, energy consumption, local impacts, regional impacts, and global impacts (Table 2). On the other hand, the societal indicators of sustainability have been divided into six categories, including quality of life; *peace of mind*; illness and disease reduction; safety improvements; and health and wellness (Table 3).

Table 2. Environmental sustainability performance indicators (after Fiskel 2003, p. 5337)

Material consumption	Product and packaging mass
	Useful product lifetime
	Hazardous materials used; eco-efficiency
Energy consumption	Life cycle energy
	Power use in operations
Local impacts	Product recyclability
	Runoff to surface water
Regional and global impacts	Smog creation, acid rain precursors
	Biodiversity reduction
Global impacts	Global warming emissions; zone depletion

Table 3. Societal indicators of business sustainability (after Fiskel 2003, p. 5337)

Quality of life	Breadth of product or service availability
	Employee satisfaction
Peace of mind	Perceived risk and community trust
Illness and disease reduction	Illnesses avoided, mortality reduction
Safety improvements	Lost-time injuries
	Number of incidents
Health and wellness	Nutritional value provided
	Subsistence costs

Following the ramifications of the need to consider ethical values in the context of metaphysics of ergonomics as discussed by Moray (1995), it is proposed here that the problems of sustainable environments, hunger and malnutrition, greenhouse gas emission, energy and clean water supply, and energy security for the entire human population on this earth are important enough to consider changing the focus of HF/E discipline and profession.

Therefore, it seems that the greatest challenge for HF/E today is to develop a new mission of *sustainable human-centered philosophy and design* that advocates the systematic use of HF/E knowledge (and specifies what knowledge should this be?) in order to achieve compatibility in the design of environmentally, economically and socially sustainable interactive systems of people and technology (Karwowski 2007b).

6 Conclusions

Contemporary society of the information age can be characterized by complex technological, economical and cultural transformations, including globalization of consumer markets, outsourcing of manufacturing, service and R&D capabilities, and the birth of a flat and wired global society, but also by the unintended consequences of the digital divide, as well as increasing environmental pollution, and global climate changes (McFarlane 2006; Rosina et al. 2007). In not too distant conceptual age, HF/E should provide a social contribution that matters by helping to solve global challenges such as energy and water security, population malnutrition and starvation, effects of armed conflicts and diseases, and contribute to increasing healthy life expectancy and economic prosperity of all citizens. Furthermore, the HF/E discipline and profession should be in a position to help in developing a sustainable and socially vibrant society (Karwowski 2007b):

- that is HF/E literate and directly benefits from HF/E science and applications,
- where children start learning about HF/E in primary schools,
- where technology is developed around the needs, abilities and limitations of all people,
- where consumer products, services, processes and work and leisure systems are designed based on human usability requirements,
- where economy benefits from applications of the HF/E knowledge and expertise.

In the conceptual age, the HF/E discipline and profession will be well-positioned to facilitate the highest quality of life for all citizens by developing universally usable and human-adaptable technologies for people of all ages, and by creating an HF/E literate society everywhere and in all areas of human endeavor. The HF/E of the future should be one that influences public opinion and consumer choices through high quality user-friendly publications, develops a broad educational base in HF/E worldwide, and serves as the most authoritative global resource of HF/E scientific knowledge and applications. By doing so, the HF/E profession should be able to earn and enjoy massive membership and global presence, and become widely recognized by mass media and appreciated by the public for its contributions to science, design, engineering and management of human-compatible leisure, home and work systems.

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Achieving Sustainability through Macroergonomic Change Management and Participation

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This article argues that sustainable development can be achieved through a conscious effort to work through people and organizations to drive change (bottom up strategy) at the societal and political, legal and global levels (top down). This will require a cultural shift that allows people and institutions to be receptive to change. Macroergonomic change management is a vital part of making this possible. Moreover, participation is a means for driving change because it has emotional and psychological components beyond the rational facts of sustainability.

1 Sustainable Development

The World Commission on Environment and Development (WCED) defined sustainable development as: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland 1987). The WCED called for international cooperation, institutional and legal changes to realize this vision. Many of the predictions from this report did not materialize; nor did the international collaboration or infrastructure. Perhaps nation states' self-interests, economic and corporate profit motives, or the sheer immobility of politics have prevented sustainable development from being realized. This strictly top-down approach to creating societal change did not have the intended effect.

Another way of moving toward sustainable development is through an organization and human systems approach. Some of the greatest social

movements in human history have been initiated through individual and group efforts rather than political or governmental mandated change.

Macroergonomics takes such an approach by examining the social, organizational and human interfaces (Hendrick and Kleiner 2002). By examining the interfaces among humans, organizations and technology we develop a better appreciation of the context within which changes need to occur. Participatory ergonomics (Imada 1991) may be a particular macroergonomic tool that can help realize global sustainable development. Without active participation from individuals it is difficult to imagine real change occurring to make sustainability a way of life in many societies and organizations.

2 The Challenge to Sustainability

Sustainable development might be one of the largest social awakenings of our time, rivaling social shifts in feminism and environmentalism of the latter parts of the 20th century. People and organizations need a new paradigm to make this shift. To date, we have disciplines that emphasize not hurting humans, smart use of recycled materials, reducing our footprint on the planet, and alternative forms of energy. Being truly sustainable requires a systems view of preserving human, natural, environmental, and energy resources as a normal course of activity. The challenge is to move out of these segmented views of sustainability into a more holistic perspective (Zink 2007).

Fortunately, we have a better understanding of how to overcome some of these challenges. Change management has taught us important lessons that we might be able to use in this challenge.

Inertia. People and organizations do not change naturally. Homeostasis is a powerful force that creates comfort and familiarity. This is particularly true when things are going well (e.g. profitability, happiness) or when the identified problem does not affect the person or institution. Stability and the predictable patterns that it creates help us to derive meaning, have a sense of control and understanding of our environment (Huy and Mintzberg 2003). The challenge is that people and systems have good reasons not to change.

Beyond rationality. Facts are interesting and useful. Intellectual buy-in to ideas is once again an insufficient condition to produce change. We may be presented with facts about global warming (e.g. Gore 2006) and alarmed by its potential and long-term effects. However, mobilizing people to change their behavior requires understanding their own rewards, self-

interests, emotions and behavior patterns. Change occurs because people understand that they must change and the task-related, emotional and behavioral components support that change (Roberto and Levesque 2005).

Fears and concerns. Whenever change is proposed it exposes people to deep-rooted or new fears and concerns. Despite the fact that the change may involve a good idea, the question of how it affects me always emerges. Questions about adequacy, place, relationship and acceptance are always risky when people challenge the existing way of doing things. Doubts and the fears that they create can overcome the greatest ideas or intentions to change.

Cultural collisions. Behaving or managing in a sustainable way will create conflicts with existing operating systems, norms or rules. Violating group, corporate, regional or national culture can have serious effects for the change agent or the change effort. Imada (1994) identifies different cultures that exist within organizations and the importance of the normative behaviors in each of these cultures to make ergonomic changes successfully. In a large-scale change toward sustainability there will be conflicts with existing cultures and subcultures within systems.

Suboptimization. While an organization may have the will to move toward a sustainable future, people in different levels and departments make unique decisions that are sensible to them but are counter to the larger initiative. This is in part inertia, but also a rational decision to maximize local processes. In some cases it makes good sense to behave differently. However, in doing so, the entire system is degraded. Individuals making unique decisions despite the organizational or system intent can be a challenge to change.

Power. Change can alter existing influence, authority and economic interests. These are strong forces to overcome. Those who stand to lose power or advantage in the change will put up the greatest resistance. Precisely because they already have the power in the current system, these are formidable adversaries to implementing change.

Capability. Though we may want to make the change and have the intention to make the change, people and systems may not possess the capability or infrastructure to change. Enabling people to change can occur at different levels. At the individual level people may need training, coaching, tools, or need to be given alternatives to perform tasks. At an organizational level changes in authority, responsibility, rewards, feedback, scope or expectations may be required to create this capability. Having the intention must be matched with an infrastructure that supports the capability for people to change.

3 The Ergonomic Alternative

Ergonomics is well-suited to address the challenges that sustainable development presents. From the early years the discipline has been associated with efficiency of movement, energy expenditure, ease of use, and cost reductions from waste. From mechanical and economic points of view, ergonomics has contributed to meeting human and organizational needs without compromising the future. The future has been preserved primarily through reductions in effort, injury, and economic competitiveness. Ergonomics has evolved far from the efficiency expert, time and motion study paradigm to profound ways of enhancing human capabilities (e.g. Boff 2006). Nevertheless, our professional heritage can be traced in improving efficiencies in the human-activity interface.

As with most large-scale system changes, having the technology to make the change is merely a necessary but insufficient condition. Getting people, organizations, institutions and social systems to preserve resources, energy, human capital and the environment cannot be approached in a simple cause and effect model. At the same time, overarching change efforts and theories, whether economic, political, or legal, that exclude the human factor are also insufficient. Macroergonomics appears to offer an approach that considers the human condition with respect to the organizational, social and technological contexts. For example, understanding how humans interact with their tools and activities has limitations when we are trying to make changes (e.g. reducing effort, injuries). Organizational rewards, group norms, individual values and available work methods have an impact far beyond the human technology interface. Understanding these contextual factors is what allows us to make meaningful change.

Implementing Enterprise Resource Planning (ERP). Imada and O'Dell (2004) describe a macroergonomic change effort in introducing ERP software into an existing organization. ERPs are alluring because they can integrate data systems and merge the functioning of independently operating systems into a unitary whole. They have the potential to increase efficiency and coordination across the entire enterprise and enables the enterprise to make informed, real-time decisions.

Like the move toward sustainability, ERP introductions require cultural changes in nearly all aspects of organizational life. ERPs changed organization's consciousness about what is possible and necessary. They also changed people's reality about what they did and how they performed their work. These present a series of physical, psychosocial organizational and learning challenges (e.g. see Imada and O'Dell 2004, p. 837).

Imada and O'Dell (2004) describe the communication, participation, training and support that were executed pre-implementation, during the ERP implementation and beyond. This change management process was an active part throughout the project's life cycle and continued years after the introduction of the ERP. The macroergonomic approach taken in this project had a positive effort in managing a profound change in an organization's life. Notably, the pre-implementation steps identified fears and concerns, anticipated cultural collisions and avoided power conflicts. The implementation phase dealt with the inertia by providing both the rational basis for the change as well as addressing fears and concerns. Training offered during the implementation further reduced fears and increased the system's capability to respond. Finally, life after the project implementation ensured that the project achieved its objective and prevented suboptimizing back to more comfortable ways of conducting business. This same approach can be used to manage change toward sustainability in other organizational systems.

Central to a successful change management effort is a clear vision and direction from credible sources. Agreement on difficult decisions from key stakeholders sets the tone for the rest of the organization. It is not possible to over-communicate this vision before the implementation. A well-defined communication plan targeted to different consumers (levels, divisions, interfaces) was critical before the implementation even began. The communications, training and involvement addressed people's feelings, fears and concerns. Speaking directly to individual self-interests helped to break down barriers to change. Engaging stakeholders from several levels in the organization enabled people to understand and cope with the changes.

Defining values. At a time when an organization was about to embark on significant changes in its history, the leadership group stopped to identify its own values. After growing successfully for more than two decades, the leadership group took the time to understand the most important things about the company. Over a period of several months the group agreed on a set of six values that made the company what it was and should be promoted. While this kind of activity is often written off as soft people-oriented work that sits on shelves, in this case it was extremely useful. First, by engaging the management it created alignment on what had led to their success and what they wanted to retain. They had a sharper image of the future they wanted to create. Second, this was the first time that they understood why they were going to have to change. Until this moment they had been "working in the business"; now they were "working on the business". This view of themselves allowed them to make significant changes about their future easier. These values provided a rational basis for making

difficult decisions when the time came to make choices. The discovery of these values reduced the inertia and tendency to get back to work instead of making difficult decisions. Many of the doubts were already addressed and their future was more important than their current fears. The values became the heuristics for making change rather than dealing with each decision independently.

Similarly, if organizations, groups or individuals understand their purpose, vision and goals beyond their immediate environment, it is possible to see sustainability in an entirely different context. Personalizing the issue also helps in this process. For example, preserving our personal resources (e.g. family, relationships, health, longevity, earning potential) seems to be an easy act of self-interest. However, we find it difficult to change the behaviors that threaten these assets until we understand the values that motivate us. It becomes easier to change when confronted with the possibility of a future without these sustained capabilities.

Changing the system. Imada (2002) describes a macroergonomic approach to reducing injuries in a petroleum delivery system. The intervention involved altering multiple parts of the system to enable it to be able to achieve its safety performance. Changes were made in training, rewards, recognitions, responsibility, selection, equipment design, supervision and senior management. Collectively, the interventions altered the entire system in a holistic way to create a culture that is receptive to change. System changes are more difficult to conceive and implement but they are important ways to consolidate the leadership and prevent power struggles in the future. This also reduces the suboptimization that occurs when individuals are allowed to make the best decision for themselves at the expense of the entire system.

Similarly, interventions toward achieving sustainability need to take a systems view over a long time horizon. The macroergonomic principles outlined in Hendrick and Kleiner (2002) offer a plan for how these interventions might be approached. Like most systems, change occurs over the long-term and in a nonlinear fashion. However, continuous change at a systems level breaks down inertia and increases the organization's capability to respond to change in the intended direction.

Engaging stakeholders. A wide range of studies have shown that participatory practices can have positive effects on ergonomic programs as well as creating system-wide changes (e.g. Kogi 2006). Imada and Stawowy (1996) used a participatory methodology to redesign food stands in a professional sports venue to improve speed of service. The approach engaged workers, managers, unions, maintenance personnel and designers in ergonomic principles for improving speed of service. Teams used a problem solving approach to identify changes, create two-dimensional solu-

tions, build mock-ups, test and finally implement the change. Speed of service was improved by 10 % at minimal cost. Food stand workers were happier with their redesigned work and relations with the union and customers improved.

The engagement of workers in the process and subsequent communication about the change were as critical as the ideas being implemented. Much of the resistance to change came from being comfortable in a successful, prestigious organization. Any attempts to alter work processes raises fear and concern. Participatory ergonomics enabled people to express these doubts and concerns.

This is another example of how macroergonomic ideas can be used to create changes in systems toward sustainability.

Imada (2007) points to the need for participatory ergonomics as a means of expanding ergonomics to a wider set of audiences and applications. Our boundary for what is ergonomic has been defined by our science-based findings. These findings can be expressed as a finite set of principles, facts, or theories. However, to expand this knowledge base to new and undefined applications (e.g. outer space, nanotech and virtual environments) our findings need to be validated and verified. By engaging users, owners and stakeholders in the ergonomic process we can find more applications for our existing body of knowledge and break ground in new frontiers. This is consistent with the cybernetic concept of requisite variety (Ashby 1956). Simply stated, to remain stable, a system's control or regulator must exhibit the same level of variety as its environment. Environmental variety is made up of the number of changes or random shocks. Variety of the regulator in a system is the number of responses it can make to these environmental changes or shocks. For ergonomics or a change strategy to remain viable, it must be able to produce at least the same variation as the applications or users demand. In addition to producing the same number of responses to the environment, the system must produce the right response. In rapidly changing environments the system must have a range or potential responses to match the environmental turbulence. Engaging users, conflicting parties and stakeholders is an important means for creating this variety.

Active participation in ergonomics, and in this case sustainability, can create experiences that lead to ownership, a more profound understanding of the problem, and engaging people emotionally. Dealing with facts is a rational process. People may understand the need to change and behave differently. Unless this experience can be moved to a deeper understanding and meet human needs, change is less likely. Imada (2005) believes that this deeper understanding can be conveyed in stories or vignettes that capture the human experience in the change effort. The retelling of these ex-

periences creates a base from which people can draw and understand at a level that promotes action.

4 Conclusions

National self-interests, economic forces and the naturally conservative nature of organizations can overwhelm legislated, regulated or mandated solutions to sustainability. Efforts to improve sustainability by meeting human, economic or environmental goals are only partially successful, and more importantly, often conflicting (e.g. reducing carbon emissions costs more). Efforts to date are driven by fragmented interests and disciplines. There is no holistic perspective for improving the total human condition.

Sustainability is often perceived as an egalitarian social objective. Enterprises and people focus more on survivability (meeting challenges in constantly changing environments) than sustainability. These are not mutually exclusive goals. To be workable the solution must have at least three components. First, it must examine the entire system. Solutions need to examine social, organizational and human interfaces. Second, the solution must also have a plan to manage change. Specific actions should target the challenges to change cited earlier in a systematic and planned fashion. This needs to occur at social, organizational and personal levels. Finally, solutions need to have a longer time horizon beyond short-term metrics. The original Brundtland (1987) definition used future generations as the time for assessing sustainability. Few systems today have that time scale and relevance.

Pikaar, Koningsveld and Settels (2007) cited the many challenges and ergonomic solutions to serving more diverse users and situations. Sustainability poses a new set of diversity questions and issues that challenge ergonomists to migrate from traditional clients, customers and venues to a new set of circumstances and criteria. How might we get there? Boff (2006) describes this journey from: (1) changing tools to adapt to human characteristics; (2) harmonizing humans and technology for cognitive fit; (3) optimizing human physiological and cognitive capabilities in harmonized systems; and (4) possibly altering humans to enhance human and system performance. While we may be comfortable with altering systems for sustainability (e.g. increasing energy efficiency) we may be less comfortable with altering humans to consume less. Making these transitions will not be easy. Until that bifurcation at each phase transition, we continue to apply what we know from our science. Ergonomics has often been viewed as science-based and robust enough to be generalized to

known situations and users. Indeed, ergonomics can be found at work, at home, play or shopping. At one point in time, we may enter an arena where the diversity (e.g. the problem, environment, user) exceeds our knowledge and capability.

Macroergonomics can bring together management concepts, ergonomic technologies, change management strategies and participatory techniques to move toward reasonable use of economic, social and environmental assets. Why the macroergonomic approach? First, macroergonomics examines the human-organizational, human-technological, and technological-interfaces that are necessary to come up with a system based solution.
Second, contact with the management and stakeholders in enterprises and organization allows a more comprehensive change management strategy than either a top-down or discipline-based initiative (safety, environment, procurement, sanitation). Finally, with the first two points, ergonomics addresses human needs. Imada (2005, 2007) identifies this as one of the major advantages that ergonomics has over other solutions, which must be human-centered and address human and personal needs. Done through stories, listening and engagement, ergonomics has the potential for making a large contribution to global sustainability.

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Continuous Technology Implementation and Sustainability of Sociotechnical Change: A Case Study of Advanced Intravenous Infusion Pump Technology Implementation in a Hospital[1]

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Recently, much public attention has been on medical errors and patient safety. Healthcare organizations are being pressured to improve their systems and processes and implement various technologies in order to prevent or mitigate medical errors. This focus on the implementation of technology for patient safety has not necessarily achieved all of the expected patient safety benefits, probably because of insufficient consideration for the human factors of technology implementation and use. This paper describes the implementation of advanced intravenous infusion pump technology in a teaching hospital. Emphasis is placed on the understanding of the effects and impact of the technology after the actual implementation. The implementation of the technology can be interpreted in the conceptual framework of episodic versus continuous change proposed by Weick and Quinn (1999). The emphasis on continuous change requires organizations to focus on continuous system adaptation and improvement; this new focus can contribute to sustainable technology implementation and use.

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1 Introduction

In 1999, the publication of the report on "To Err is Human: Building a Safer Health System" by the US Institute of Medicine (Kohn et al. 1999) brought forward the issue of medical errors. We have known for quite a long time that medical errors occur quite frequently and are caused by poor system design (see, for example, the early research conducted by Chapanis and colleagues on medication errors: Chapanis and Safren 1960; Safren and Chapanis 1960a, 1960b). The 1999 IOM report indicated that between 44,000 and 98,000 people died each year in the US because of medical errors. The recent attention of the public to patient safety has generated much pressure on healthcare organizations to change their systems and processes in order to avoid or mitigate errors and hazards.

Our research group has proposed a systems approach to patient safety that defines the work system elements that influence care processes (and other processes) and affect both patient and worker safety (Carayon et al. 2006). The so-called SEIPS (Systems Engineering Initiative for Patient Safety) model of work and patient safety focuses on the system factors that need to be redesigned in order to foster the performance of healthcare providers and promote and improve patient safety. Technology is only one of five elements of the work system model (Carayon and Smith 2000; Smith and Carayon-Sainfort 1989). Technologies are being introduced at an increased pace in healthcare, primarily to improve the quality and safety of care provided to patients (Bates and Gawande 2003). There is considerable pressure on healthcare organizations to use technologies to prevent medical errors and improve patient safety. For instance, bar coding medication administration technology that matches patients with the right medication and IV (intravenous) infusion pump technology that can set drug dosing limits have been proposed as solutions to reduce medication administration errors (Institute of Medicine Committee on Quality of Health Care in America 2001). According to the SEIPS model (Carayon et al. 2006), it is important to understand the systemic impact of technology, i.e. the possible positive and negative impact of technology on the rest of the work system. In addition, the process by which technology is implemented, and the actual use of the technology need to be examined in order to understand the full impact of technology and its effectiveness at improving patient safety.

In the context of increased technological change in health care, we present a case study of the implementation of IV infusion pump technology in a teaching hospital. We emphasize the importance of going beyond implementation issues when examining a technological change. Much can

happen after the "official implementation date" of a technology, therefore resulting in the concept of "continuous change". The paper first reviews background literature on (1) episodic versus continuous change, and (2) technology implementation in healthcare organizations. A case study on the implementation of IV infusion pump technology is then described and discussed. The emphasis of the case study discussion is on the need to consider the process of technology implementation in health care as both episodic and continuous. In addition, according to the SEIPS model (Carayon et al. 2006), the impact on both patients and providers and their organization needs to be considered. Considering all stakeholders affected by the technology is a prerequisite for sustainable successful technology implementation and use (Zink 2002).

2 Background

2.1 Episodic versus Continuous Change

Weick and Quinn (1999) contrast "episodic change" to "continuous change". Episodic changes tend to be relatively infrequent, discontinuous and intentional. When examining episodic changes, emphasis is placed on the preparation for change, such as implementation strategy and planning for change. The change is considered a source of disequilibrium and discontinuity. Emphasis is placed on short-run adaptation. The change is episodic because it occurs in a distinct period of time during which an event such as a technological change occurs. In episodic changes, the change agent is a "prime mover who creates change". The change agent can be a single individual, but is most often a team of individuals who are highly committed to the successful implementation of the change. Much research has been conducted to describe characteristics of good change agents (Kotter 1996).

On the other hand, continuous change represents changes that are ongoing, evolving and cumulative, and often uncertain and less predictable. Multiple continuous changes that occur over a period of time can accumulate and create a large substantial change. A key concept in understanding continuous change is that of learning. In continuous change, learning occurs at various levels: learning of individuals (e.g., skills and knowledge), and learning of the organization (e.g., new modes of organizational functioning). Because changes are ongoing, individuals and their organization have opportunities to learn about the changes and adapt and adopt the

changes. The mini-changes occurring can be both reactive and proactive modifications. Table 1 summarizes the main characteristics of episodic and continuous changes.

Table 1. Characteristics of episodic and continuous changes (adapted from Weick and Quinn (1999))

Characteristics	Episodic changes	Continuous changes
Nature of change	Infrequent, discontinuous, intentional, discrete	Ongoing, evolving, cumulative, less predictable
Metaphor of organization	Organizations are inertial. Change in organizations is infrequent and is an occasional interruption or divergence from the status quo.	Organizations are emergent. Change in organizations is constant and is comprised of numerous modifications in work systems and processes.
Time scale	Distinct period of time during which an event occurs	Multiple continuous changes over a specific period of time
Emphasis	Preparation for change (e.g., implementation strategy, planning for change) and short-run adaptation	Long-run adaptability
Key concepts	Focus on inertia and potential for leverage	Learning at various levels: individuals and organization
Change agent	"Prime mover who creates change"	"Sense maker who redirects change"

Weick and Quinn (1999) compared and contrasted episodic changes to continuous changes. Our case study will show how both episodic and continuous changes can be embedded in a single technological change. The initial phase of technological change can assume the characteristics of an episodic change, whereas the issues occurring after the implementation of the new technology can be described as a continuous change.

Carayon and Smith (1993) discuss three categories of effects or influences of technology change on employees: (1) process of technological change (i.e. how the change is planned for and implemented), (2) similarities and differences between the "old" work system and the "new" work system, and (3) effects of the technological change on the work system. In research on human and organizational aspects of information technology, much attention has focused on the first two areas, but little consideration is typically given to the third area: once the technology is implemented, change is assumed to have been completed and further change thought to be of little consequence or is unanticipated. Studies by Cornford and colleagues have highlighted the importance of understanding what happens

after the actual implementation of information technologies (Cornford 2003; Lin et al. 2003). They argued that much emphasis has been placed on the implementation phase of information technology at the expense of issues regarding the actual use of information technology and the "world of users". Therefore, they advocate an approach that focuses on the actual use of the technology in the context of operational life: "a system in use", its emergent features, and planned and unplanned consequences (Cornford 2003).

2.2 Technological Change in Health Care

Various types of technology have been proposed to improve the quality and safety of care, such as technologies for medication administration (e.g., bar coding medication administration technology, Smart IV pump technology) and technologies for supporting information flow at various stages of patient care (e.g., EHR or Electronic Health Record, CPOE or Computerized Provider Order Entry). Whereas some research exists that demonstrates how those technologies can lead to patient safety improvements (Bates et al. 1999; Rothschild et al. 2005), there is emerging research that shows some of the "unintended consequences" of those technologies (Ash et al. 2004; Ash et al. 2007; Koppel et al. 2005). This research is important as it highlights the need to examine the technology "in use" and to be prepared to manage additional continuous changes.

Studies on technology implementation in healthcare have mainly conceptualized the technological change as an episodic change. Studies have examined, for instance, the impact of information technology such as CPOE on physicians by collecting data on their work before and after the technology implementation (Overhage et al. 2001). Some studies have begun to understand the actual process of information technology implementation in healthcare (McDonald et al. 2004). Our own research has examined the process of implementing an EHR system in a small clinic and its impact on the clinic staff (Carayon et al. 2007). We have also examined the actual use of bar coding medication administration technology by nurses in their own work environment; this research identifies some of the system factors that can hinder the safe and efficient use of this technology (Carayon et al. 2007).

The prevalent approach to the study of information technology in health care has largely ignored the "technology in use", i.e. what happens once the technology is implemented (for an alternative approach, see Berg (1999)). In this paper, we use the concept of continuous change to examine the implementation of one particular technology, IV infusion pump, at a

hospital. This case study demonstrates the importance of examining both the implementation of the technology (i.e. episodic change), as well as the ongoing use of the technology (i.e. continuous change) in order to evaluate the sustainability of successful technology implementation and use.

3 Case Study

The hospital is a 450-bed, university-based, tertiary care center serving south central Wisconsin and northern Illinois with a large referral base from a four-state area. It is a recognized leader in patient safety and quality. The hospital has been an innovator and early adopter of new technology and processes to streamline the medication use process including robotics, unit dose dispensing, and decentralized pharmacists with staffing in the intensive care units and all patient care units. Bar code medication administration technology was piloted in December 2001 and systematically implemented unit-by-unit hospital-wide, achieving full implementation in 2004. A summary of the timeline of events concerning the implementation and use of the IV pump at the hospital is displayed in Table 2.

Table 2. Timeline of the IV pump technology implementation

When?	What?
October 2002	The hospital performance improvement committee commissioned an IV pump safety committee to evaluate IV pump technology for safety.
May–October 2003	Safe Intravenous Medication Administration FMEA
June 2003	Pilot test of the new IV pump on two units of the hospital
September 2003	AHRQ grant awarded: "Medication Error Reduction, Technologies and Human Factors" (SMArT^{HF} project[2]; collaboration between researchers and hospital
October 21, 2003	Implementation of new IV pump throughout hospital
November 10, 2003	Discovery of a failure mode associated with new IV pump (tubing mislead causing free-flow)
May–June 2004	Usability testing of redesigned IV pump
July 2004	Implementation of the redesigned IV pump

The hospital's decision to purchase the advanced IV infusion system with decision support software began following the reporting and analysis of several IV pump errors and related adverse events. The hospital was inter-

[2] http://cqpi2.engr.wisc.edu/smarthf/index.html

ested in providing the safest health care to patients by taking advantage of technology, such as an IV infusion system with decision support software, that may avert human error. The hospital's Performance Improvement Coordinating Committee (PICC) commissioned an IV Pump Safety Team to review the current IV pump and the available product alternatives. The team was composed of members from nursing, pharmacy, anesthesia, medicine, quality improvement, plant engineering and environmental engineering. Twenty-nine pump safety criteria were developed by the committee, and the IV pump ECRI report (ECRI 2002) and other literature were reviewed. Alaris Medley with Guardrails© Smart IV pump was chosen after a vendor demonstration and a site visit to another institution that had implemented the Alaris IV pumps. A large capital investment was approved by the hospital for hospital-wide implementation of the pumps.

In June 2003, the hospital piloted the new IV pump on one inpatient unit. Fifty nurses underwent training in a two-week time period and all pumps were exchanged in one day. One programming error was found during switch over to the new pumps: a milrinone drip running at the wrong rate due to programming the wrong concentration (this error occurred on the old pump and was corrected when switching to the new pump). Twenty nurses who worked five or more shifts with the pumps returned post-trial surveys assessing the pump usability. All of the nurses felt the training was adequate and that the pump was acceptable for use. Overall nurses felt the pumps provided improved safety. They felt more confident when using the new pumps with IV infusions. During the Spring of 2003, an FMEA (Failure Modes and Effects Analysis) team was formed to prepare for the IV pump implementation (Wetterneck et al. 2004; Wetterneck et al. 2006). The IV Pump FMEA team started its work 3.5 months before the projected implementation date of the new technology. The implementation was delayed for one month to allow the team to finish its work and implement the team recommendations. The full hospital-wide implementation of IV pump technology occurred in October 2003 after a one-week training period that targeted all hospital end users (nurses and anesthesia providers). Post-implementation, the FMEA team continued to meet regularly to discuss user problems with the technology and a dedicated nurse was hired to manage the technology and use issues.

About three weeks after the implementation of the IV pump, a free-flow event related to a tubing misload of the pump occurred in the operating room (Schroeder et al. 2006). This event triggered a series of activities aimed at understanding the factors contributing to the event. Those activities involved both internal and external evaluation of the IV pump involved in the incident. Over a period of six months, discussion between the hospital and the pump manufacturer led to a number of proposals regard-

ing redesign of the pump. A group of researchers in collaboration with the hospital conducted usability testing of the proposed redesigns, and identified one redesign that addressed the design deficiencies at fault with the initial pump (Hundt et al. 2005).

4 Discussion

The implementation of advanced IV pump technology in the hospital has characteristics of an episodic change. The technological change occurred over a short period of time: training was spread over one week, and the actual switch between the old pumps and the new pumps occurred over one day. Several activities and processes occurred before the new IV pump technology was implemented:

- Convene a committee to evaluate IV pump technology
- Conduct a return-on-investment analysis of the IV pump technology
- Perform an FMEA of the IV medication administration process
- Execute a pilot test of the new IV pump
- Hold training

These activities and processes were aimed at getting the organization "prepared" for the technological change. Several people were involved as "change agents". For instance, the hospital hired an IV pump coordinator whose initial job was dedicated to the implementation of the new IV pump, in particular the training of nurses and other front-line users.

The case study also demonstrates characteristics of a continuous change. The occurrence of the pump-related event led the organization to a series of activities that were not initially anticipated or planned (Schroeder et al. 2006). These small changes were ongoing and evolving. The event in the operating room led to many other activities, such as discussion between the hospital and the manufacturer, external evaluation of the new IV pump technology, usability testing of the pump redesigns by a team of researchers and hospital employees, and ultimately redesign of one aspect of the pump. The preparation for the technological change allowed the organization to be more likely to adapt to events after the implementation. The preparation involved establishing and strengthening relationships between different disciplines within the organization. For instance, the FMEA team involved pharmacy, nursing administration and end-users, anesthesia, medicine, biomedical engineering, anesthesia engineering, safety, and quality improvement (Wetterneck et al. 2006). Upon implementation of the new IV pump, an implementation team formed that involved many of the

FMEA team members. This team led the investigation and found the cause of the pump malfunction event and then transitioned to the IV Pump Oversight Committee that dealt with the redesign of the pump for safe IV administration. The organizational characteristic of the implementation, i.e. a FMEA team (i.e. elements usually characteristic of episodic change), significantly contributed to the capacity of the organization to adapt and react to the many changes that occurred after the actual technology implementation (i.e. elements of continuous change). Individual learning (e.g., hospital employees involved in the usability testing learned about this human factors method), as well as organizational learning occurred in response to the continuous changes and facilitated further positive change. In addition, the IV pump coordinator's role changed somewhat as she then conducted ongoing monitoring activities to ensure proper use and follow-up of any pump-related problems users encountered.

This case study demonstrates how a technological change can be considered as both episodic and continuous. The initial phase of preparation and implementation has characteristics of an episodic change, whereas the post-technology implementation process has characteristics of a continuous change. In addition, the initial phase of planning and preparation very much affected the post-technology implementation and the continuous change phase. For instance, in the planning phase, a multidisciplinary team was formed to conduct an FMEA of the medication administration process and the impact of the Smart IV pump on this process. This helped various disciplines learn to work together and trust each other. This also affected the capacity of the organization to come together and bring all involved disciplines together after the free-flow event was discovered. Therefore, the episodic change and the continuous change were not independent from each other.

The capacity of the hospital to sustain the safe, effective and efficient use of the IV pump technology was very much related to the hospital's ability to handle the challenges following the technology implementation. Understanding the "technology in-use" over a period of time can help to achieve a sustainable successful implementation. In addition, for sustaining successful technology implementation and use, it is important to consider the impact of the technology on various stakeholders (Zink 2002); in our case study, all stakeholders were represented in the various committees involved in the planning, implementation and follow-up phases.

5 Conclusion

This case study of the implementation of IV infusion pump technology in a hospital demonstrates the need for understanding the events preceding the implementation, as well as significant events following the implementation. The case study poses interesting challenges concerning the "evaluation" of technology in health care. A study design with a pre-implementation measurement and a limited number of post-implementation measurements would not capture the richness of the "technology in use", i.e. the process of continuous change. Some of the research on the evaluation of information technology in health care tends to adopt a longitudinal study design with the objective of (1) comparing the "before" and "after" data on, for instance, work tasks and work flows; and (2) examining the short- and long-term impact of the technology. Such a study design assumes that the "short-term" effects are transitory effects due to the need of both the end users and the organization to adapt to the change. Another assumption is that with sufficient time, one is able to capture the "true" impact of the technology on the end users and the organization: after some time (e.g., six to twelve months), the technology has been adopted, end users are familiar with the technology, and stability has been achieved. Our case study shows that such a design would probably not work with a continuous change such as the implementation of IV pump technology. To understand the implications of continuous change, other types of research design are necessary, relying much more strongly on qualitative data collection methods and approaches.

Healthcare organizations that are implementing technologies need to understand the characteristics of both episodic and continuous changes. From the viewpoint of episodic change, healthcare organizations need to consider elements of change management, project management, user-centered design and usability, communication, and training (Karsh 2004; Korunka and Carayon 1999; Smith and Carayon 1995). From a continuous change viewpoint, organizations need to be aware of changes or events that may occur after the implementation of the technology; this can help organizations anticipate and manage that change and ensure that the "technology in-use" is effective, efficient and safe. Understanding that the implementation of technology in health care can be a continuous change highlights the need for considering organizations as dynamic systems (Carayon 2006). Continuous system adaptation and improvement need to be embedded in the organizational functioning and structuring. For instance, after the technology has been implemented, "change teams" need to revise their roles and responsibilities and focus their attention to usage

issues; organizations need to provide the support and resources for this change in focus. Organizations need to go beyond efforts targeted at motivating end users to learn and use the technology; they need to help end users "make sense" of the new technology and its impact on their work (Weick 2001). This focus on system adaptation requires organizations to conceptualize technological change as continuous change.

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The Influence of Project Duration and Focus on Involvement in Participatory Processes

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A hypothesis on the influence of project duration and focus on involvement in participatory processes is formulated based on the literature. Longer lasting projects could theoretically have more involvement of top management. Technological oriented projects should have less top management involvement and more involvement of engineers and designers compared with more organizational focused projects.

Asking 277 experts about their latest project indicated that top management is significantly more involved in the longer lasting projects and engineers and designers more in the technological oriented projects. The disadvantage of this study is that it concerns a specific group of experts interested in participatory ergonomics biasing the outcome and categories could be interpreted freely by the experts. Further (longitudinal) case-control research is needed to have a better and more valuable predictive value of the effects of involvement of various participants.

1 Introduction

Positive effects of a participatory approach have been demonstrated in previous studies. The European Foundation for the Improvement of Living and Working Conditions (1999) reports that direct participation in production organizations most often leads to quality improvements (90 % of the cases), to reduction of throughput times (60 % of the cases), and to reduction of costs (60 % of the cases). However, these facts are merely estima-

tions by experts. Apart from these estimations, some more quantitative effects have been reported as well (e.g. Beevis and Slade 2003; Koningsveld et al. 2005). Lawler states (1986) that employee involvement affects five major determinants of organizational effectiveness: motivation, satisfaction, acceptance of change, problem solving and communication. Lawler also argues that involving workers in the definition of methods and procedures is an effective improvement approach, and can motivate employees to produce a better quality job, which is preferable from a sustainable point of view as less corrections are needed, which is probably better for the environment and due to the more satisfied employee better for the work force health on the long-term. Not all participatory approaches are successful. There are examples of ineffective participatory approaches as well (e.g. Molen et al. 2005). However, a majority of the cases described in the literature shows the positive effects.

The participatory approach has been applied in ergonomics as well. The growth in participatory ergonomics projects and attention on conferences over the past 15 years has been marked (Haines et al. 2002). Such growth has been fed by the recognition by companies of there being room for improvement in working methods whilst not having resources to bring in ergonomics specialists for every need, the increasingly participatory nature of approaches to industrial health and safety generally, and the related processes of the total quality movement (Haines et al. 2002). Reasons to promote a participatory ergonomics (PE) approach include improved ideas and solutions, smoother implementation, better direct results and a number of systemic outcomes of value to the organization or individuals or both (Wilson and Haines 1997). Difficulties can be perceived time and cost, the effort needed to turn interventions into programs, motivating participants and knowing how to embrace those represented but not active in the process – the non-participatory stakeholders. Despite the vastly increased PE endeavors, there is still little agreed theoretical knowledge. It is also difficult to compare across different PE projects, in terms of processes and of outcomes. Therefore, a framework was developed and success factors were extracted from participatory ergonomics projects.

1.1 Framework

Participatory processes include a large variety of approaches focused on a large variety of topics. Some projects are focused on productivity increase, others on quality or flexibility. For sustainable innovation (sustainable is defined in this case as an innovation that lasts longer than just a short-term effect) the target of the project should be combined with a health increase

or an environmental improvement. Of course the structure of the participatory process depends on the goal. A useful framework to classify the approaches has been developed by Haines et al. (2002). This framework has nine different dimensions (see Table 1) each with two or more associated categories which define a feature of a PE initiative. Three dimensions of this framework will get extra attention in this paper as practitioners of eleven courses showed special interests in these dimensions. These three permanence, involvement and focus are described below.

Table 1. Version of participatory ergonomics framework described by Haines et al. (2002)

Dimension	Categories
Permanence	Ongoing – Temporary
Involvement	Full direct – Partial direct – Representative
Level of influence	Entire organization – Department/work group
Decision-making	Group delegation – Group consultation – Individual consultation
Mix of participants	Operators – Supervisors – Middle Management Union Personnel – Specialist/Technical Staff – Senior Management
Requirement	Compulsory – Voluntary
Focus	Designing equipment or tasks – Designing jobs, teams or work organization – Formulating policies or strategies
Remit	Process development – Problem identification – Solution generation – Solution evaluation – Solution implementation – Process maintenance
Role of ergonomics specialist	Initiates and guides process–Acts as a team member – Trains participants – Available for consultation

1.1.1 Dimension 1: Permanence of Initiative

This dimension considers the permanence of participatory ergonomics within an organization. Participatory ergonomics mechanisms may function on a temporary basis and may take place outside the normal organizational structures. Alternatively, ongoing participatory mechanisms may be developed which may well be much more integrated into the structure of the organization.

1.1.2 Dimension 2: Involvement

The second dimension of participatory ergonomics considers whether people participate directly or indirectly (via representatives).

1.1.3 Dimension 3: Focus

This dimension identifies the topics addressed by participants, and it was assumed to be self explanatory. However, in validating the framework practitioners preferred the name "topics addressed" (Haines et al. 2002). The three categories in this dimension are: Physical design/specification of equipment/workplaces/work tasks – Design of jobs teams or work organization – Formulation of policies or strategies.

1.2 Success Factors

Apart from the classification, it is interesting to know what factors influence the chance of being successful. Some success factors have been described in various studies (e.g. Koningsveld et al. 2005; Looze et al. 2001; Vink et al. 2006).

These are:

- arrange involvement of the important stakeholders,
- carry out a good inventory,
- use a step-by-step approach (see Table 1),
- arrange that a steering group is established with responsibilities,
- check the effects, including side-effects, at an early stage,
- do not focus only on health issues,
- describe the cost: benefit ratio in monetary terms and with non-quantitative measures.

The first factor could be interpreted in various ways and needs further specification. The studies of Koningsveld et al. (2005), Looze et al. (2001) and Vink et al. (2006) mention "arrange direct workers' participation and strong management support" and the need for involvement of experts has been described before as well (Vink 2005). It is not only involvement of stakeholders. Imada (1994) asserted that we must understand the context in using comprehensive change management concepts (Zink et al. 2007). For example, understanding a group's norms, language and concerns of the different actors is critical to being successful in the intervention.

So, one aspect "involvement" is seen as a success factor and is described in the framework of Haines et al. (2002). The question is who should be involved when. Therefore in this paper a relationship is described between the permanence (long versus short) and topics addressed (focus: designing equipment/technology or improving organizational issues).

Table 2. Possible steps in a participatory ergonomics process

Step	Phase	Possible activities
1.	Introduction	Planning the process, informing participants, defining the main focus
2.	Analysis	Study experienced problems and determine impacts on productivity and health
3.	Idea generation	Select main problems, make an overview of existing solutions, brainstorm improvements, design concepts
4.	Idea selection	Discuss the feasibility of ideas and concepts and select improvements with the work force and management
5.	Prototyping	Detail design of one or more solutions, manufacturing of parts or working prototype
6.	Testing	Test the selected improvements
7.	Adjustment	Adjust the design based on testing
8.	Implementation	Train the participants, buy materials, set up new organization/work stations
9.	Evaluation	Measure experienced effects, objective effects, adjust improvements, evaluate the process

1.3 Purpose of this Paper

In this paper an attempt has been made to understand the effect of permanence or focus of a participatory ergonomics process on involvement of participants. First a hypothesis is described based on literature and common sense, followed by the opinion of practitioners.

1.4 Effects of Duration of the Project

Due to the variation in participatory approaches it is to be expected that the involvement could be influenced by the duration of the project. First the hypothetical effects of the project duration are described and then hypothetical effects of the focus of the project.

In theory top management involvement should be higher in projects that last longer, because more budgets are involved or because these projects have consequences a longer period of time for the enterprise. Middle management involvement should not be affected that much by changes in duration as this involvement is needed both in longer and shorter projects. In projects with longer durations employee involvement could be affected. Longer projects could be more complex, which makes it more complex to discuss changes with all employees directly. Therefore, the chance of di-

rect participation of employees should theoretically reduce with longer lasting projects.

A participatory project could be focused on organizational, technological changes or on strategy and deployment issues. In this paper we focus on the difference between physical (equipment/technology) and organizational changes as these issues were the majority of cases of the practitioners consulted in this study. Examples of organizational changes are new work-rest schemes, other work procedures, introduction of self-steering groups, other task division between departments and other team/department structure. In case of the organizational change, top management involvement could be higher than in case of the physical changes as in many cases the impact of physical changes could be smaller. New workstations, tools and equipment could be introduced without involvement of other departments and staff. However, for technological changes the involvement of engineers and designers could be higher, because for instance the development of new workstations involves designing and engineering activities.

1.5 Hypotheses

Based on the abovementioned arguments the following hypotheses are formulated to be tested in this project:

- Longer lasting participatory projects have more involvement of top management and the employee involvement is more indirect in longer projects than shorter projects.
- Organizational oriented participatory projects have more involvement of top management than more technological oriented participatory projects.
- Technological oriented participatory projects have more involvement of designers and engineers than more organizational oriented participatory projects.

2 Method

To test these hypotheses two groups of subjects were asked to complete a PEP[1]-questionnaire (see Appendix). The first group to complete the questionnaire consisted of 219 experienced Dutch health and safety experts who were enrolled across eleven training courses conducted at different locations (four times an in-house training, seven times a public course). Of

[1] PEP: Participatory ergonomics process

these eleven health and safety experts four attended a full-day and seven a half-day session on participatory ergonomics. This means that the results should be seen in the light that the majority of the projects are health and safety focused.

The second group was made up of 58 attendees at an international conference on human factors, management practices and sustainability in Germany with attendees varying from organizational researchers to quality researcher and ergonomists. 75 % of the 77 questionnaires distributed in this group were returned.

The questionnaire asked about the involvement of the stakeholders at different phases of an ergonomics change process and included specific questions regarding the size of the project and the topics addressed focus (physical versus organizational; see Appendix).

In the first group, a participatory ergonomics case was presented. In this case special attention was given to the role of the participants involved. Following the case, a list of potential participants was presented. These participants were: top management, middle management, employees, designers, ergonomists and staff. Staff was defined as the group consisting of: human resources management, finance, administration, facility management and engineering. The subjects were then asked to complete the questionnaire regarding their involvement in the steps based on their last project. After completing the questionnaire, a discussion took place regarding the role of the different stakeholders.

For the 58 attendees at the German conference the situation was somewhat different. The word "ergonomists" was replaced with "experts" because the group was more diverse and because in Germany some consultants and researchers see themselves more active in "Arbeitswissenschaft" (science with respect to labor) than in "ergonomics". Also, little time was spend on explaining "staff".

The percentage involvement of all participants in projects with a longer duration was compared to the percentage in shorter projects and the percentage involvement of participants in organizational oriented projects was compared with the technological oriented projects. The duration of the projects were classified in four groups: projects between zero and six months, projects between six and twelve months, projects between twelve and 24 months and projects longer than 24 months. Between all categories (0–6, 6–12, 12–24, 24–36 months, technological versus organizational focus) t-tests for paired comparison ($p<0.05$) were used for involvement of top management, middle management, employees, engineers and designers for each step to test the hypotheses.

3 Results

Regarding the questionnaire that was completed by 219 Dutch ergonomists, 41 % called themselves ergonomists and 63 % saw themselves as consultants. They had 2–23 years of experience (average five years). The projects lasted 0.2–36 months (4.5 average). The projects of the 58 attendees of the conference in Germany had a mean duration of 17 months (2–36 months).

There were hardly any significant differences between the four categories of duration. In the first group (219 Dutch) effects were only found in step 1, the introduction of the project (see Fig. 1). This step had the most involvement of top management in all steps of Table 2. In step 1 shorter projects (<6 months) had significantly less involvement of top management compared with projects longer than six months (see Fig. 1). In the second group (58 attendees) the same phenomenon was found (see Fig. 2). Additionally, there was a significant difference between the projects longer than two years and the projects shorter than two years regarding top management involvement.

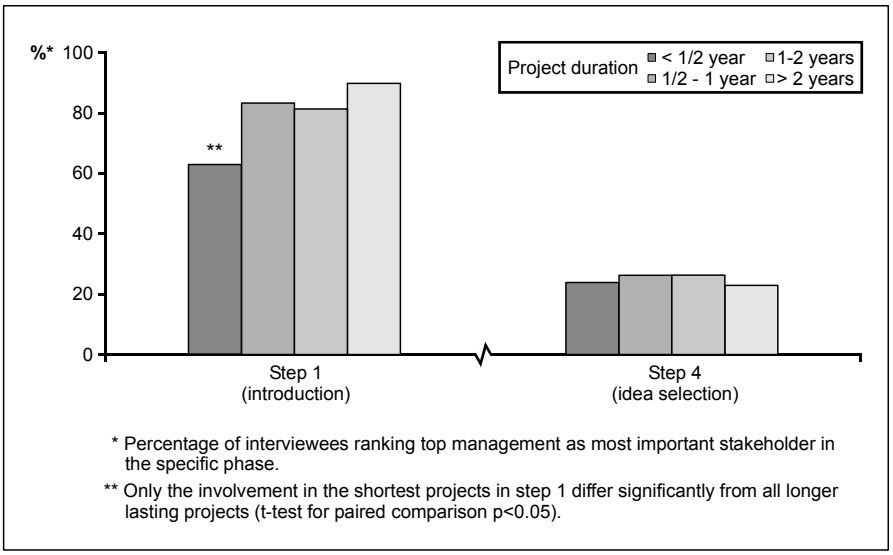

Fig. 1. Top management involvement according to the 219 Dutch ergonomists in step 1 and step 4 for projects of different lengths

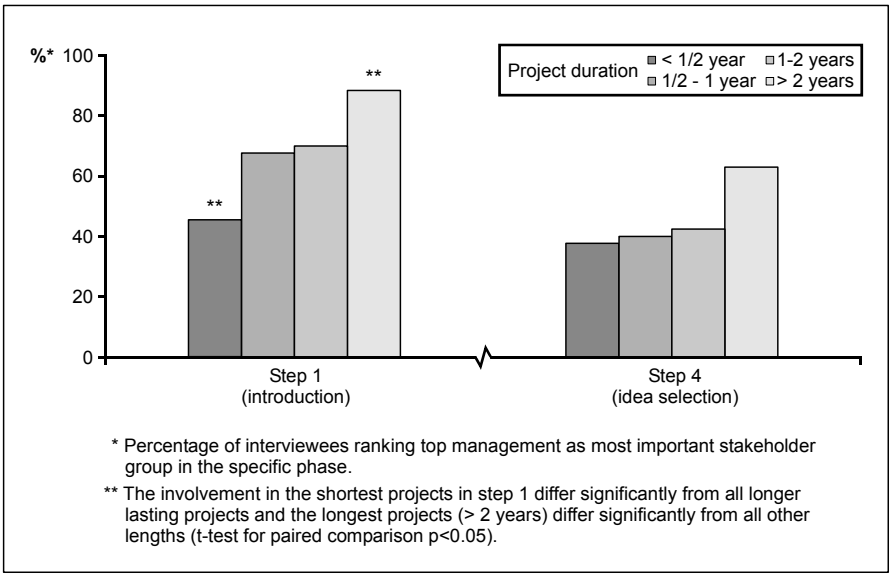

Fig. 2. Top management involvement according to the 58 conference attendees in step 1 and step 4 for projects of different lengths

The involvement of middle management showed no significant differences between longer and shorter projects (see Fig 3). Also, employee involvement did not differ significantly between the shorter and longer projects (see Fig. 4).

Regarding the difference between technological and organizational change there was no difference in involvement of top management seen (see Fig. 5). There was a very high standard deviation. Within technological focus all technological oriented answers were clustered like ICT, tools, equipment, machines, production lines etc. If we select in the first group (219 Dutch) only the tool/equipment focus and compare these with the organizational focus difference could be distinguished regarding top management involvement. Top management was significantly less involved in projects focused on tool/equipment changes compared with the organizational oriented projects.

The involvement of engineers and designers was significantly higher in technologically oriented projects in step 3 (idea generation) and step 5 (prototyping) compared with the organizational focused projects (see Fig. 6).

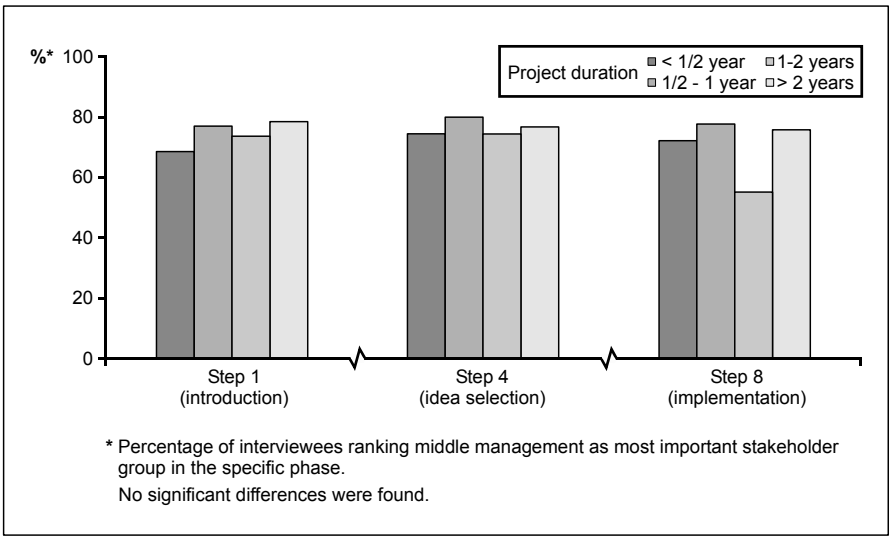

Fig. 3. Middle management involvement according to the 219 Dutch ergonomists in step 1, step 4 and step 8 for projects of different lengths

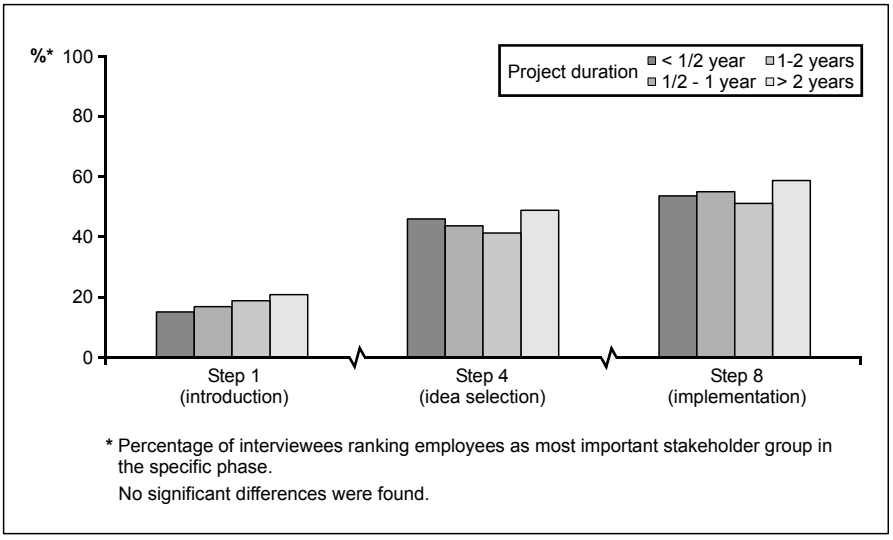

Fig. 4. Employee involvement according to the 219 Dutch ergonomists averaged over all steps for projects of different lengths

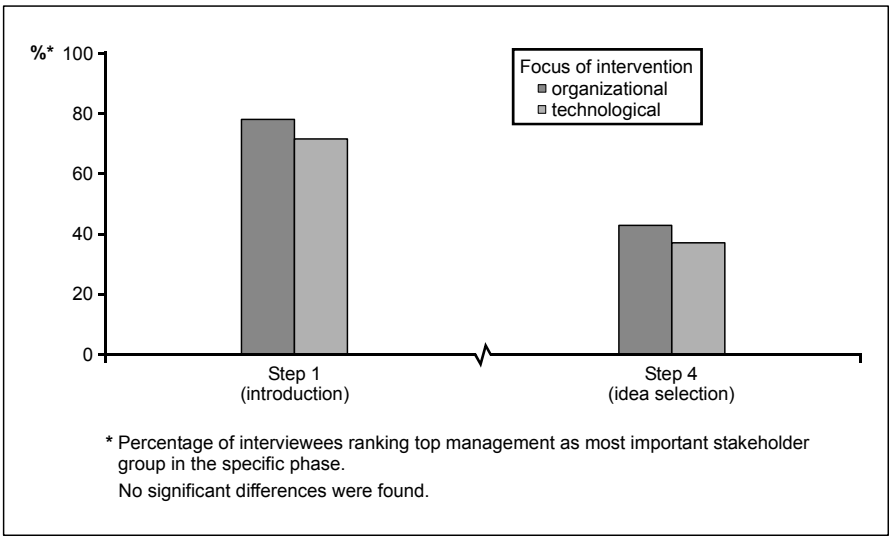

Fig. 5. Top management involvement according to the 219 Dutch ergonomists in step 1 and step 4 for projects focused on organizational interventions and technological interventions

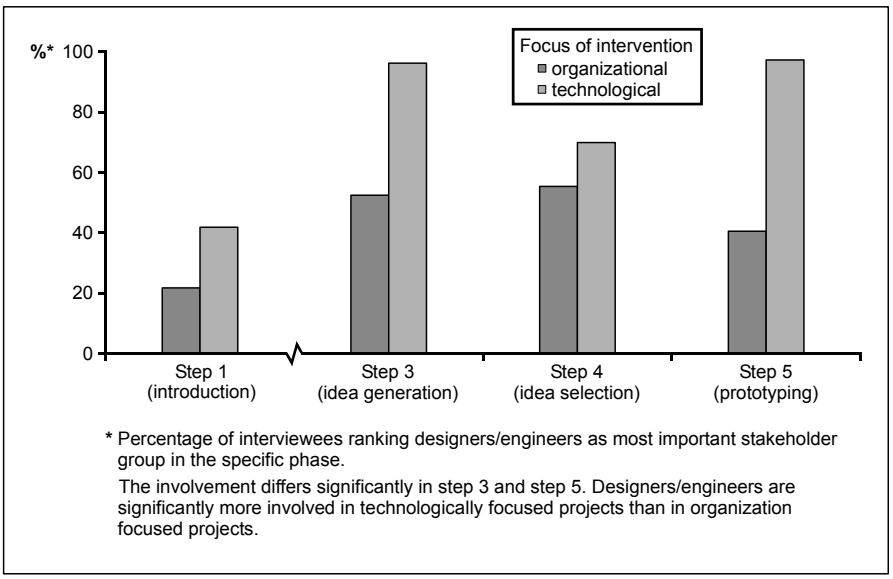

Fig. 6. Involvement of engineers and/or designers according to the 219 Dutch ergonomists in step 1, step 3, step 4 and step 5 for projects focused on organizational interventions and technological interventions

4 Discussion

4.1 Verifying the Hypotheses

It is important to mention that this study is only based on a retrospective analysis, where experts give their opinion. This means that conclusions are more of an indicative nature.

This paper indicates that the *first hypothesis* that longer lasting participatory projects have more involvement of top management and less employee involvement than shorter projects is partly true. Only differences were found in the involvement of top management in the first step (introduction) in both study groups. It is not strange that the difference was only found in the first step as another study on the same data (Vink et al. 2008) showed that top management involvement was highest in this first step (see Fig. 7). Often top management involvement is connected to the success of projects: more involvement should increase the chance of being successful (Koningsveld et al. 2005). However, contrary to these studies Ingelgård and Norrgren (2001) state that top management involvement was not found to be the most important factor for change outcomes. Instead, process factors were of at least equal importance. The fact that this study focused on behavioral patterns and the behavioral aspects of change processes could have influenced this result. Anyhow, it is important not only to focus on top management involvement, but also pay attention to a good change process design. Koningsveld et al. (2005) discuss that management commitment is important for several reasons. Firstly, it gives employees the feeling that it is a serious project. Secondly, the commitment is necessary to ensure that proposed changes will be implemented, provided that the cost-benefit effects are positive. Lastly, interventions could have a more widespread impact than only on the workplaces that are the subject of the project. In this way, management commitment may help to get support from others who are confronted with change.

Regarding the employee involvement this study indicated no difference between longer and shorter projects. In the discussions with the participants of the eleven training courses it was mentioned that longer projects were connected to larger numbers of involved persons. However, in longer projects there is also more time to involve participants. Jong and Vink (2002) also described a large scale project where all participants were involved. The discussion also mentions that even direct and indirect involvement can be organized in various ways. Perhaps a more precise definition of employee involvement in more categories could be helpful in

establishing differences here. Cotton (1993) describes direct involvement as "typically face-to-face involvement where workers can have an immediate and personal impact" and contrasts this with indirect involvement which "incorporates some type of employee representation in which, rather than the employee interacting, his or her representative is involved". In the abovementioned framework of Haines et al. (2002) three forms of participation are distinguished: direct participation – partial direct participation – representative participation, which might be more appropriate to find differences.

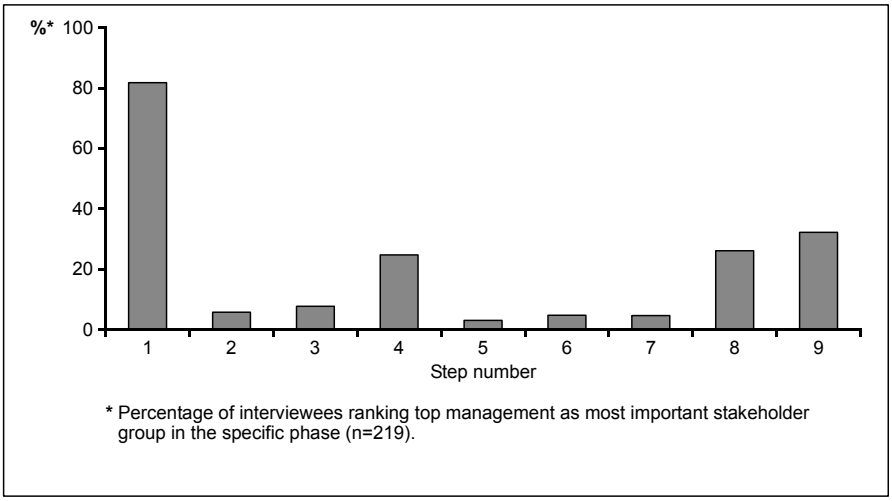

Fig. 7. Top management involvement in the various steps of table 1 according to Vink et al. (2008)

The *second hypothesis* that technology oriented projects have less involvement of top management compared with the organizational oriented projects is not affirmed in this study. No significant differences were found in both groups for all steps. Only if we analyze the data in more detail and select the projects focused on tools or equipment a significant difference can be found. It is to be expected that top management involvement is lower in buying tools, like new screwdrivers or in buying equipment, like engines. In the discussion with the participants of the eleven training courses it was mentioned that technological projects with ICT changes, new production lines and intelligent products have large consequences financially and for other related departments. It even could influence the way of working and therefore top management involvement is preferable.

The *third hypothesis* on the expected high involvement of engineers and designers in more technological oriented projects was affirmed and is easy

to explain. Technological changes, like workstation design, new machines and lay-out can hardly be done without engineers and designers. Figure 6 shows that the involvement is almost the highest possible in step 3 (idea generation) and step 5 (prototyping), which is easy to explain as in these steps engineering and design are the core of the work.

4.2 Disadvantages of this Study

Abovementioned conclusions are drawn based on the impression of experts involved in changes in practice. It is a retrospective subjective analysis of the roles of various participants in a project. This means that the real testing of the hypotheses needs more thorough research. This paper only indicates some support for the hypotheses. One of the reason to be careful is that the study is retrospective and the subjective opinion of experts. The outcome could be biased as well as the group studied is interested in participatory ergonomics because this group did register themselves for these courses. Perhaps the percentage of involvement in this group is higher compared with ergonomists that will not follow this course and are less interested in participatory ergonomics. Another point is that the categories were not precisely described and every expert could define middle management, top management and employees itself which could lead to some differences. The experts made the decision on what is within that category. This is especially true for the category staff. Another restriction is that the majority of the cases was focused on health and safety issues. This is of importance for sustainable results regarding workers health, but the results could be different if the focus is on economic issues leading perhaps to stronger top management involvement.

Of course further research is needed to have a predictive value of the effects of involvement of various participants, like the longitudinal case control study of Molen et al. (2005). This study only leads to some descriptive parameters and indicates that top management could be more involved in the longer lasting projects and engineers and designers more in technological oriented projects.

Anyhow the hypothesis that longer projects have more top management involvement in the beginning of a participatory ergonomics project gets some support by this study and engineers and designers could be more involved in the technological oriented projects.

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Appendix: The PEP[2]-Questionnaire

The PEP questionnaire aims to find out which role the different participants play in practice. Think about your last project and circle the stakeholder that played the most important role in the specific phase (more circles are possible per phase).

Example

Phase	Stakeholder					
13) All phases	Top management	Middle management	(Employee)	Ergonomist	(Designer)	Internal staff

Put the circles in this table

Phase	Stakeholder[3]					
1) Introduction	Top management	Middle management	Employee	Ergonomist	Designer	Internal staff
2) Analysis	Top management	Middle management	Employee	Ergonomist	Designer	Internal staff
3) Idea generation	Top management	Middle management	Employee	Ergonomist	Designer	Internal staff
4) Idea selection	Top management	Middle management	Employee	Ergonomist	Designer	Internal staff
5) Prototyping	Top management	Middle management	Employee	Ergonomist	Designer	Internal staff
6) Testing	Top management	Middle management	Employee	Ergonomist	Designer	Internal staff
7) Adjustment	Top management	Middle management	Employee	Ergonomist	Designer	Internal staff
8) Implementation	Top management	Middle management	Employee	Ergonomist	Designer	Internal staff
9) Evaluation	Top management	Middle management	Employee	Ergonomist	Designer	Internal staff

[2] PEP: Participatory ergonomics process

[3] In the version of the questionnaire used in Germany the word ergonomists is replaced by expert.

Personnel information

What is your job title?……
Are you more an advisor, researcher or manager?…….
How many years of experience do have as advisor/researcher/ manager?…….……
Are you female/male?…….
What is your specific area of work the last year?……...……
How long did your last project last in months?……..months
Was this last project focused on a tool, workplace adjustment, layout, organizational issue, or……? ...……

The Role of Ergonomics in Securing Sustainability in Developing Countries

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This paper addresses the issue of sustainable effects of appropriately conceived ergonomic interventions in the industrially developing Third World. It is argued that all targets of the Rio Declaration of 1992 relative to sustainable progress (economic, social and environmental) can be addressed by appropriate ergonomic intervention where it is most needed viz. in developing regions. When economic, social and environmental conditions are poorest, small unremitting improvements have a greater impact than when conditions are optimal. The small changes ergonomists can easily effect in ameliorating working conditions in industrially developing countries can reverberate through local, regional, even national economies, and if done correctly, these effects will be culturally absorbed thereby ensuring sustainability. When an ethos for care of national resources, be they human or physical, is inculcated, the goals of the Rio Declaration are met. It is no exaggeration to assert that ergonomics, properly administrated in industrially developing countries, has a meaningful role to play in this connection.

1 Potentials to Reverse the "Negative Spiral"

The universally accepted term "Industrially Developing Countries" (IDCs) immediately conjures up negative images of never ending problems. Are these problems insurmountable? Clearly to perceive them as such we would be giving up on vast geographical regions and billions of human beings who live under sub-standard conditions. It is beyond the scope of this paper to offer some grand solution to a well recognized global problem; however, the question whether ergonomics can play any role in negating

this bleak scenario has yet to be effectively addressed. While many argue that the magnitude of the problem is too immense for ergonomics to make any impact, the aim is to demonstrate that indeed ergonomists can and should take a far more dynamic and committed stand within developing regions by assisting impoverished countries to overcome their adversities, and by so doing, help them start making a meaningful contribution towards the global economy rather than draining it.

Over the years I have proposed a "negative spiral" as descriptive of conditions common to developing regions (Scott 2001b and 2006). To put it succinctly, IDCs are areas in which the bulk of the people live in poverty, with associated poor health, and as a generalization there tends to be wide-scale abuse of workers and concomitant low productivity. Although on the surface it would seem that ergonomists can hardly be expected, let alone able, to do anything about issues such as the housing and health status of workers, we certainly can do a great deal to improve working conditions and work output. Unfortunately it appears that it is necessary to make the obvious link, that once productivity has improved, so too does the economy of a poor country, allowing for better salaries for workers who typically work for less than $2 a day in the informal sector (O'Neill 2000). Indeed the negative spiral can be broken, and even reversed, ultimately resulting in improved living conditions and better health. There is no doubt that ergonomics has the potential to provide far-reaching benefits in developing nations; benefits which are more extensive than would accrue in more advanced areas under the rule of diminishing returns.

2 Basic Scenario in Industrially Developing Countries

While a poverty-driven negative spiral is reflective of the life-style of the majority of the people living in IDCs, most developing regions characteristically harbor isolated affluent sectors in which people live in luxury and work under optimal conditions as good as, or sometimes better than, those typically found in Industrially Advanced Countries (IACs). It is indeed unfortunate that many visitors, social or official, to developing countries may only witness the best side of things and often wonder what all the concern is about. Taking South Africa as an example, approximately one tenth of the population live and work under what might be called ideal conditions, while the vast majority have never experienced even the minimal amenities of running water, electricity and basic sanitation. The differentiation within IDCs is immense, and despite globalization and international efforts, the gap between IDCs and IACs is growing. Why?

Absorption of technological developments in IACs, initially geared towards minimizing physical stressors and more recently in the direction of reducing cognitive stressors, has been such that affluent societies have culturally kept pace with the rapid change; something IDCs are simply not equipped to do. Consequently accelerative growth of this very technology further advances the already prosperous regions and has left behind the needy, destitute millions living in lesser developed countries. While IACs talk in terms of increasing bandwidth, many IDCs are bereft of basic electricity. The problem we now face is whether IDCs will ever be able to catch up. What they require is small-scale transformation at the grass-roots level. Unless ergonomists accept that the reason why these countries, despite ill conceived grants-in-aid from the Developed World, never seem to achieve anything is grass-roots incapacity to deal effectively with their resources, we will compound rather than solve the problem. Ergonomics in advanced areas has forged ahead in the last decade and some exceptional work has been achieved, but while this has occurred, we must realize that the majority of the populace in IDCs is still oblivious to ergonomics. What they need is basic, practical input to improve horrendous, unacceptable working conditions, which their workers put up with because they know no better, and because they cannot afford not to work, as they need every last cent of their menial earnings just to survive.

There is no doubt that IDCs have great potential to expand the quality and quantity of their production. The problem is that although they have natural physical resources, which are generally internationally acknowledged and sought after, they also have human resources which are generally unappreciated and too often abused. Working hours are long, conditions are appalling and physical demands are excessive. If we ever hope to ameliorate the situation then the focus must be, not only on the tasks (which are excessively physically demanding), but very much on the *human* element. This sentiment is in keeping with the 1992 Rio Summit where it was clearly stated that the need to satisfy material needs must be achieved without imposing any danger on human health. A human-centered approach requires that work demands must be lowered to levels within the basic physical capabilities of the indigenous labor force, whose capabilities are low due to the poor nutritional and health status. Although we all accept that ergonomics is all about compatible interaction between the worker and the task demands within a specific working environment, the emphasis in IACs tends to be task-orientated, human rights being taken for granted. However, in IDCs, where many interactions are haphazard and often dangerous, the critical need to consider the status of the worker is often neglected. In IDCs, in addition to evaluating the task requirements, workers' responses to heavy manual labor must form the basis of any in-

tervention. For example, recent work conducted in the forestry industry in Chile and South Africa has identified a chronic imbalance between the nutritional status of the laborers and the energy expenditure required for the job (see Apud 2006; Scott and Christie 2004). An obvious, but not thought of intervention such as just supplying cool, fresh drinking water at regular intervals throughout the work shift would improve the situation considerably. Figure 1, illustrating a cross-section of examples of work carried out in developing regions, clearly demonstrates the devastating *incompatibility* between mal-resourced workers and the taxing physical jobs they are required to do on a daily basis.

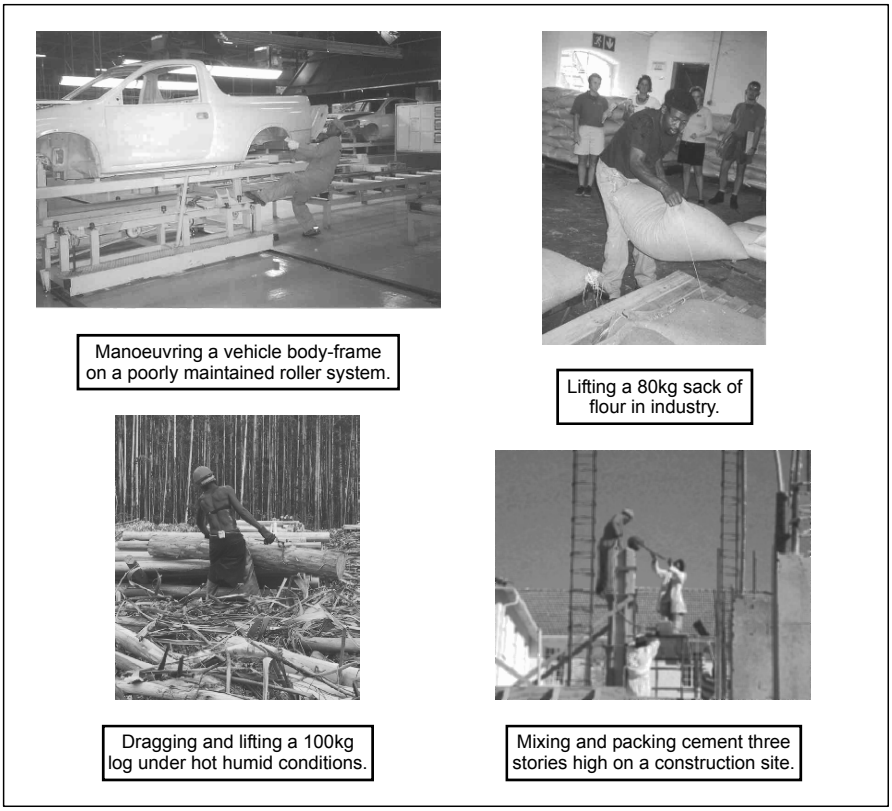

Fig. 1. A cross-section of physically demanding tasks common in IDCs

Clearly under such conditions productivity is low. This inefficient malaise is endemic, and characteristic of society as a whole. Not surprisingly the economy of these countries is poor. The undesirable consequence of this ubiquitous situation is that at the micro-level it saps workers' energy and

lowers productivity, while at a macro-level it increases corruption and drives away foreign investment. There is a general feeling of helplessness and a sense of depleted resignation; Scott and Charteris (2004) talk of "deprivation dulling aspiration". If one can barely cope with the demands of the day, how can one think and plan for tomorrow? The result is that IDCs "tend to be countries in debt and unable to get out of debt"; they are caught in a negative economic spiral, and the gap between them and IACs widens.

3 Basic Requirements for Sustainable Change

When working in IDCs there is a need to go back to fundamentals. Grass-roots problems require grass-roots solutions. The rudimentary objective of ergonomics is to assess the overall situation and to identify incompatible interactions between the various components, which comprise a specific work site. As the components in the majority of IDC work scenarios tend to be simple, with limited technology, any intervention strategies must therefore be basic and easy to implement. Shahnavaz (1996), Kogi (1997) and Scott (2001b) all advocate small, low-cost, even no-cost, adjustments to bring about immediate and obvious improvements so that the impact of ergonomic input is felt by first-tier laborers. Unsophisticated solutions are understandable to unsophisticated people. A straight-forward, everyday example is used to demonstrate the concept. Lifting is a common task executed in all industries at some time, but is very much more evident in IDCs where the bulk of lifting is done manually, often for the entire duration of an eight hour (or longer) work shift. Figure 2 offers self-evident illustrations of three low-cost interventions designed to reduce the physical stress placed on the manual laborers concerned, thus minimizing the likelihood of musculoskeletal problems resulting from continuous stooping. While the immediate benefit is obvious, the cumulative effect of these rather crude modifications is substantial. Similar basic interventions are used to reduce the physiological cost of excessive manual work, and the growing cognitive loads resulting from unsupervised importation of advanced technology. To quote a leader in the field, "a small input has a profound effect" (Sen 1984). Although we know this always pertains, few realize the extent to which it pertains in Third-world situations.

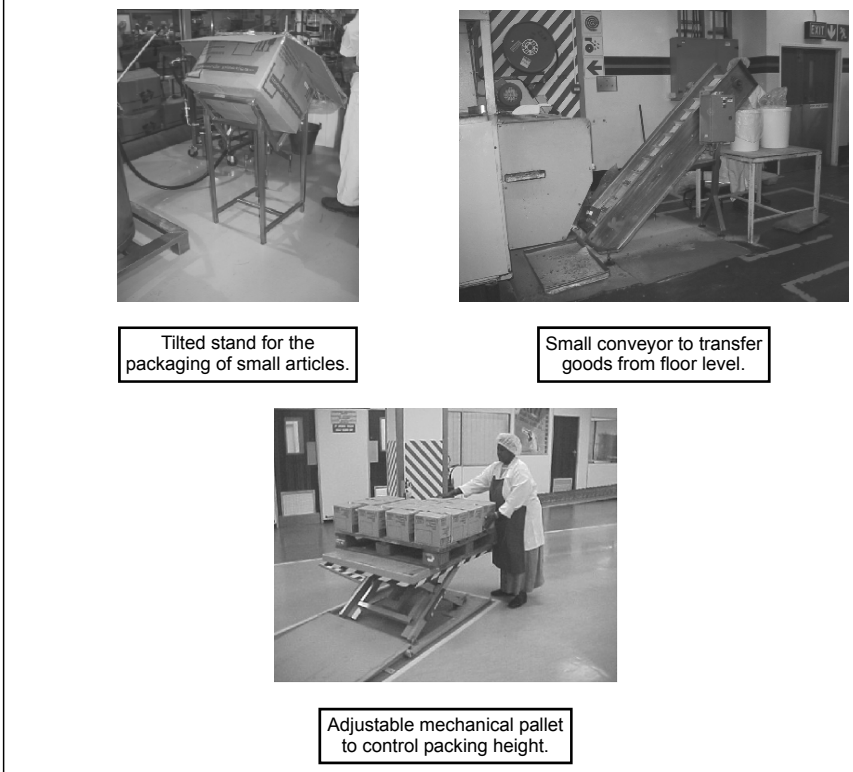

Fig. 2. Practical examples of low-cost in-house modifications to work stations

While these micro-level immediate improvements are important, not only to reduce the acute and cumulative physical strain experienced by workers, but also to demonstrate the effectiveness of even basic ergonomic input, they are often only short-term solutions to obvious problems, and may have very little impact on the company as a whole. They are therefore not effective in terms of sustained improvement. Rather, if positive, but minor improvements are to be sustained it is essential to move beyond the local and obvious problem, and take an all-inclusive macro-level appraisal of the situation. A growing number of developing regions are beginning to recognize the benefits of ergonomics, yet in practice they remain stuck at a micro-level of application. In order to achieve corporate sustainability there must be a corporate commitment to improvement of the entire working environment, including the socio-economic status of the majority of workers and the general life-style of all. While in IACs there is talk of ergonomics investigations going beyond the eight hour work shift, in IDCs it

is imperative to take cognizance of the 24 hour life-cycle of workers. This requires a comprehensive mind-change from corporate management, and indeed from government. Only then can IDCs become self-sustaining, viable contributors to the global market.

4 Securing Sustainability

Three basic, interdependent elements, education, research and effective international assistance are necessary for sustainable change.

Education is the key to any advancement, and basic schooling is essential, but beyond the scope of this paper. Rather the focus here is on the potential we have to educate people generally about ergonomics; that includes people involved in business, formal and informal work settings, governments, the public at large and local enthusiasts who wish to become professional ergonomists. There is a dire need to establish ergonomics programs at the tertiary level, as well as at a lower, more practical level within the working environment itself. A growing number of universities and technical colleges in IDCs are introducing ergonomics modules or courses, and this is where IAC schools with well-established programs can assist by sponsoring a staff and student exchange system. A scheme, which I propose, would be beneficial to both parties, as IAC experts would gain worthwhile insights into the reality of working conditions for the vast majority of workers around the globe. Once IDC ergonomists, with reciprocal IAC insights, are produced in their own countries the status of professional ergonomists will rise locally and the quality of their work will greatly benefit specific companies and their respective countries as a whole. However, a word of caution is necessary regarding the need to be aware of charlatans who claim to be ergonomists after having attended a one-day workshop. Again, international guidelines are necessary in the introduction of a certification system in order that the standard of the profession be protected internationally.

Beside rigorous academic qualifications, another critical facet in promoting self-sustaining ergonomics is the continuation of the International Ergonomics Association initiative regarding the concept of “Roving Workshops”. A key requisite of these workshops is that the international experts work in conjunction with the locals in the running of the workshops and in teaching the indigenous workforce. Kogi, Shahnavaz and Scott have done this very successfully over the last decade (see Scott and Shahnavaz 1997; Kogi et al. 2006; Scott 2006). These workshops need to include a theoretical basis in ergonomics, plus solid practical application

and a great deal of interactive discussion between the leaders and attendees of the workshop, together with the workers used in the on-site assessments. Nowhere is the principle of "Participatory Ergonomics" more important than in IDCs. Involvement of supervisors, medical personnel, unions, management, safety officers and most importantly, the workers themselves must be encouraged, and then recognized and rewarded as they learn to become more involved and realize just how much they have to offer, and how beneficial the whole process is. Scott has written extensively on this topic and strongly advocates that such workshops should lead to the establishment of an "Ergonomics Facilitation" team within individual companies. Again protecting the profession, she has proposed a two-tiered certification system in which the requirements for a registered ergonomist meets international standards, while at the second level, "Ergonomics Facilitators" must at least have attended workshops and be able to show some evidence of ergonomics conducted in their own working environment. These individuals will thus be able to facilitate ergonomics within their own company under guidance from a qualified ergonomics consultant who should visit the company on a regular basis (Scott 2001a and 2006).

In addition to creating an ethos of ergonomics within the actual workplace it is important in developing regions not only to conduct laboratory research, but to go out into the field and conduct *in situ* research under the harsh conditions so typical of many IDC work stations. While detailed evaluations of tasks are necessary, it is important to conduct holistic analyses of worker responses *in situ* in order to quantify biomechanical, physiological and psychological stresses imposed by the task. No simulated laboratory setting could possibly emulate real situations, nor would such simulations be ethically acceptable. It should therefore be obvious that volunteer participants (usually strong, healthy young students) will cope with the reduced stresses of laboratory experimentation so much better than under-nourished manual laborer in the field, thus rendering laboratory findings invalid when transferring them for practical use in the field. The theoretical and technical rigor, and the experience gained from laboratory research needs to be taken into the "real world" for field investigations in order to more accurately appreciate what millions of IDC workers contend with on a daily basis around the globe. No wonder there is high discontentment and low productivity.

5 Conclusions

The proposed basic formula for corporate sustainability in developing countries is short, but it is, I suggest, the *sine qua non* for improving organizational design and management in those countries which most need these interventions; poor countries, whose share of the world's population accounts for 75 %.

Nothing is to be gained in these struggling regions by a "giving and leaving" approach, which eases the givers' conscience without requiring time-consuming commitment. The African bush is littered with high-tech equipment, imported and left, eventually to rust because the requisite maintenance infrastructure was never put in place. In the majority of instances this *modus operandi* has served only to foster abuse and corruption within the recipient country. It may be worth repeating the old, trite phrase that sums up the Third World: "Give a man fish and you keep him dependent on you for life. Give him a rod and your work is done". As ergonomics has, all too slowly, filtered through to developing regions, the premise of its educational programs, from a one-day seminar or workshop to post graduate work at universities, has been to "help others help themselves". The objective is to establish an awareness of the benefits of running a company on sound ergonomic principles and achieve a commitment from all within the company to operate via "co-operative co-responsibility" (Scott 2006).

The United Nations Rio Declaration of 1992 addressed conservative use of available resources as the key to economic, social and environmental sustainability. Some corporations active in IDCs have operated responsibly, but too many either fall into the inefficient local ways of doing things, or try to impose their First World organizational methods locally, without prior confirmation that their methods are understood and accepted by the local culture. The solution is on-going bottom-tiered upliftment, rather than top-down collusion. After a decade of running ergonomics workshops, and interacting with the indigenous work force while implementing basic ergonomic principles, progress is becoming more evident. Grassroots "Ergonomics Facilitators" in South Africa have already began to provide an auto-catalytic impetus for sustained improvement within industry. These representatives from within the labor force have shown remarkable ingenuity and, because they are accepted and respected by their fellow workers, are highly motivated to maintain the drive to improve standards of work output and worker well-being. Thus small, unremitting changes resulting from creating an ergonomics ethos within the company, eventu-

ally reverberate beyond the confines of the company to the society as a whole.

The Developed World must call corrupt, exploitative, aid-demanding governments to account in order to ensure an end to their corruption. The same must be done with those multi-national businesses, which too often lead the way in exploiting the cheap labor of developing countries. International companies must take more responsibility for their local branches in IDCs. A personal visit to the coal-face often brings home the reality of the unacceptable conditions in which they may be generating their wealth.

Assistance, whether to countries, corporations or individuals, must be in the form of "coins", which, on one side offer "rods" not "fish", and on the other demand an accounting of operating responsibility taken rather than grants squandered. All contributors, whether from political, corporate, academic or personal quarters, should use these two-sided coins to ensure that IDC recipients, at whatever level, are educated in *their* responsibility to ameliorate the plight of *their* people.

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Participation as Precondition for Sustainable Success: Effective Workplace Improvement Procedures in Small-scale Sectors in Developing Countries

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Based on recent experiences in developing countries in Asia, common features of effective action-oriented procedures for improving workplaces in small-scale sectors are examined. Experiences of partners of our Asian work improvement network are referred to. Simplified participatory procedures are commonly used to improve working conditions and environment in small and medium-sized enterprises, small construction sites, small-scale farms and home workplaces. These procedures have proven effective when they (a) build on local good practices for immediate changes, (b) focus on readily practicable improvements in multiple areas of basic ergonomics, including many low-cost solutions, and (c) take serial group work steps with the support of locally adjusted group work toolkits. Numerous workplace improvements have been achieved with the help of easy-to-apply procedures and site-specific support. These procedures are facilitated by networks of local trainers. The international exchange of positive experiences in workplace improvement procedures adjusted to each local situation is particularly useful.

1 Relevance of Participatory Workplace Improvement Procedures

There is a growing need for designing effective workplace improvement procedures that are sustainable in small-scale sectors. This is accelerated

by the development of participatory ergonomics programs in diversified settings (Gustavsen and Oscarsson 1991; Noro and Imada 1991; Vink et al. 1995; Kawakami et al. 1999; Haines et al. 2002). Recent experiences in action-oriented programs for small-scale sectors in many developing countries point to the importance of simple easy-to-apply procedures adjusted to these sectors (Kogi 1998; Ito et al. 2001; Kawakami 2006). These experiences suggest that simplified workplace-level procedures focusing on immediate improvements can motivate people to plan and implement them in various small-scale sectors such as manufacturing, construction, services and agriculture (Zalk 2001; Kawakami and Kogi 2005).

An increasing number of reports indicate that participatory steps involving local people in voluntary workplace improvement procedures can lead to concrete results in small workplaces despite their many constraints (Kogi 2002; Kawakami and Kogi 2005). These reports reveal the spreading impact of participatory steps focusing on local good practices achieved by low-cost types of improvements in managing risks in these workplaces (Thurman et al. 1988; International Labour Organization 1996; Shahnavaz 2000; Itani et al. 2006; Kogi 2006). Both voluntary group work steps and low-cost improvements are usually stressed as means of facilitating risk assessment and control procedures that have real impacts (Koda et al. 1997; Hakkanen et al. 1997; Kogi et al. 2003; Lahiri et al. 2005; Nishikido et al. 2006).

This trend is linked to the recent development of management systems for workplace-level risk reduction. Awareness is growing that the participatory "Plan-Do-Check-Act" procedures within the management systems can effectively manage workplace risks, including many ergonomics-related risks, also in small-scale enterprises. Attention is drawn to easy-to-apply procedures for identifying and implementing immediate improvements in line with the internationally valid guidelines (Kogi 2002; Kawakami and Kogi 2005). The ILO (International Labour Organization) guidelines of occupational safety and health management systems, known as ILO-OSH 2001, emphasize worker participation and tailored procedures adjusted to small enterprises. The merits and limitations of simple procedures in dealing with the complex work-related risks should be carefully examined.

There is a strong need for developing widely applicable strategies relying on simple risk-reducing procedures. It is meaningful to examine the common features of these action-oriented procedures suited to improving small-scale workplaces. Learning from the network partners' experiences in developing countries in Asia, we may examine the types of simple procedures for small workplaces that can (a) build on local good practices; (b)

focus on low-cost improvements in multiple areas; and (c) use locally adjusted toolkits for their direct use by local people.

2 Subject of Investigation

Common features of workplace improvement procedures emphasizing participatory steps and immediate improvements in small-scale workplaces are reviewed based on the recent experiences of our Asian inter-country network partners. These procedures are undertaken in participatory action-oriented programs in different settings, including small and medium-sized enterprises, construction sites, home workplaces and agricultural farms. The procedures of these programs reported at a jointly operated website[1] and study reports are examined.

The programs reviewed include (a) participatory training courses applying the WISE (Work Improvement in Small Enterprises) methodology (Thurman et al. 1988; International Labour Office 2004; Takeyama et al. 2006) in the Philippines, Thailand and Vietnam; (b) similar training activities for improving small enterprises, construction sites and home workers in Bangladesh, Cambodia, Korea, Laos, Malaysia, Thailand and Vietnam (Kawakami and Kogi 2005; Itani et al. 2006; Koo et al. 2006; Krungkraiwong et al. 2006); (c) rural workshops for farmers applying WIND (Work Improvement in Neighbourhood Development) methods similar to WISE methodology (Khai et al. 2005; Khai et al. 2006) in Thailand, the Philippines and Vietnam; and (d) training activities applying POSITIVE (Participation-Oriented Safety Improvement by Trade Union InitiatiVE) methods developed jointly with national trade union centers and the Japan International Labour Foundation (Kawakami et al. 2004, Tachi et al. 2006) in Bangladesh, China, Indonesia, Mongolia, Nepal, Pakistan, the Philippines, Thailand and Vietnam. Main features of participatory procedures in these programs are reviewed by Kogi (1998), Kawakami and Kogi (2005) and Khai et al. (2005).

The effective types of participatory procedures used in these programs are discussed. A particular attention is drawn to the means of motivating local people towards better workplace practices and achieving concrete improvements in the different settings. Effective types of support functions for facilitating the participatory results-oriented procedures are also discussed.

[1] http://www.win-asia.org

3 Results and Discussion

3.1 Building on Local Good Practices through Participatory Steps

It is noteworthy that all the reviewed programs are undertaken for the purpose of immediate implementation of voluntary measures meeting local needs. As a rule, action-oriented training of local people, including managers, workers and farmers, is conducted by short-term training courses or workshops of one to several days. The training is usually conducted by collaborating units that may include government agencies, safety and health institutions, university departments, employers' and workers' organizations or farmers' organizations. The short-term training is concentrated on learning how to identify locally practicable improvements and implement them immediately using local materials and skills.

Each short-term training program usually consists of a worksite visit combined with the use of an "action checklist", technical sessions on learning local good examples and relevant ergonomic principles of practicable workplace improvements and group work sessions on priority low-cost improvements that can reduce existing occupational safety and health risks. While the duration and the kinds of technical sessions differ between them, the reviewed programs are similarly composed of learning sessions on local good practices and group work sessions on the planning and implementation of selected improvements. In this sense, these programs rely on commonly simplified procedures. The WISE training program for small and medium-sized enterprises lasts for several days to two weeks, with a checklist exercise, workshop-style sessions and a final session for reporting achievements held on a few separate days. Training workshops of 2–5 days for various small firms, construction sites and home workers likewise consist of site visits, technical sessions and group work on action plans. WIND workshops for farmers are conducted for 1–2 days on learning local good examples and appropriate types of low-cost improvements by household visits and technical sessions and on planning immediate action plans. The reporting of actions taken is done with the help of trainers. In POSITIVE methods for trade unions, 3–4 day courses are organized also including a checklist exercise, learning of local good examples and planning of low-cost improvements in selected areas. Trade union roles in promoting occupational safety and health at the workplace-level are then discussed.

It is confirmed that group work procedures are separately used for learning local good practices and for planning immediate improvements. This is usually done by the initial step of learning local good examples and the subsequent steps for agreeing on and implementing practicable improvements, as shown in Fig. 1. These steps are undertaken in the form of group work of local people guided by trainers.

The initial step of learning from local good practices is usually done by worksite checklist exercises and by technical sessions on practicable improvements learned from good examples locally achieved. The learning process is facilitated by group discussion of local good practices in sessions dealing with different ergonomic aspects. The next planning process focuses on simple changes practicable in the local context. Many local good examples and illustrated manuals showing how to make ergonomic improvements are used in the group work for prioritizing immediate actions. The planned improvements are normally undertaken based on group work.

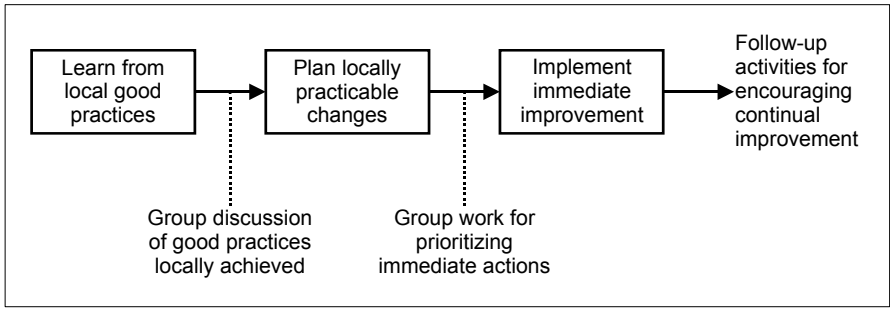


Fig. 1. Participatory steps commonly used in the reviewed programs for immediate workplace improvements

The advantage of these participatory initiative-building procedures learning from local good practices is seen in the sustainable nature of the programs reviewed. The initial step of learning local good examples is straightforward and helpful for proceeding to the planning and implementation of similarly practicable improvements. In particular, WISE and WIND programs relying on similar methods are spreading to an increasing number of countries in Asia, Latin America and Africa. POSITIVE programs are likewise spreading, now in use in nine countries through the cooperation of national trade union centers in these countries.

This advantage of the reviewed programs is demonstrated by Fig. 2 extracted from the follow-up activities of the WISE project for the Philippines. The number of courses is shown for the initial project period of

1994–1997 and for the subsequent government activities during 1998–2004. The awareness and comprehensive courses were sustained after the ILO project for over several years. These continued activities resulted until 2004 in 590 WISE courses that led to more than nine thousand improvements reported from small and medium-sized enterprises in four regions of the Philippines. It is of interest that about 80 % of these improvements were accomplished during the post-project period of 1998–2004.

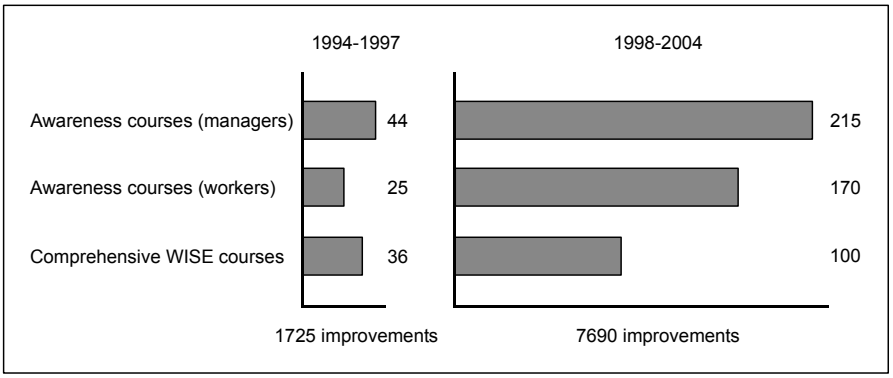


Fig. 2. Numbers of WISE courses organized in the ILO project period of 1994–1997 and in the subsequent government activities during 1998–2004 in the Philippines (the total of 590 courses involved 14,603 participants and led to 9416 improvements)

Similarly sustainable impacts are seen in the case of WIND and POSITIVE activities as shown in Fig. 3. For WIND courses held in four provinces in Vietnam, twenty core trainers who had been trained by a ten-day training-of-trainers course organized two-day workshops for 71 farmer trainers in the four provinces. These farmer trainers conducted about 600 mini-workshops for farmers who reported over 4000 improvements in the one-year period. In the case of POSITIVE courses in China, 160 trainers trained in participatory methods trained about five thousand local trainers in three provinces in the project period of three years. These union trainers organized 178 seminars and enterprise-level workshops. As a result, a large number of union members were trained and reported numerous improvements done at their workplaces.

We may confirm that the participatory action-oriented procedures that build on local good practices are useful for facilitating voluntary improvements in small workplaces in a sustained manner. It is important to support the initiative of people by facilitating the group learning and planning of practicable improvements.

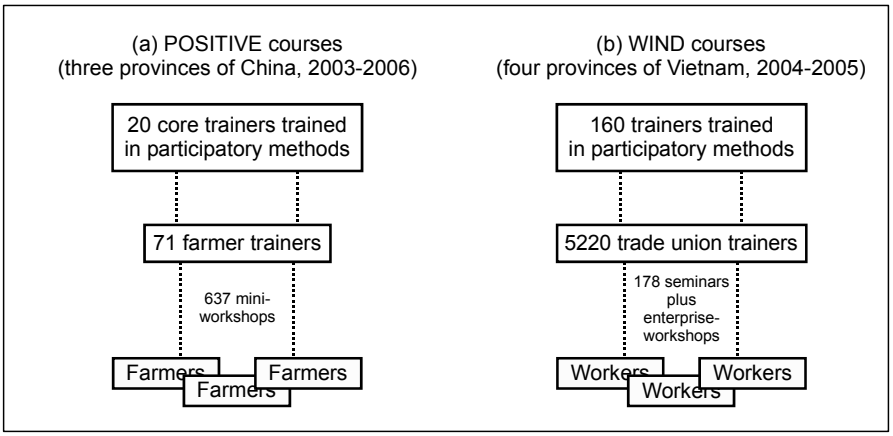


Fig. 3. Networks of trainers trained in participatory methods for sustained activities applying WIND and POSITIVE programs

3.2 Focus on Low-cost Improvements Relying on Basic Ergonomic Principles

It is significant that all the reviewed programs are applying easy-to-understand procedures of selecting low-cost improvements that can be done by using local materials and skills. The low cost of the improvements aimed at is obviously favorable for applying the simple procedures for their selection. Particularly in the planning step, participants are guided to look into typical low-cost improvements that are achievable in the given local conditions. The participants then conduct group work for selecting necessary improvements from relatively short lists of low-cost improvements in each of the technical areas.

The low-cost improvements achieved by the programs cover various aspects of conditions of workload and the working environment. The aspects that have commonly led to concrete workplace improvements are (a) materials storage and handling, (b) workstation design, (c) physical environment, (d) welfare facilities and (e) work organization. Additionally, in WIND programs, daily life conditions and community cooperation are also often covered. In POSITIVE courses, improvements related to management–worker cooperation are also frequently covered.

The distribution of such improvements by technical area is shown in Fig. 4. The results from WISE courses held in four regions in the Philippines and those from a single WISE course in Cebu in which 20 enterprises took part are compared. In the four regions, 1725 improvements

were done covering materials handling, workstations, physical environment, welfare facilities and work organization. Interestingly, a similar distribution of the different aspects is seen also in the case of a single WISE course.

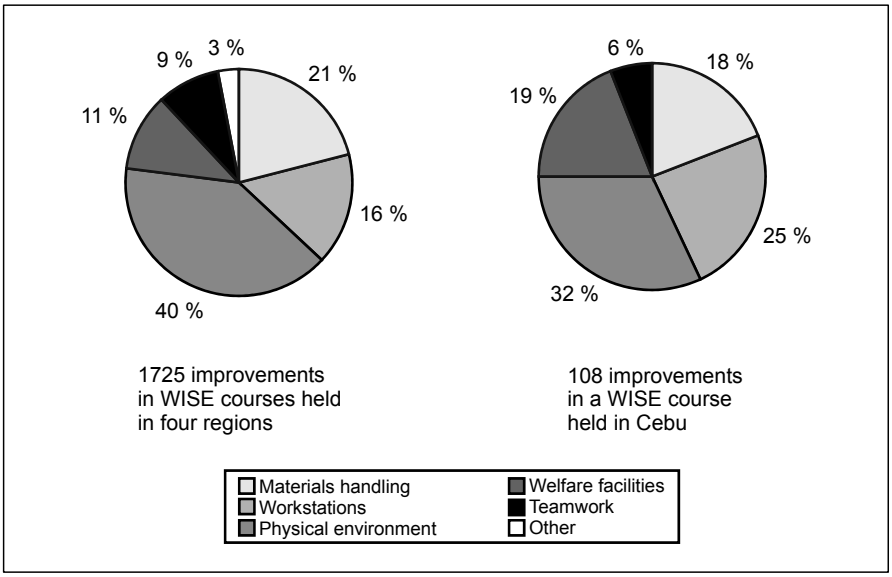


Fig. 4. Distribution of different aspects of improvements done by small enterprises in WISE courses in four regions of the Philippines during 1994–1997 and by those in a WISE course in Cebu (Kogi 1998)

The simple procedures of planning low-cost types of improvements can thus guide participants to improve multiple aspects of workload and the working environment together. It is known that the costs of improvements achieved by participatory action-oriented programs are generally low. Follow-up studies of a WISE course in Thailand and a WIND course in Vietnam have confirmed that about one-third of improvements could be achieved at zero cost. Another one-third could be done at less than US $20 in the WISE course and at less than US $10 in the WIND course. These low-cost improvements are found in all the technical areas of materials handling, workstation design, physical environment and welfare facilities. Most of these improvements are based on basic ergonomic principles learned from local good practices, as listed in Table 1.

Table 1. Typical ergonomic principles incorporated into low-cost modifications widely applied by the participatory programs reviewed

Technical areas	Examples of modifications	Ergonomic principles
Materials handling	- Carts and mobile racks Multi-level shelves/homes for tools - Lifting devices and safe grips	- Fewer, faster handling movements - Reduced handling loads
Workstation design	- Easy reach to materials and tools - Elbow-height work and good seats - Fixtures for work items - Coding of displays and items	- Easy and steady access - Efficient and less stressful operations - Easy-to-follow tasks
Machine safety	- Proper machine guards/fences - Interlocks and two-hand controls - Labels and warnings	- Barrier-free work space - Fail-safe measures - Reducing mistakes
Work environment	- Good lighting and ventilation - Isolating hazard sources - Providing barriers and exhausts - Signs at areas requiring PPE	- Nuisance-free work - Avoiding exposures - Reduced exposures - Regular use of PPE
Welfare facilities and cooperation	- Drinking water/eating facilities - Clean toilets/washing facilities - Resting rooms/corners - Teamwork and self-paced work - Fostering supportive climate	- Routine sanitation - Refreshing effects and recovery from fatigue - Autonomous team-work - Less psychosocial stress

PPE: Personal Protection Equipment

This helps attain real impacts on reducing workload or environmental risks. It is important that there are basic ergonomic principles that are widely applicable in small-scale workplaces. Typically, these principles are readily incorporated into low-cost modifications practicable in these workplaces as shown in the table. Many of these modifications have risk-reducing effects. For example, fewer and faster handling actions can reduce muscular and physical loads and transport injuries. Elbow-level work with easy access to materials and controls can reduce postural strains and enhance work efficiency. Machine guards and labels can reduce accidental contacts and mistakes. Isolation of hazard sources can reduce exposure to hazards and lead to more productive work. Sanitary and refreshing facilities can help keep routine sanitation and recover from fatigue. Autono-

mous teamwork with the supportive climate can reduce job-related stress. These effects have real impacts particularly when the modifications are applied in multiple ways.

This emphasis on readily applicable improvements that are meaningful from ergonomic points of view helps people follow versatile procedures in building on local good practices. The procedures are thus easy to start, useful for keeping a broad scope and advantageous for consensus building in the planning and implementation of selected improvements. This versatile nature of the simplified procedures is noteworthy.

3.3 The Use of Locally Adjusted Toolkits that Can Facilitate Changes

The simple procedures for identifying and implementing low-cost improvements suited to small-scale workplaces may be assisted by the combined set of action-oriented tools. A typical toolkit consists of learning materials showing local good examples, action checklists and illustrated how-to guides. All these toolkit elements are found to be extensively used in all the programs reviewed. As a set of easy-to-use tools, each toolkit is action-oriented so that their users can readily look at low-cost improvements readily applicable to small workplaces. The main roles of these toolkit elements common to the programs are indicated in Table 2.

Table 2. Main common roles of the three toolkit elements widely applied through the reviewed programs

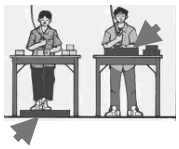
Toolkit elements	Aim of the use	Main roles in training
Local good examples (photographs, video clips, fact sheets)	Show local good practices achieved in local conditions in multiple technical aspects	Help build local initiative through learning of visualized local successes
Action-form checklists (clear focus on low-cost improvements)	Select low-cost improvement actions that are locally available	Help have an overview of options reflecting basic ergonomic principles
Illustrated how-to manuals (with locally easy-to-apply examples)	Provide how-to guidance for immediate actions	Help select feasible options that use local materials and skills

Combining these roles, the toolkits used are meaningfully adjusted to each local situation. This is done by incorporating many real improvements achieved locally and by adapting both the action checklists and how-to guides so as to reflect these local achievements. Thus, photographs of local good examples are extensively used in training sessions. The 30–50 items

in each action checklist correspond to common types of local good practices. Training slides usually comprise many local examples.

The usefulness of simple toolkits is exemplified by a recent toolkit for participatory action-oriented training of home workers, as shown in Fig. 5 (Kawakami et al. 2006).

(a) Illustrated local good examples



Use a platform for small workers and an item holder for tall workers to adjust their work height to their elbow levels.

Use convenient material containers to keep frequently-used materials within easy reach and in an orderly manner.

Provide a cabinet with multi-compartments to keep all chemicals in good order.

Provide first-aide equipment in an easy-to-see place.

(b) Corresponding items of the action checklist

Adjust work height for each worker at elbow level or slightly lower than elbow level.	Put frequently used tools, controls and materials within easy reach of workers.	Put labels and covers to all the containers of hazardous chemicals.	Provide first-aid equipment and train a qualified first-aider.
Do you propose this action? [ ] No [ ] Yes - [ ] Priority	Do you propose this action? [ ] No [ ] Yes - [ ] Priority	Do you propose this action? [ ] No [ ] Yes - [ ] Priority	Do you propose this action? [ ] No [ ] Yes - [ ] Priority

(c) Practicable improvement options in the manual

- Adjust working height to your elbow level. - Use a foot platform for small workers and an item holder for tall workers. - When exerting greater force, adjust workstations slightly lower than your elbow level.	- Put most frequently used tools and materials within your easy reach. - Use boxes and containers to keep small items within your easy reach. - Hang tools such as hammers or scissors at the table side.	- Make sure that all the containers of chemicals have labels and covers. - Put easy-to-understand labels to avoid misuse. - Keep chemicals in a multi-compartment cabinet. - Collect waste bottles in a separate container.	- Equip a first-aid kit easy-to-see. - Position the kit out of reach of children. - Prepare for transport to a hospital in case of emergency.

Fig. 5. Extract from a recent participatory action-oriented toolkit for home workers (Kawakami et al. 2006)

The toolkit contains many illustrated examples of locally practicable improvements and an action checklist for proposing feasible actions referring to these available types of low-cost improvements. The action manual mentions easy-to-apply improvement options reflecting basic ergonomic principles. This simple structure of the toolkit helps workers select immediate actions based on their own experiences.

It is encouraging that these locally adjusted toolkits are reported to be effective in following the action-oriented procedures of building on local good practices for immediate changes. As a result, there has been developed a variety of WISE checklists adjusted to different industries and countries as well as different shorter and longer versions of WIND checklists containing site-specific items. POSITIVE checklists are used as local language versions in all the nine countries and their illustrated action manuals contain many photographs of locally achieved improvements. We may verify that the three types of tools are commonly used to perform the support functions summarized in Fig. 6. These support functions are: (a) building local initiative for immediate actions learned from local good practices, (b) focus on practicable options assured to have real ergonomic impacts and (c) promoting serial group work steps in a locally adapted manner.

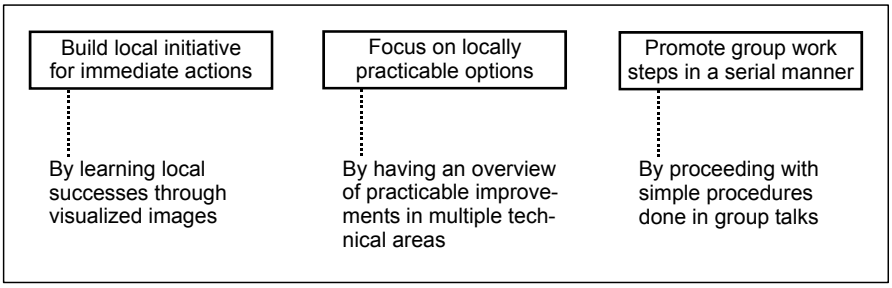


Fig. 6. Support functions of the action-oriented toolkits comprising good practice examples, action checklists and illustrated manuals

The effectiveness of the simple action-oriented procedures is confirmed by various field reports in our network. These reports show the positive evaluations of the participants about the easy-to-apply procedures and the benefits gained through accomplished improvements. It should be noted that the workplace improvement procedures followed in these programs may well correspond to the "Plan-Do-Check-Act" cycle for risk management. The initial learning of local good examples may correspond to the initial review of existing risks problem areas and help people go through the "Plan" phase. The selection and implementation of low-cost improve-

ments applicable to the local situation through the use of action-checklists and how-to guides may represent the "Do" phase. The reporting and other follow-up activities may correspond to the "Check" and "Act" phases for reviewing the results obtained and confirming the need for continual improvement. This link with actual risk reduction steps of the apparently simplified procedures of the reviewed programs may explain the rationale for these procedures. The procedures commonly used thus represent risk management steps of planning good practices and implementing priority risk control measures. The use of locally adjusted toolkits can play a crucial role in linking the checklist application with appropriate risk-reducing options. The observed close link of the participatory procedures assisted by the locally adjusted toolkits and the risk reduction steps is important from a risk management's point of view.

Since the participatory procedures are relatively simple as discussed, local people trained in the toolkit usage can better understand the link and help create local climate for improved risk management. The recent development of occupational safety and health management systems can thus be interlinked with the participatory programs. This has been demonstrated by the experiences in our Asian network.

There is a need for caution in applying the simplified procedures in small workplaces. The action-oriented training sessions should be carefully organized to encourage voluntary initiative of local people. Local good examples used should be taken from those in small-scale workplaces in the same local situation. It is necessary to clearly focus on low-cost ideas attainable by using local materials and skills. The participatory steps should aim at changing the existing workplace conditions on the step-by-step basis. Above all, the trainers should act as facilitators of the voluntary stepwise progress relying on the initiative of local people.

The simplified procedures of the participatory programs reviewed are considered favorable for developing the networks of trainers (Kogi 2002). The lessons learned from the developing countries confirm the wide applicability of such procedures in different settings. Similarly simple procedures utilizing locally adjusted toolkits can be proposed to small-scale sectors in both industrially developing and developed countries (Ito et al. 2001; Itani et al. 2006; Yoshikawa et al. 2006). It is suggested to foster these networks by spreading the strategic use of the participatory procedures and locally adjusted toolkits for undertaking improvements practicable in the local context.

4 Conclusions

The simplified action-oriented procedures commonly used to improve small-scale workplaces are found useful. The experiences gained in WISE, WIND and POSITIVE programs and similar participatory training methods in developing countries in Asia demonstrate the effectiveness of these procedures. Numerous workplace improvements are achieved in different small-scale settings including manufacturing, construction, services, home work and agriculture. As shown, these procedures have proven effective when they build on local good practices in multiple technical areas, focus on low-cost improvements learned from these practices, and utilize locally adjusted toolkits. The versatile nature of the group work procedures relying on voluntary initiative is crucial in leading to concrete results. The emphasis placed on low-cost improvements reflecting basic ergonomic principles appears equally important in following the procedures.

It is suggested to develop and use locally adjusted toolkits comprising action checklists and illustrated how-to guides. Presentation of locally achieved good examples in multiple technical areas is essential. This type of site-specific support for the participatory procedures taken by managers, workers and farmers can expedite the planning and implementation of practicable improvements in the locally adapted manner. The use of the versatile toolkits is useful for spreading the action-oriented programs for workplace improvements in many small-scale workplaces in different settings. The international exchange of positive experiences in this direction is important.

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The Future of Work in a Sustainable Society

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The rapid pace of change in our society has been well documented, and models predict that it will continue at an increasing rate. We need to make plans and take actions based on realistic future states to ensure that our actions result in a sustainable planet despite limited resources, not one currently overshooting the earth's capacity. The technical conditions for overshoot are growth, a resource limit and faulty actions by a controller. All are present in the world and in aspects of work. Humans, however, do not perceive accelerating changes particularly well, with a tendency to predict linear future states. This disparity between perception and reality may help explain the lack of action by many governments and organizations faced with choices they would rather put off for short-term political/economic gain. As ergonomists we have a major role to play adapting our actions to the future of work, which in turn depends on the future of the enterprises where we work, and ultimately on the future of society. This paper looks at the future of work from a sustainability perspective and suggests actions ergonomics can take to be ready for an accelerating future.

1 From World through Work to Ergonomics

Predicating the future is a notoriously unreliable task, but outlining possible futures, in contrast to impossible ones, is a more sensible undertaking. To extrapolate into the future requires both data from the past and an extrapolation model, and these are quite lacking at the level of human factors/ergonomics (HFE). The issues of sustainability have been mooted within the HFE community over a decade ago (Moray 1993) but hardly taken up systematically since then. Perhaps an alternate, parallel way to examine the problem of HFE futures is to work from the outside (the

world) in towards our professional concerns (HFE). This approach has been used to consider the future of ergonomics (e.g. Drury 2006) and earlier to examine future impacts of work on musculo-skeletal disorders (NRC 2001). Here we apply it to issues of sustainability by first considering what is known about past and future effects of human choices on the earth's well-being, then showing how these are likely to affect people's work, to finally provide a rationale for a HFE response.

2 Sustainability at the World Level

The word "sustainability" was first used in its modern form in the World Council of Churches in 1974 (WCC 1974). It gained wide acceptance in a report to the UN entitled *Our Common Future*, (WCED 1987) usually known by the name of its leader, Norway's Gro Harlem Brundtland (see Dresner 2002). As used by the authors of that report, sustainable development meant: "*Development that meets the needs of the present without compromising the ability of future generations to meet their own needs*". Since then there have been widespread criticisms of the concepts of sustainability and sustainable development. Meadows et al. (2004) see sustainability as "a term that remains ambiguous and widely abused" while Dresner (2002) sees "the suspicion among some environmentalists that sustainable development is a meaningless concept". However the idea of sustainability as non-depletion of capital, whether resources, carrying capacity or even monetary or social capital, is a concept that has taken deep root in the environmental movement.

Perhaps the most famous report on sustainability is the Club of Rome's 1972 report *The Limits to Growth* (Meadows et al. 1972) which used computer models of the earth as a closed system to outline possible futures. Despite widespread criticism by governments and industry leaders that its prediction of oil production collapse in the 20th century (in fact it made no such prediction!) did not come about, the main outlines of its methods and conclusions are still valid 35 years on. Treating the earth as a dynamic system with many interconnections and feedback loops conforms to good HFE principles (c.f. general systems theory) of considering the full system rather than an isolated part of it (Ropohl 1999). Dresner (2002) detailed how the original report had been translated into about 30 languages and sold many millions of copies, found its way into academic, political and environmental discussion and been widely misquoted as Malthusian. A 30-year update of that report (Meadows et al. 2004) came to rather similar conclusions from its generation and analysis of nine scenarios rather than

the original twelve: there has been an overshoot of human activity that is beyond the capacity of the earth to sustain. The different scenarios, based on different sets of assumptions (e.g. about technology and political action) can lead to different long-term outcomes, ranging from catastrophic collapse to sustainability. They note that the thirty years since 1972 have not seen concerted action to modify the growth imperative, and that many options available in 1972 were no longer possible. The point is not whether we believe specific scenarios, but that none of the scenarios leads to sustainability with our continued policy of growth.

Perhaps the most useful concept for HFE to emerge from this modeling, analysis and data is that of overshoot. Wackernagel et al. (2002) tracked the impacts of many components of our activity on earth (from growing crops to fishing to use of fossil fuels and damage to the biosphere) as natural capital since 1961, a much shorter time scale than the usual environmental impact graphs. Their conclusion was that sometime in the 1990s we exceeded the earth's capacity. Figure 1 (from Wackernagel et al. 2002) shows this as an overshoot: we are no longer in a sustainable mode of living on earth. As Stiglitz (2006, p. 161) notes: *"If we had access to a thousand planets, it might make sense to use one to conduct such an experiment… But we don't have that choice…"*

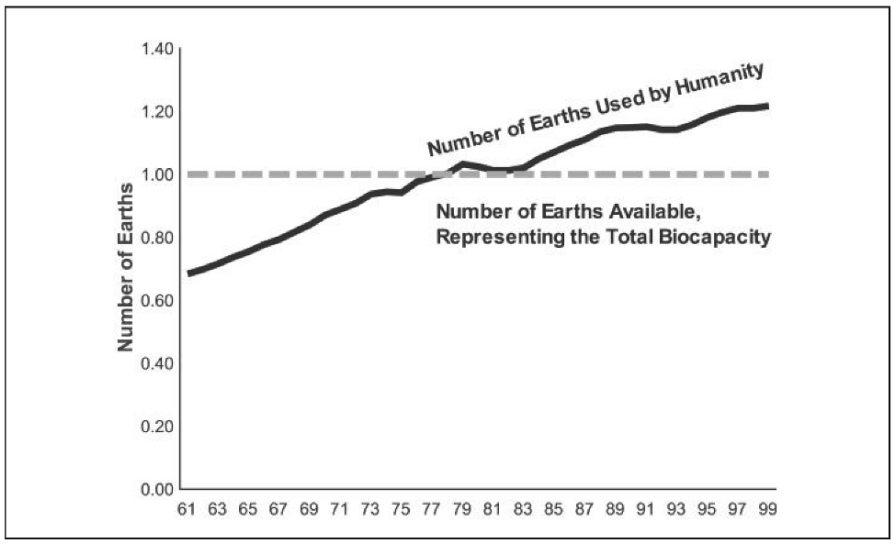

Fig. 1. Overshoot of earth usage beyond earth capacity (Wackernagel et al. 2002, p. 9269)

Meadows et al. (2004) take up this concept of overshoot as a general attribute of systems given certain combinations of conditions.

They show three necessary and sufficient conditions for an overshoot as (Chap. 1):

- Growth, acceleration, rapid change
- A limit or barrier beyond which it is unsafe to go
- A delay or mistake in perception or response

These not only provide a general definition applicable to all systems, but are rather simply translated in the effects of the humans on the world or, as we note later, specific aspects of work with HFE implications.

3 Growth, Limits and Perception at the World Level

All of the data we have on economics and populations show growth, and often exponential growth (Meadows et al. 2004, Chap. 2). Drury (2006) examined evidence from technological innovation studies that also showed exponential growth. Kurzweil (2005) listed major technological innovations over the past ages to demonstrate that the time since each previous technological change is approximately the same number of years in the past (Fig. 2).

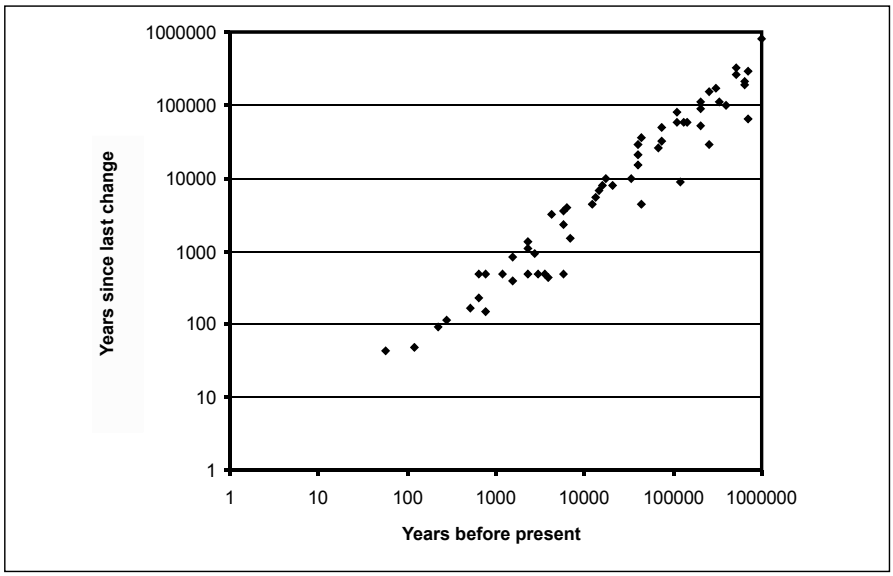

Fig. 2. Data from several authors showing increasing frequency of major events/inventions (Drury 2006, p. 2; after Kurzweil 2005)

The implication is that change is not only a constant, known since to Heraclitus in about 500 B.C.E., but is in fact accelerating. Kurzweil (2005) sees a "Technological Singularity" where change will be so rapid that humanity will not be prepared for its consequences.

If both our current use of resources and our technological innovation are exponential, then we have the first of the conditions of overshoot postulated by Meadows et al. (2004). Some may see hope that technological innovation will rescue us from our own mismanagement, but the Meadows et al. (2004) model and the conclusions of Wackernagel et al. (2002) are relatively insensitive to this parameter. For example, in an exponential growth scenario, a doubling of technological innovation would only represent a short extra time in which action must be taken.

Limits are obvious at the world level for most of the resources we are considering here. The effluent carrying capacity of the land and its oceans are just one example where historically low levels of economic activity could ignore the limits but at the turn of the 21st century we can no longer take this naive view.

The third factor necessary for overshoot in Meadows et al. (2004) directly concerns the controller of a system. Misperceptions and delays are widely-recognized categories of human error, assuming that the system controller is ultimately human.

The typical closed loop control behavior of a system including a human operator is shown in Fig. 3, with the human operator portion enlarged in Fig. 4. The misperceptions of interest here primarily concern how human perceive change. Gottsdanker (1952) had participants predict the motion of a point on a display that disappeared after a time interval. The main conclusion was the prediction was linear (constant velocity) whether the point had been accelerating, decelerating or moving with constant velocity before it disappeared. Applied to our overshoot scenario, we can expect people to predict on the basis of linearity even where the relationship is nonlinear, indeed exponential. This is a misperception with potentially dangerous consequences for sustainability.

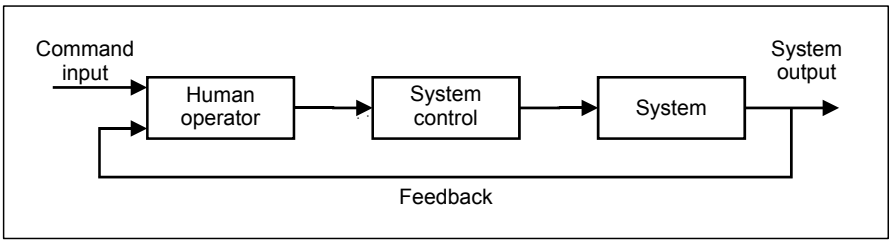

Fig. 3. Human operator in a closed loop control system

Delays are part of the human response system, even when tracking rapidly-moving objects (McReur and Jex 1967). In slower process control tasks, delays are also evident, although human operators do tend to have trouble differentiating between a true change of state and random fluctuations (Kelly and Drury 2002). This has led to the statistical process control systems in widespread industrial use since Shewart's studies in the 1930s. If delays are evident in such small-scale human activities as tracking or process control, they are even more pronounced at the societal level. Politicians, and the populations who vote them into office, have widely contributed to the delays seen in responding to sustainability challenges with initially unpopular programs. The 30-years of little action following *The Limits to Growth* are evidence for this conclusion. One remedy for delays is anticipation of the future state and of future inputs.

In Fig. 4 there is an explicit model of the system, without which a controller would not know how to function. The model states the operator's beliefs about how the system will respond given the current system state, the current command input and the actions the operator may take. Operators' models, known as mental models, may of course be incomplete or even wrong. In process control tasks in industry, there is often an industrial mythology about how the system functions, based on shared knowledge and prior experience. However, false knowledge as well as correct knowledge may be shared, and people may impute causality from random events and correlations. Wrong models are abundant in the political sphere, with statements about the lack of a current ecological overshoot, or even human causality, widely presented and believed.

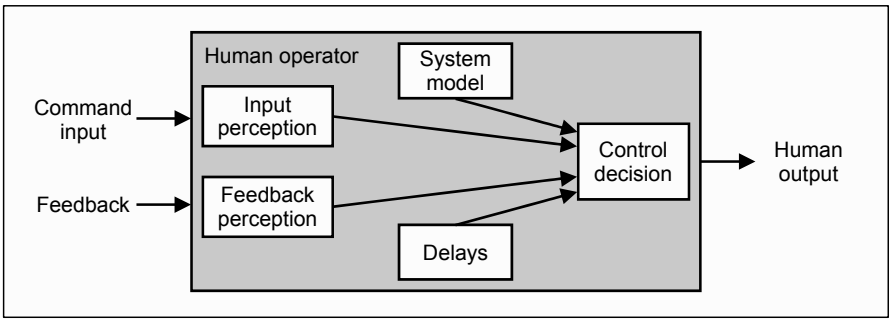

Fig. 4. Expanded view of the human controller of a system

Our conclusions from this section are that the earth is in an overshoot state with respect to human activity, and that conditions necessary to this overshoot are quite predictable from even older models of human behavior.

4 Changes in the World of Work

With such profound changes in technology and human activity taking place in the world, it is hardly surprising that the world of work is changing. Drury (2006) reviewed a number of changes directly related to human work and therefore to HFE responses. They are summarized briefly here.

4.1 Technology

The rapid historical changes in technology have already been seen (Fig. 2), but more specific technologies are enablers of changes at work. The two most relevant are two of three elements labeled by Friedman (2006) as the *Triple Convergence*. These two comprise the wide availability of standard computing platforms with relatively good interoperability and the low cost worldwide fiber optic networks that resulted from the dot-com bust at the turn of the century. Between them, these changes have allowed much of the globalization of work to occur. They have also profoundly affected people's jobs, both by moving work to other regions and by changing the way work is performed. Workplaces have become more capable, with many simpler tasks automated so that the operators can (have to?) deal with more complex questions and exceptions to rules. New operator skills are required, but that has been true with every change over centuries.

4.2 Social Networks

Books by Putnam (2000) and Fukuyama (1999) have popularized the notion of *social capital*, i.e. the fact that as people interact with each other they build mutual trust and understanding which can have beneficial effect on individuals and on society. Data from the past century have documented that social capital has been eroding as interactions decreased, postulated as a cause of rising crime rates, divorce rates and teenage pregnancies. Although social capital appears to be rising again over the past decade, it is still an important concept to build into work and into enterprises.

4.3 Globalization

This term has come to stand for a raft of changes, some beneficial and some not, concerned with the ability of enterprise to distribute its operations and customer base across continents. This has given rise to global supply chains that see products designed and built in a distributed manner. For example, *for the first time with the 787, Boeing is outsourcing more*

than 70 % of the airframe and is giving all aircraft suppliers the responsibility for doing the detail engineering designs (Holmes 2006).

For the workplace, this has meant collaboration across continents and time zones, enabled by the interoperable computers and cheap communications described above. There are clear implications for workforce well-being coming from around-the-clock working. There are also implications fore the migration of labor and jobs. From a sustainability perspective there is the obvious consideration of the global transportation requirement, whose true environmental costs are not being paid by the transportation companies or their customers (Stiglitz 2006, Chap. 6).

4.4 Move to Service

In all countries over the past few hundred years the employment trend has been away from agriculture to manufacturing, followed by a further movement to service industries. Again the convergence of interoperable computers and cheap communications have aided the trend as service industries are at least as concerned with the movement of information as movement of physical goods. Figure 5 (from Paulson 2006) shows this trend in a number of countries.

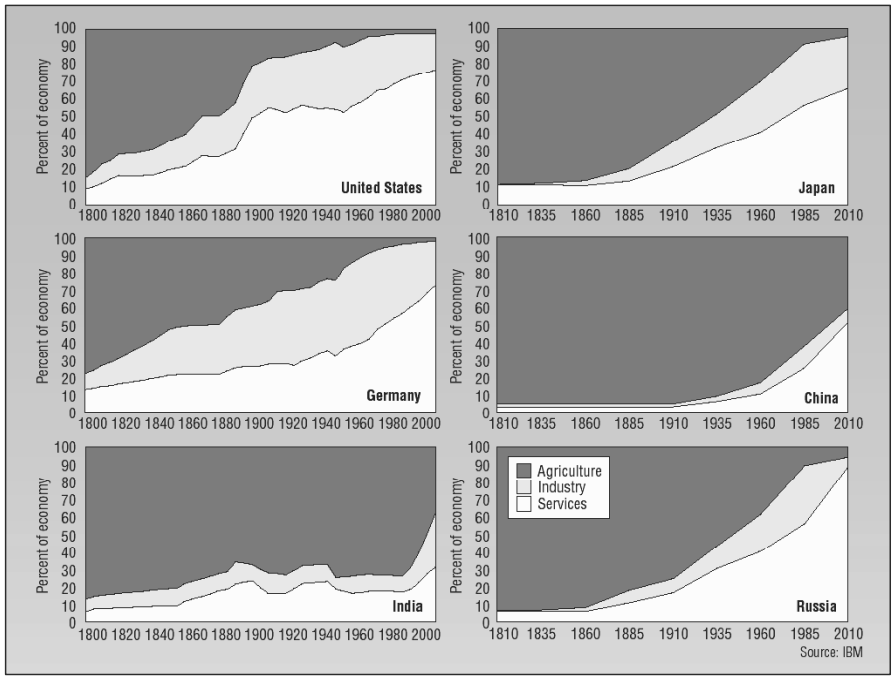

Fig. 5. Demographics changes over two centuries (Paulson 2006, p. 12)

The implications for work arise from the nature of service work. In service the offering (goods or services) is jointly produced by the customer and the operator (Grönroos 1990), as seen for example in ordering one of the many thousand coffee combinations at a global retailer such as Starbucks. It is even more evident in medicine and travel planning (Chen and Drury 1999). In contrast with traditional manufacturing, the service operator must be more skilled at interacting with customers, for example to help them select (design) their customized offering.

4.5 Demographics

Human demographics are changing and with them workforce demographics. There are larger scale migrations between countries and regions, as here have been thought human history: they are just taking place more rapidly now and with greater public knowledge. The life expectancy is growing in most countries, with serious implications for the workforce. As more workers are able to work for longer, beyond the traditional retirement ages of 60–65 (e.g. NRC 2001 for USA data), they create a pool of knowledge, but also a pool of workers with declining physical abilities. In the past, most industries had less arduous jobs for older workers, but with the loss of lifetime employment this may no longer be an option. In addition, the diversity of the workforce is increasing with more immigrants, more women and more disabled people taking part in work (Szafran 2002).

4.6 Work Intensity

Historical changes in the length of the work week, the organization of the work day and the amount of vacation time have a large potential effect on work and HFE. Hours of work per year have been increasing in the USA (Schor 1991) while in most countries the mean hours of work per week have not changed much. What has changed (e.g. Watson et al. 2003 in Australia, Jacobs and Gerson 2004 in USA) is the distribution of hours per week across individuals. There are more people working long weeks (>50 hours) and short weeks (<20 hours) compared with a "standard" week of about 35–40 hours, although most people want a more standard week – labeled the *Goldilocks Hypothesis* by Goldenhar et al. (2003). In addition, the removal of jobs, by downsizing or other management initiatives, has increased the intensity of work performed by those remaining (Green 2003; Watson et al. 2003) leading to potential for errors and loss of well-being due to increased work intensity.

Overall, there have been many changes affecting work, of which resource limits and sustainability represent only a small fraction. In the broader definition of sustainability that includes reducing inequalities in the distribution of well-being across countries and socio-economic groups (Dresner 2002), there are positive and negative consequences to these changes. While more lucrative employment may be available to a wider set of international participants due to globalization, there are obvious dangers from lack of international standards and from repeating many of the unsustainable policies of western market economics in the industrially developing world.

5 Adapting to a Sustainable Reality: HFE Roles

The world must adapt to the changes noted above if it is to survive in a recognizable way without catastrophe (Meadows et al. 2004). So what are the potential roles of HFE in this adaptation? The problem of adapting our behavior to resource limits can take place on at least three levels of interest to HFE:

1. At the level of work in an enterprise, where most HFE is implemented
2. At the level of responsibility outside the workplace, a traditional topic in HFE via consumer product design and use
3. At the level of our own activities as individuals and as members of a world society

Examples will be given of actions possible at these levels, based on our analysis so far of a world in an overshoot state. Recall that the three necessary and sufficient conditions for an overshoot are growth, a resource limit and an inadequate response. The last of these is perhaps the one where HFE action is most likely as we can usually not do a great deal about the resource limit and changes to growth often demand action at higher levels than HFE normally accesses.

At the enterprise level, work has already started on better fitting the reward system of the enterprise to a range of measures beyond the typical ones of effectiveness and efficiency of task completion. Wang and Lin (2007) look beyond the earlier ideas of green manufacturing to an accounting system that encompasses economic prosperity, environmental quality and social justice. This has been termed Triple Bottom Line (TBL) accounting (e.g. Deegan 1999) and is seen as a way forward towards sustainable development. Wang and Lin (2007) present a TBL optimization

model based on the three bottom line components and their overlaps/interactions. This model includes stakeholders beyond the traditional ones of stockholders, customers and organized labor, e.g. government, community and suppliers (e.g. in a global supply chain). This is a multi-criteria decision making model, well known in operations research. It can have an explicit value structure (e.g. multi-attribute utilities) in which case trade offs become straightforward (although computationally difficult), or an implicit value structure which can still be used to find dominant solutions where all bottom line measures can benefit. Such a framework helps those in an enterprise, e.g. HFE professionals, to bring all aspects of an enterprise response into the open for debate and consideration. In terms of our overshoot model, it gives a much more realistic and sustainable model for decision makers to use, reducing misperceptions and allowing the forseeability of delays and interactions. We are already seeing some companies making conscious decisions about sustainability, e.g. becoming carbon-neutral, although whether they have incorporated these choices into a TBL model is uncertain. The TBL model allows companies to make decisions in a more rational way than simply treating non-economic criteria as constraints.

Also at the enterprise level, we need to apply concepts such as overshooting to the many aspects of work changes noted above. Here we just take one as an example: work intensity. Most of the changes in work intensity are involuntary as far as the worker is concerned (Watson et al. 2003), leading incidentally to a reduction in individual control, one of the causal factors in stress (Karasek and Theorell 1990). Those experiencing the negative consequences (negative externality in economic terms, see Stiglitz 2006) are different from those making the decisions and presumably experiencing positive consequences.

What may be an overshoot comes about through growth/acceleration of economic competitiveness in a global economy where enterprises are in direct competition with the rest of the world rather than only with those in the same region. This urge to competitiveness encourages decision makers to reduce costs, and the easiest way is to reduce direct labor costs, although these represent much less than half of total product costs in most industries. Although the workforce is reduced through cuts, the total work content may not change, meaning that those remaining must increase work intensity to meet enterprise objectives. The resource limit in this case is probably the workforce's ability to maintain performance (and well-being) despite increased work intensity. If this limit is exceeded in a resource-limited task (see Norman and Bobrow 1975) then errors will result from a speed-accuracy trade-off, SATO. Even at the enterprise level, the effects of lack of resources can be seen. Bearden (2003) evaluated NASA's

"faster/better/cheaper" missions by first developing a baseline relationship between development time and mission complexity from pre-existing data. He then plotted the "faster/better/cheaper" missions on the same graph (redrawn here as Fig. 6), showing that those missions that failed or were impaired had relatively insufficient development time. Cuts have consequences.

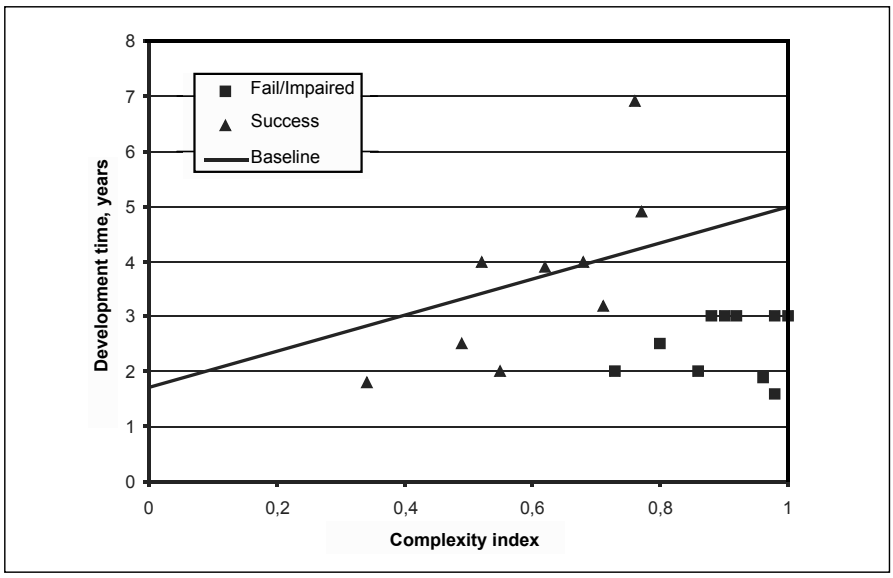

Fig. 6. Data from NASA on "faster/better/cheaper" missions showing baseline data compared with successful and failed/impaired missions (after Bearden 2003, p. 378)

The inadequate response condition leading to overshoot in the example of work intensity is either the misperception by decision makers of the consequences of their actions, or an inadequate model of the process. Here the inadequate model may well be the effects on remaining workers of planned cuts leading to increased work intensity which in turn can lead to performance errors or loss of long-term well-being. Both are highly relevant to HFE and its concerns with performance and well-being, according to the definition of the International Ergonomics Association (IEA).

At the level of use of consumer products, there is a long tradition in HFE of designing such products for ease of use during activities of daily living (ADLs). As Moray (1993) noted, issues such as population, water resources and energy/greenhouse gas use are all of our responsibility, and what HFE professionals do today "*appears startlingly trivial in light of the*

coming problems". For sustainability we need to go beyond usability to sustainable usability, i.e. a responsible use to ensure that each "*meets the needs of the present without compromising the ability of future generations to meet their own needs*". Again, overshoot is the state to be avoided. There is clearly growth, greater than linear, in the production of devices from automobiles through consumer electronics to the energy sources that sustain them. There are resource limits, well documented for fossil fuels and disposal systems, e.g. landfills. There are few ways that HFE professionals can affect these two factors, but we can certainly influence the models people use (or misuse) as a basis for purchase and use decisions. People, ourselves included, misperceive trends as noted earlier, so may not understand that growth by a constant percentage is unsustainable. If we know this we can help present data more effectively to help people understand. Again, we do not perceive well the effects of delays in a system growing exponentially. The story is told by Meadows et al. (2004, p. 21) of a pond with initially one lily pad but with double the number each day. If the pond is covered in N days, then only one day earlier it had been but half full. Delaying action can have profound consequences. Incidentally, this also illustrates the insensitivity of growth results to changes in resource limits. If the pond doubled in size, it would only buy one extra day until it was filled. Here again, HFE professionals who understand human perceptions can present data in such as way as to minimize misperception, even using folk tales where this is effective. HFE professionals can also use their knowledge to encourage choices that minimize the effects of overshoot, for example by encouraging recycling or resource substitution. The major international success stories of environmental action (ringing back many whale species from extinction, and reducing ozone depletion through banning CFC's) had no HFE input as far as we know, but it would be instructive to examine how our knowledge might have helped, or how we might learn lessons from their success.

Finally, there are the actions we can take as individuals and collectively to move towards sustainability. As individuals we need to make informed choices in our daily lives and in our professional work. We also need to lead by example in the projects we chose to undertake (even working for an enterprise gives us choices, see Drury 2006) and the manner in which we undertake them. HFE professionals are used to a "double bottom line" of performance and workforce well-being, so extending this to a triple bottom line should not be too difficult in the abstract. It will be difficult in practice, as many of the choices we need to advocate at work and home will not be popular in a society that values immediate gratification of evermore-exotic "needs" without heed for the consequences. Again, there are historical precedents that such advocacy may become easier. We hear very

few voices raised for expansion of tobacco smoking or gender inequality, both of which were majority views only a few decades ago.

One area where HFE advocacy is probably most effective is in international standards work. We are often involved at the national and ISO levels where there are HFE concerns, and have done valuable work, for example in helping enterprises harmonize standards across the world rather than take short-term advantage of lower standards to move work to other countries. If sustainability means equity throughout the world as well as between "now" and "the future", as some advocate (e.g. Dresner 2002), then we need to advocate and even take action at the local level to help. For example, towns such as Angelsey in Victoria, Australia have banned plastic packaging in their shops as one way to band together to reduce their own human footprint on the earth. As another example, many towns (Garstang in the UK is often quoted) have become Fairtrade towns helping to ensure equity for producers in places remote from them but still part of the one earth whose capacity we are in the process of overshooting.

In summary, there are multiple ways that HFE professionals can help avoid the overshooting of the earth's capacity for human habitation: personally, within our enterprise, at the international level and within our local society. To do this, according to Moray (1993): "*We will need far more interdisciplinary interaction, fieldwork, social action, and international cooperation*." That need still exists.

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Part 4

Sustainability as Challenge for Human Factors and Integrated Management Systems

Social Responsibility, Strategic Management and Comprehensive Corporate Development: Old Roots, New Issues?

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As socio-economic stakeholders, in most of the countries in the world, businesses, institutions, trade and public organizations and associations presently all heavily question the possibility of ensuring compatibility and a certain consistency among major societal issues with their own strategies and development.

The "managerial" terms for referring to such issues vary, but we note they are increasingly disseminated. Given the present preeminence of certain expressions such as "CSR" for "corporate social responsibility" in the dialogue of many managers and in researcher publications, we could be led to think such concepts and reasoning are new and linked to a contemporary context. This, however, is not the case, since we also find such concerns with theoreticians and corporate specialists as of the mid 20th century, and more broadly, as of a quarter of a century!

Hence, we may wonder if this is not a cyclical fad phenomenon, or if, on the contrary, in the present day we find ourselves in a much more critical situation than in the past, which would lead to highlighting old, underlying concerns from another angle.

1 Numerous and Varied Concepts, but a Basis of Common Concerns: What Are We Faced with?

1.1 Identifying a Few Key Concepts

For evoking the relationship between corporate objectives and the major challenges of society, several concepts have been employed, whose contours and meanings are not always very clear. We outline a few of the major concepts below.

Corporate Social Responsibility (CSR)

At the outset, we may note that the notion of CSR has two ways of being articulated, depending on the milieu and the country: some speak of "social" responsibility whereas others (as does France) prefer the neologism of "societal" responsibility for clearly highlighting the role of the issues of society as a whole.

There exist numerous meanings and connotations of this expression, as Votaw recalls as of 1973, "The term (CSR) is a brilliant one: it means something, but not always the same thing, to everybody".

Today, however, CSR often seems to be evoked in a triple dimension perspective ("triple bottom line") which leads to evaluating corporate performance from three different angles: environmental (compatibility between business activity and protecting ecosystems), social (social consequences of business activity) and economic (financial performance). In this perspective, most definitions offered insist on the time factor, with CSR going beyond short-term profit-seeking by endeavoring to prepare, or even preserve the long-term.

CSR is defined by the European Commission in its Green Paper (European Union 2005), as "corporations willfully integrating social and ecologic preoccupations into their commercial activity and relationships with their stakeholders". Such corporate responsibility is hence expressed both with respect to employees as well as all stakeholders with which it has ties, whether directly or indirectly, or which could be impacted by its business activity. The dimension of social responsibility is thus two-fold, internal and external to the company.

Sustainable Development

"Sustainable development" is, according to the definition proposed in 1987 by the International Commission on the Environment and Development in a report by Ms. Brundtland, Norwegian Environment Minister: "development which meets the needs of the present without jeopardizing the capacity of future generations of meeting their own needs". The expression is henceforth very broadly used throughout the world. It concerns mostly the "macro" scale of the countries of the world, but we do also find it in dialogue regarding "micro" aspects of companies or public organizations; in the latter case, it is hence employed with the CSR meaning mentioned above.

Entreprise Citoyenne (Citizen-oriented Firm)

In some countries such as France, the expression "*entreprise citoyenne*" was used to considerable extent some 20 years ago (in particular by a professional club of managers called the "*Centre des Jeunes Dirigeants*"[1]) for designating the role of corporations in taking into consideration the external aspects of their businesses induced on society. The concerns were essentially related to the topic of employment (during a period of heavy industrial restructuring and decreasing the payroll) and pollution. Alongside this movement and, during the same period, some public systems were at times defined as "administration-businesses" for inciting state organizations, institutions and public bodies to combine economic realities and the taking account of the client-user etc.

Societal Strategy

In the history of the thought process around corporate strategy, the enhancement of the very concept of "strategy" underwent several stages. One such reflection within the "strategic management" trend consisted of having the company face its "social-political" environment. In such a concept, the corporation cannot be seen uniquely as a technical-economic stakeholder, but is also considered as a social-political institution subjected to numerous influences and itself a producing factor with respect to its environment. Hence the apparition of the notion of "societal strategy".

[1] Center for Young Managers

Governance/Stakeholder Model

The United Nations Development Program (UNDP) uses the term "governance" for emphasizing that public decisions include a circle of stakeholders much broader than governments and administrations alone. Today, governance still remains poorly or diversely defined, but reflects the need to name the complex reality experienced by corporations and institutions. We could firstly mention the awareness of the growing number of "stakeholders" (in the sense of Freeman's term) concerned by a specific action. This situation hence indicates that a manager, in his/her business activity, is closely linked to other stakeholders, either public or private, collective or individual. In such a concept, the sets of networks and partnering operations are likely to increase. Furthermore, identifying a corporation's major stakeholders or even their meeting at certain critical periods, leads to forms of management known as "governance". The very nature of management variables to be taken into account consequently develops, since the stakeholders urge the putting forth of their own specific issues: it is hence that corporations integrate the overall challenges of society.

For purposes of temporarily ending here a non-comprehensive inventory, let us finally quote *business ethics* trends (Brenkert 2002) which are along the same lines and stress the responsibility of managers with respect to certain fundamental questions, especially those of human rights.

1.2 Major Societal Issues Likely to Concern Businesses

Depending on the approach, the definitions and perimeters of corporate responsibility with respect to the company are hence numerous.

If we endeavor to recapitulate the entire set of issues and challenges mentioned, we can identify the following categories (see Fig. 1).

Such a clearly non-comprehensive list, inevitably leads to questioning the capability of a firm and its managers to bear such responsibilities as well as the pertinence of such an approach with respect to their role within society. This type of questioning is undeniably quite touchy and does not lead to an easy solution. It is undoubtedly one of the reasons why its roots reach so far back in time.

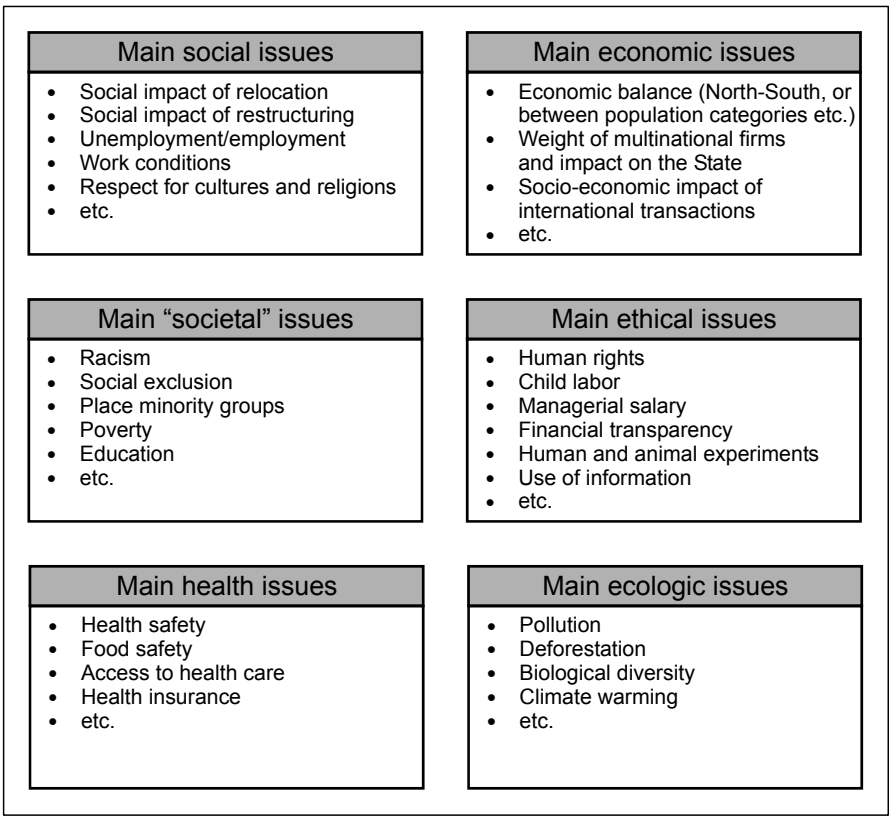

Fig. 1. Main issues of corporate responsibility regarding companies

2 Old Roots: A Useful Journey Back to a Quarter of a Century Ago

2.1 A Few Founding Works

Social science has been interested for several decades in the issue of corporate social responsibility.

For management science, the sources of CSR seem to reach back to the mid 20th century, more precisely to 1953 if we refer to the book by Howard Bowen "Social Responsibilities of the Businessman" which some consider as being the foundation stone of this trend (Carroll 1999). Bowen in-

deed develops the idea of an "obligation for businessmen to conduct policies, make decisions and follow a line of conduct which meets objectives and values considered as being desirable in our societies". Bowen was an economist, a Keynes follower at the University of Illinois. The study published in this book was the result of a commission initiated by the "Department of the Church and Economic Life", one of the study committees of the Federal Council of the Churches of Christ in America. We hence comprehend that the religious ethics (in particular, Protestant) serve as the backdrop for this book.

A few years later, in 1963, McGuire revisits these notions; the idea of social responsibility assumes the corporation does not only have legal and economic obligations, but that it also has responsibilities toward society which go beyond these minimal obligations. In the case of Carroll, in 1979 he states "CSR combines all the economic, legal, ethical and philanthropic expectations society may have with respect to a firm at a given time". Economic responsibility concerns the need for businesses to be productive and profitable. Legal responsibility implies that the firm fulfills its economic duties in compliance with prevailing laws. Ethical responsibility requires firms to comply with an established code of ethics, while philanthropic responsibility reflects the wish of seeing firms actively involved in improving the well-being of society.

2.2 Strategic Management: Birth, Basis and Breakdown

The advent of the strategic management school of thought immensely strengthens such perspectives. Hence, moving from strategic planning to strategic management as marked by Ansoff at the end of the 1970s, is accompanied by the development of societal strategy emphasizing corporate societal issues (Ansoff 1980, 1983). It is within this framework that Freeman in 1984 defines the well-known notion of "stakeholder", which strives to take account of all of the social-political actors of the corporate environment. Developed through reference to the notion of "stockholder", the premise of stakeholders broadens the corporate environment beyond economic and financial factors by adding to it social, political and societal factors. Such factors are assumed to contribute to corporate economic and social performance. Taking such factors into account must be combined into the firm's strategic management approach, from the analysis stage through to implementation and evaluation, within the framework of the firm's action plans vis-à-vis each of its stakeholders. In this perspective, the firm is viewed as a social-political organization (Martinet 1984) engaged in a con-

stant conflict-cooperation relationship with its internal and external stockholders.

Within such a framework, we, 20 years ago, developed the concept of corporate "comprehensive development" (Bartoli and Hermel 1987, 1989) based on researching 82 firms. This, indeed, did highlight the approach of certain firms which aimed at taking into consideration the complexity of their operations and their environment in view of global and sustainable performance. The firm's comprehensive development within this concept is characterized by the following dimensions:

- Interaction of the different variables reflecting the major "functions" of the firm, with, in particular, a strong emergence of the social variable as a strategic factor.
- Taking into consideration the complexity of phenomena and situations, both inside and outside the firm.
- Associating development with a certain momentum, with the dynamics of change and improvement which we may call aspiring to excellence.
- Enriching the concept of corporate performance, especially with a view to the time factor (taking account of short, mid and long term performance) and with respect to the systems of the various stakeholders.

Corporate comprehensive development is broken down into the two poles of internal and external strategy analysis and action. Among the *Domaines d'Analyse et d'Action de Stratégie Externe,* "*DASEX*" (External Strategy Poles of Analysis and Action), taking corporate social responsibility into account is apparent and highlights the social, economic, ethical, ecological issues appearing in above chart: the policy regarding relations in the workplace, sponsoring actions, treating ecological problems, dealing with the effects of internal restructuring on employment etc. Internally, the importance of taking into consideration the various categories of stakeholders in the approaches to management is underlined.

Work in the 1980s in strategic management had already strongly mobilized the notions of corporate social responsibility and comprehensive, global and sustainable development. Are we today at exactly the same phase?

3 What Differs 25 Years Later?

Would there hence be nothing new in present research on CSR? Although the roots are quite old, we are doubtless, at the outset of this 21st century, facing a partially different situation.

International Dissemination of Concepts and Models

Research in the 1980s on such topics at times induced limited repercussions. This is no longer the case today, where the speed of dissemination of the issues of sustainable development and corporate social responsibility is quite impressive. Such dissemination is in part increased by two combined phenomena:

- The development of "information technologies" bringing each and every one of us to very quickly becoming informed of any corporate or state innovations, initiatives and approaches on this subject.
- The role of international institutions which incite promoting more and more homogenous CSR models through their surveys, methodological counseling or guidance; here, we may, in particular, quote the case of the OECD, the World Bank, ISO, EFQM, etc.

Much More Critical Situation

Due to the movement of combined businesses and increased weight carried by multinational corporations in the economy over the course of recent decades, the impact of "business" on society has incessantly risen. It is the firm's "societal powers" in particular that are at stake, as Mintzberg had already stressed in the 1980s. Hence, the economic powers of large corporations bear increasingly greater social and environmental consequences, very strongly developing its external aspects throughout civil society. Such phenomena are magnified through globalization and provoke a situation which is becoming more and more critical on a daily basis etc.

A Well-honed, Enriched Approach

Research in the 1980s on social responsibility was in the building stages. Little by little, through a phenomenon of accumulation and gradual enrichment of presentation through former research, the approaches became more complete, more global. Today, we note that the presentation of CSR, better and more clearly spells out the various groups of social-political and societal issues. Furthermore, the "time" factor seems to be better marked than in the past, and most of the theoreticians or corporate experts aware of these topics demonstrate the importance of taking into consideration the long-term, the perpetual, sustainable aspects, even concerning mid-term strategies.

Businesses Pressed to Consider the Taking Account Factor

Businesses are increasingly urged, or even pressured, to integrate the issues of social responsibility.

Such insistence is particularly due to:

- Internal and external stakeholders, having gained in legitimacy, can now express their expectations more easily.
- The issue of image brought to a head by excess media coverage and the "showcase" effect of certain corporate practices displayed as examples, or, on the contrary, as being scandalous; we refer, of course, to negative examples such as Nike and child labor or, at the other end, Johnson and Johnson, seen as a "responsible corporation" (especially since its good ranking on the Dow Jones Sustainability World Index in 2006).
- Regulations which at times push businesses to produce public "reports" on their efforts in terms of social responsibility (as we will see with the French example below).
- The training of managers, who combine more and more of such topics into their strategic management schemes.

French Examples

In France, the insistence is also legislative and state-oriented. The French Ministry of Ecology and Sustainable Development defines corporate social responsibility (CSR) in the following manner: CSR is the application of the premise of sustainable development on a corporate scale. One of the important levers impacting a firm's socially responsible conduct is that of financing. "Socially Responsible Investment" (SRI) concerns management of funds which combine criteria of a social and environmental nature with classical financial criteria.

Article 116 of the law governing New Economic Regulations (*Nouvelles régulations économiques – NRE*) demands that French firms on the stock market formalize the social and environmental impact of their business activity in their annual reports. The report "also includes information, a list of which is set by Council of State Decree, on the manner in which the firm takes the social and environmental consequences of its business activity into consideration". The said legislation concerns approximately 700 corporations ranking on the stock exchange, all falling under French law. An initial assessment, upon request by the government, was conducted in June of 2004 by the *Observatoire de la Responsabilité Sociétale des Entreprises – ORSE* (Corporate Social Responsibility Observatory), in compliance with Article 116 of the NRE (New Economic Regulations) and the

associated decree. It demonstrates that the NRE legislation played a catalyzing role on such social and environmental issues for corporations. Hence, the legislative article appears to be accepted and integrated by most of the firms concerned and their stakeholders, even if such firms do not yet apply it, and even if some stakeholders, such as investors, declare being unsatisfied with the first generation of reports; indeed, they would not necessarily treat the most significant issues; we also regret that certain topics are not dealt with (particularly those related to work ethics such as human rights or corruption). The assessment also mentions that businesses should include their practices as a part of a continuous approach for progress and improvement, based on establishing dialogue with the stakeholders.

In France, many businesses call themselves "*entreprises citoyennes*" (citizen-oriented firms). It is hence that the hypermarket food retailing firm, Carrefour, defines itself under such terms. Danone, known as of the 1970s[2] for its innovative "double economic and social project" henceforth talks of the "Danone way" for describing its global approach to development, based on taking into account its various stakeholders. French businesses are also quite numerous in referring to "GRI" (Global Reporting Initiative) in their reports combining the NRE law (for example Carrefour, Danone, France Telecom, Renault, Saint-Gobain, Total, Véolia, EDF etc.). They are evidently not the only ones, and many firms from different countries also use this type of reference.

International References

"GRI" is indeed an approach for developing international standard reporting procedures in terms of sustainable development and social responsibility. There does exist, however, a cultural difficulty in using international standards in this field. It is thus, that GRI, for example (which is an Anglo-Saxon notion) includes indicators related to discrimination that French firms have a problem with. In the opposite sense, GRI social indicators are lagging behind with respect to the already well-anchored French experience in the area of social assessment. Other international references exist in the area of CSR and also contribute to disseminating "good practice" models. This is the case of the OECD with its various instruments, such as: "the principles of corporate governance", "guidelines for multinational enterprises", "anti-corruption guidelines", etc.[3]; it is also the case of the ISO which set up "a guidance on corporate social responsibility". According to the various references, some countries are considered as ranking very well.

[2] At the time, Danone was still called "BSN"

[3] www.oecd.org/sustainabledevelopment

Thus, the 2006 Sustainability Index reveals that Finland and Norway are in the top two positions, followed by Uruguay and Sweden. We hence note the strong awareness of Scandinavian and Northern European countries.

The Role of Regulations

The example of France demonstrates the possible stimulation of the legal factor. How do other countries fare? In Europe, Norway is also obliged to do reporting on social and environmental aspects for businesses. Other countries have national regulations demanding "environment" reports to be produced: this is the case of Denmark, the Netherlands and Sweden. Concerning social reports, other than France and its social assessment (*bilan social*), we find Belgium and Portugal.

Open Questions Regarding Power

Taking account of the stakeholders within the framework of a combined total quality and CSR approach, raises new questions. Indeed, traditional „customer-supplier" relations, internal or external, henceforth transformed into „stakeholder-company" relations, are always specific in range and nature. They are particularly different in terms of power and leeway depending on the stakeholder involved. For example, the degree of freedom and the capacity of influence of the personnel with respect to the employer is far from being identical with that of the customer with regard to the supplier, the banker with regard to the financial director or the public control body with regard to the company legal advisor etc. The quest for "business excellence" is reflected, therefore, by an enriched model of comprehensive development which raises new (and as yet, unresolved) questions in terms of power games among the actors.

4 Conclusion

There presently exists a growing comprehension of the advantages of a proactive approach to management and corporate social responsibility (CSR). Indeed, with the advent of ecological and social preoccupations linked to sustainable development, the apparition of environmental regulations, increasing stakeholder pressure and a more global sense of performance, businesses felt the need to preserve their hard-earned reputation and work on their image, taking account of rising values (respecting the environment and human rights, the responsibility of their entities in the community in which they are installed etc.).

Research on strategic management over the last quarter century thus confirms the need for a global approach to corporate development and performance. We can, however, still be astonished at the enormous gap existing between the henceforth quasi-permanent discourse and effective corporate practices. Our own research in the 1980s had already highlighted and analyzed this phenomenon, revealing the abyss which often existed between the intention and the implementation of a system of comprehensive development for the firm. We had then highlighted the four categories halting effective implementation: strategic, structural, cultural and behavioral. Although businesses have clearly advanced in the perception of issues fostering social responsibility, it seems that less progress has been made for effectively turning their efforts into a reality!

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Human Factors and Comprehensive Management Concepts: A Need for Integration Based on Corporate Sustainability

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Many of the papers in this book have dealt with sustainability in relationship to either total quality management respectively organizational excellence concepts or human factors approaches especially understood as human factors in organizational design and management. This paper discusses the development of human factors and TQM and shows their relationship. In a next step a possible integration for both TQM and human factors into the context of sustainability is shown. Finally it will be argued that sustainability can provide a basis for the integration of both concepts. Such an approach could promote both disciplines, but also improve the implementation of corporate sustainability.

1 Some History

A growing market complexity connected in part with globalization but also misuse of economic power and ecological development shows that old and sometimes "easy recipes" do not work any longer. There is also more and more criticism regarding consultants offering "new programs" every year to solve all problems of a company within a short time. Looking at the field of business administration there seems to be a development (taking the balanced scorecard as one example), that shows that simple finance based controlling and accounting methods are not longer adequate. Therefore older stakeholder based approaches, as described in the paper of Philippe Hermel in this book, like (corporate) social responsibility or sustainable development gain a new importance. Regarding business accounting

in Germany there have been e.g. some approaches to renew reporting systems like introducing human resource accounting, corporate social accounting or corporate social audits even in the 1970s (see e.g. Dierkes et al. 2002).

At that time negative effects of a growing economy and a critical discussion of Tayloristic production concepts led to these new approaches of reporting including social effects of corporate activities. At the end of the 1970s these alternative procedures of reporting disappeared again because the approaches had been too theoretical, not target group oriented or more or less an instrument of public relations (Herzig and Schaltegger 2005, p. 13).

In some European countries the reporting was prescribed by law: In France e.g. in 1977 a law was referring to social balance sheets including employees' concerns and in 2001 an additional law called "Nouvelle Régulation Economique" (NRE) has been introduced. According to the law of 2001 all companies being active at the Paris stock exchange have to report their social and ecological activities to their shareholders based on a comprehensive list of indicators. But there are two problems: this report has only to be given for the holding company (and not the subsidiaries) and there are no sanctions if the report is not given (Antal and Sobczak 2005, p. 80). In the meantime the Global Compact and especially the Global Reporting Initiative proposed reporting systems creating transparency regarding social and ecological activities of companies world wide (Antal and Sobczak 2005, pp. 83 f.). But there is still the question of verification discussed intensively in the papers of the European Commission e.g. within the discussion about corporate social responsibility (European Commission 2001, 2002, 2004).

In the area of quality management the history of broader approaches is even older: The first ideas of total quality management appeared soon after the Second World War, when – especially in Japan – quality was understood in a "companywide" sense or as the quality of the whole corporation instead of the quality of a product (Ishikawa 1985). In Europe first books including the title total quality management had been published by Oakland (1989) and Zink (1989). In the same year the introduction of the journal "Total Quality Management" edited by Gopal K. Kanji had been realized.

In 1992 an ISO definition of total quality management was published. ISO 8402 defined total quality management as a "management approach of an organization, centred on quality, based on the participation of all its members and aiming at long-term success through customer satisfaction, as well as benefits for all members of the organization and for society"

(DIN EN ISO 8402). This definition – though dismissed by ISO in the meantime – will be relevant for the further discussion.
Seeing the success of companywide approaches in Japan many Western companies tried to imitate the "Japanese way", but failed in most cases because they were only using some instruments and not understanding the necessity of a fundamental change of culture. In the United States (Melan 1998, p. 127) first reports of failures in the implementation of TQM appeared in the early 1990s – and surveys by US consultancy firms showed that two thirds of the implementation processes had been given up (Brown et al. 1994). Similar reports came from the UK (Smith et al. 1994). The primary reasons offered for failures (or success) are leadership, management commitment and involvement, established need and (long-term) strategic view (Brown et al. 1994; Smith et al. 1994). Similar experiences were made in other parts of Europe (see e.g. Dahlgaard et al. 1997; Zink 1998). This situation has been partly different in companies taking a more "structured way" in introducing TQM using the models of the international quality awards based on self assessment approaches like the US-American Malcolm Baldrige National Quality Award (MBNQA) (NIST 1988) or the European Quality Award (EFQM 1992). Some ex-post-studies could show, that especially the award-winning companies had improvements in their financial performance (Centre of Quality Excellence 2005). But the success of the other companies can be considered the same as in any company trying to realize a major change project: no more than a third of these companies achieve the success they have intended (see e.g. Zink 1998).

As mentioned before, the failures have been caused – among others – by a missing leadership approach or the will and ability to change the culture.

This might also be connected to the fact that these concepts and even the National Quality Awards included the term "quality". Although many of the "gurus" tried to implement a new understanding of quality in many companies TQM has been understood as a quality management concept as described in the ISO 9000 standards. Therefore top management did not see the necessity to be involved by itself but delegated the tasks to a TQM manager. In Western countries quality has been related to product quality for many years with impressive efforts in quality assurance based on inspection. Globalization and international competition showed the limits of such approaches and the introduction of national or regional quality awards then presented a broader picture, which has been used by a growing number of companies. But here as well the term of quality was not promoting these concepts, therefore today all international award models do not use the term quality any longer. The European Quality Award is now the EFQM Excellence Award based on a model for excellence (in for-

mer times: business excellence). The MBNQA is based on a model of performance excellence.

Another point is that total quality management has also been driven by consultants, and consultants need new topics to survive. Therefore many companies gave up TQM and replaced it e.g. with the balanced scorecard (Kaplan and Norton 1996) or six sigma (Harry and Schroeder 1999). Based on this development some authors suggest that TQM could have a revival under a new name: six sigma (Green 2006). But as six sigma has the same "quality image" as TQM, in many companies a "real" revival will not be possible. Therefore other concepts have to be discussed.

Since the early days of Jastrzebowski (1857) ergonomics dealt with more or less fragmented approaches analyzing e.g. the interdependencies between nutrition and performance, working time or rest pause schedules and performance, the one best way of performing, selection of personnel and performance, etc. Consistently performance and economic results have been the determining forces.

After the Second World War there was a growing interest in approaches to promote ergonomics or human factors. Although psychological and sociological topics have been dealt with, the concept of stress and strain and more physiological aspects (e.g. in heavy industry) have dominated. Ergonomics in industrial practice has been mostly corrective and additive (as in the field of quality in those days).

During the 1970s work redesign under psychological aspects, including the implementation of semi-autonomous working groups, became a relevant issue in Europe. This was also the time to talk about preventive and prospective work design (including personal growth) and to try to have ergonomics as an integrative aspect of design instead of an additive approach. During these years the topic of employee participation arose through the introduction of quality circles – as part of the above described TQM-approaches. And a "broader" approach within ergonomics was born: the field of "human factors in organizational design and management" (ODAM). Another field of action has been the growing number of workplaces including human-computer-interaction and the necessity for respective ergonomic solutions.

In the 1980s international competition and the emergence of "lean production and lean management" were not very helpful for ergonomics: Many large companies gave up their ergonomics department and weakened the field by decentralization.

In the 1990s new technologies expanded and new forms of work and collaboration (like virtual networks) appeared, but also new concepts of design (like virtual reality) provided new chances. The above mentioned concepts of assessing companies (based on excellence models) and activi-

ties within ODAM, now redefined as macroergonomics, included some new chances for human factors or ergonomics. The field of TQM became part of ODAM or macroergonomics sessions as in the IEA 2000 conference at San Diego (Human Factors and Ergonomics Society 2000) and there was also an international conference in Linköping in 1999 entitled "TQM and Human Factors" (Axelsson et al. 1999). Nevertheless, looking at history, most of the ergonomics approaches have focused on specific topics – and in this sense have been fragmented. The solutions often have been expert driven and "applied ergonomics" was not always "holistic", "integrative" and "preventive" as described in "academic ergonomics".

Therefore ergonomics or human factors has not increased in all countries in the way it should have. On the other hand there are a lot of chances for human factors in the context of the above described developments which should be used (see e.g. Zink 2000a).

Summing up especially the discussion of the historical development of ergonomics/human factors and total quality management, but also the actual state of the art, one can conclude that both disciplines have not developed as they should have, and that there is a need for integration in a broader context.

2 Stakeholder-Orientation as a Common Frame?

When going back to the roots of quality management as a basis for more holistic and comprehensive management concepts and ergonomics as basis for human factors in organizational design and management, there are some common fields of interest. The first one – which is obvious – is the interest in prevention: Being active before problems appear! But there are other similarities: In describing the quality of a product ergonomics issues like usability are as important as describing the quality of a work place or the quality of working life – and even the quality of life!

Both disciplines also have the problem of being used in a more corrective instead of preventive manner and not being included in a life-cycle approach. This perspective is slowly changing e.g. in Germany, because of the introduction of a law concerning closed substance cycles and waste management in 1996 (Waste Avoidance, Recovery and Disposal Act). Quality management systems – but also human factors design concepts – have to take this development into account.

There is also another issue of common interest: to focus not only on one target group but a broader range of "stakeholders". This leads to the necessity to discuss this point in more detail. The term "stakeholder" first ap-

peared in management literature in an internal memorandum of the Stanford Research Institute in 1963 (cited in Freeman and Reed 1983). A broader discussion was initiated by Freeman (1984) in his book "Strategic Management – A Stakeholder Approach". He defined stakeholders as "individuals or groups which depend on the company for the realisation of their personal goals and on whom the company is dependent" (Freeman 1984, p. 13). In this sense employees, owners, customers, suppliers, creditors as well as other groups are stakeholders. Later in his book he specified them as "those groups without whose support the organisation would cease to exist" (Freeman 1984, p. 31).

Coming back to TQM and excellence models first of all one can see that they all include the relevant stakeholders: customers, owners or shareholders, people and society, but also suppliers. But even the above mentioned ISO 8402 definition concerning TQM included these target groups.

They have an influence on the decisions of an enterprise and they are necessary to survive: Without capital a company cannot be founded, without customers but also without employees a company cannot survive – and even society has a strong influence by defining the frame for corporate activities like laws, taxes, and by financing the infrastructure including schools and universities.

Looking at ergonomics the same is true: First of all human beings are in the focus of ergonomic concepts as employees but also as customers.

Workplace and environment design is one example regarding occupational health and safety of employees. Usability of products is another one concerning customers, but also capital goods should fulfill ergonomic demands. There are also many fields of ergonomics relevant for society: Again occupational health and safety with its objectives to prevent health problems and costs for illness – or preventing early retirements. But also the security of complex systems (like traffic or power plants) depends on respective ergonomic interventions. Complex societal problems may be reduced by community ergonomics approaches, workability and employability are the results of other society relevant ergonomics interventions.

As in the case of society, ergonomics can also pay off at the company level in the sense of reduced costs for illness or fees for insurance companies but also as a result of a better turnover caused by ergonomically designed products. Customer oriented products may also increase market shares.

For a first summary one can state that there are several similarities between ergonomics and quality in a broader understanding. One of these similarities is a stakeholder-orientation which will be relevant for the further discussion.

3 Relationship between Total Quality Management and Human Factors in the Past

As mentioned above there have been relations, also in the past, referring to the international conference in Linköping in 1999 on "TQM and Human Factors", but also many presentations on TQM within IEA or ODAM conferences during the last years (Axelsson et al. 1999). One of the "connecting points" has been the topic of employee participation: Taking quality circles e.g. as a core element of TQM but also of ODAM in its early stages (see e.g. Brown Jr. 2002; Zink 1996).

Including international excellence models one can describe the relationship in more detail.

3.1 Human Factors as a Part of Excellence Models

In all international excellence models "people" or "human resources" are a part of the preconditions for success but also of the results criteria.

Furthermore they are – based on the stakeholder-orientation – also part of the evaluation method. Taking the Malcolm Baldrige National Quality Award and the European Excellence Model as examples one can find the following fundamental concepts or core values:

a) Malcolm Baldrige Performance Excellence Framework:
Because "employees success depends increasingly on having opportunities for personal learning and on practicing new skills", the criteria for performance excellence include "personal learning" and "valuing employees" among others. Opportunities for continuing growth and development may include "job rotation and increased pay for demonstrated knowledge and skills" (NIST 2007, p. 2). Personal learning leads to results for the company, but also to satisfaction and motivation and especially employability. Valuing people means "committing to their satisfaction, development, and well-being". Major challenges in the area of valuing people include (1) demonstrating commitment to employees' success, (2) providing recognition that goes beyond the regular compensation system, (3) development progression and development, (4) sharing the organization's knowledge so the workforce can better serve customers and contribute to achieving strategic objectives, (5) creating an environment that encourages risk taking and innovation, and (6) creating a supportive environment for a diverse work force (NIST 2007, p. 2). Among others the criteria include questions like: "How do you prepare your workforce for changing capability and capacity needs?", "How do you manage your workforce to prevent

workforce reductions?" or "How do you ensure and improve workplace health safety, and security?", "What are your improvement goals for each of these workplace factors?", "How do you support your workforce via policies, services, and benefits?" (NIST 2007, p. 28).

b) EFQM Excellence Model:
People development and involvement as a fundamental concept comprises identifying and understanding the competencies needed now and in the future. How are these competencies matched with policy and strategies, objectives and plans and actively and positively supported? What has been done to prepare people to meet and adapt changes required of them? How is the increasing importance of intellectual capital met? How are people cared for, rewarded and recognized? Is the potential and active involvement of people maximized through shared values and a culture of trust, openness, and empowerment? Are ideas for improvement generated and implemented? There is also the idea of continuous learning referring to people, but people oriented aspects are also included in leadership, policy and strategy, resources and process criteria. As the Baldrige Model the European Model also has a result criterion for employee satisfaction and well-being (EFQM 2003, pp. 9 f. and p. 13).

As a summary one can state that human factors aspects are a relevant part of all international excellence models – or that human factors are a relevant precondition for business excellence (see e.g. Pfeffer 1998, but also Zink 1999a). In addition the people criterion has e.g. the second highest rating in the European Excellence Model (with 18 % of all criteria) (EFQM 2003, p. 28).

3.2 TQM as a Part of Macroergonomics (Human Factors in Organizational Design and Management)

As mentioned above quality circles as a means of participatory ergonomics have been one of the early methods used in ODAM (Brown Jr. 2002; Noro and Imada 1991). Participation or participatory practices can be understood as a principal methodology in the analysis and design of work systems – and they are also (as in the context of TQM) an important instrument of continuous improvement. But this approach of involving people in the activities related to their workplace has also been used for concepts like job enrichment, semi-autonomous working groups or high involvement working teams. Recent studies by O'Tool and Lawler III (2006) but also Cascio (2006) show the economic impact of employee behavior on organizational performance. The results of this research show that "high-involvement-companies", which are giving their employees the organiza-

tional structures, resources, and discretion they need for realizing their ideas and potentials, can even compete with companies in countries with a low remuneration level (O'Tool 2007, p. 57).

Going back to the definition of macroergonomics one can show further similarities with TQM approaches because of macroergonomics' "fundamental research roots in the sociotechnical systems tradition" (Hendrick 2002, p. 3). In this sense "macroergonomics is concerned with the human-organization-interface (HOI) technology" (ibid.) and its goal "is to optimize the work system's design in terms of its sociotechnical system characteristics". It has thus the same basis like comprehensive management systems which differentiate between "behavior" and "structures" (see e.g. Bleicher 2004; see also Zink 1998).

TQM is strongly connected with continuous improvement but also with the necessity of organizational breakthroughs including comprehensive change approaches. Here again macroergonomics in using a socio-technical systems approach shows a strong relationship to TQM. As Kleiner pointed out a socio-technical systems understanding is a precondition for a successful large-scale change. As a consequence macroergonomics can be used to perform an important role in society by helping to retain and create jobs, and can thereby impact industrial expansion which, in turn, positively influences regional economic development (Kleiner 2002, p. 281). The relationship between ODAM or macroergonomics and managerial change concepts or management systems has also been shown by Zink (2000a, pp. 924 f.) when he argued, that it would be better to use a socio-technological approach instead of a socio-technical to include economic and ecological aspects too (ibid.).

Beyond the limits of single enterprises total quality management has also been part of so called excellence centers or excellence councils in the United States (see e.g. Zink et al. 1998), but also in macroergonomics there has been a development called "community ergonomics", which used socio-technical concepts for "a design approach to the interface between people and system design in societal contexts" (Smith et al. 2002, p. 289).

As mentioned earlier many of the three-annual congresses of the International Ergonomics Association (like Tampere 1997, San Diego 2000, Seoul 2003, Maastricht 2006) had tracks concerning TQM (as one example see Zink 2000b).

4 Integration in Concepts of Sustainability as a Common Challenge

As mentioned at the very beginning human factors (or ergonomics) and TQM have not developed the way they could have. Therefore the discussion about their future is ongoing since years. One has to discuss whether there are broader concepts helping both disciplines to secure their future in an integrated way.

In a first approach the usefulness of the sustainability concept shall be shown separately for TQM and human factors.

4.1 TQM and Sustainability (Zink 2007)

Without any doubt the contents of TQM are still a necessity for any organization; but why then replace them? One of the reasons could be that TQM was never understood correctly by most companies. "Redefining" an already used term will not bring the momentum needed for a turnaround.

If it has been a consultancy product or a management fad too, it does not make any sense to continue with this "headline", but what else can be done?

Coming back to the earlier used ISO definition of TQM one can see that sustainable success is related to a stakeholder approach. But this stakeholder approach can also be found in the EFQM Model for excellence (see Fig. 1).

During the last years not the stakeholder concept of Freeman but Rappaport's book on "shareholder value" gained an increasing interest in the United States at first, but in the meantime also in other Western countries (Rappaport 1998). As the title describes Rappaport developed a new way of evaluating a company's success in placing a long-term success for shareholders in the first place. In practice especially analysts misused Rappaport's concept in applying it for short-term evaluation. The consequences of a short-term orientation combined with stock options for the top management can be shown by US but also European finance scandals of the last years (see Kennedy 2000).

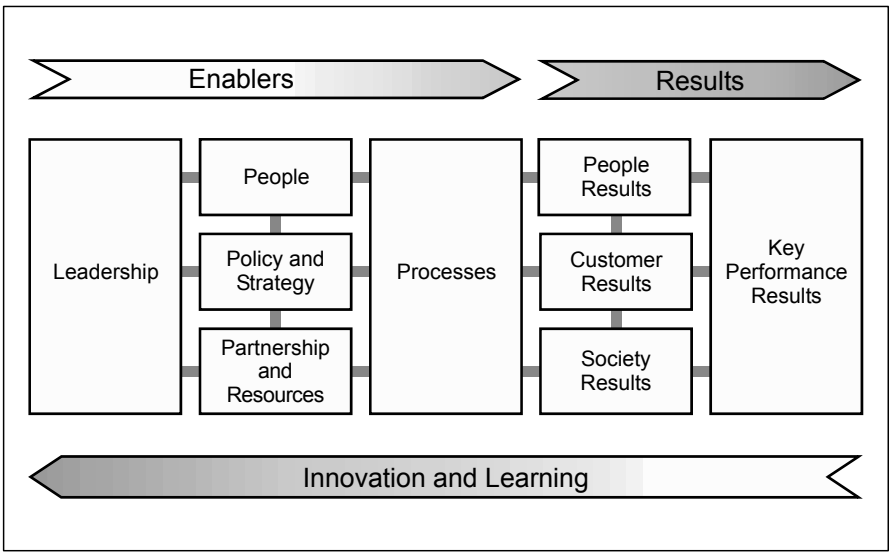

Fig. 1. EFQM Model for Excellence (EFQM 2003)

This misunderstanding and misuse of the shareholder value concept started a worldwide discussion about corporate governance, but also about corporate social responsibility. Especially in Europe the concept of corporate social responsibility (CSR) as part of sustainability is of growing interest. The European Commission launched a green paper to promote a series of activities in this field (see European Commission 2001 and 2002).
In the United Nations the former Secretary General, Kofi Anan, started the UN Global Compact Initiative in 1999, seeking to advance responsible corporate citizenship in a time of globalization (United Nations Global Compact Office 2007). The topic of CSR has also been included in the "portfolio" of the European Foundation for Quality Management (see EFQM 2004). All these concepts are based on a stakeholder approach.

Among others the European Union has initiated a European multistakeholder forum on CSR (see European Commission 2004). Besides these more political activities there is also a growing discussion on the role of business in society respectively in tomorrows society by academics (e.g. the John F. Kennedy School of Government at Harvard University), but also by business itself (e.g. the World Business Council for Sustainable Development). There has also been an international research project supported by the A. P. Sloan Foundation asking the question whether there is a need for redefining the corporation. The redefinition of the corporation – as result of this research project – reads as follows: "The corporation is an organization engaged in mobilizing resources for productive uses in order

to create wealth and other benefits (and not intentionally destroy wealth, increase risk, or cause harm) for its multiple constituents, or stakeholders" (Post et al. 2002, p. 17). In this context organizational wealth is understood as "the summary measure of the capacity of an organization to create benefits for any and all of its stakeholders over the long-term" (Post et al. 2002, p. 45).

This definition is strongly connected with the idea of corporate sustainability: The concept of sustainability has been discussed for years in the international community. The Rio de Janeiro Conference on Environment and Development in 1992 has been an important step to promote these ideas. There sustainability has been understood as resting on three pillars: economic growth, ecological balance and social responsibility (DESA 1992).

In the last few years many corporations committed themselves to the vision of sustainable development. The results of a study conducted by the Global Environmental Management Initiative (GEMI) and Business for Social Responsibility (BSR) show a growing engagement in sustainability and 94 % of the managers state that this topic will have more important impacts on the business strategy over the next five years (GEMI-BSR Survey 2006). These results are coincidental with a growing tendency to link sustainability (including CSR) with business strategy. This can e.g. be found in the (further) development of reporting initiatives which intend to create more transparency to overcome the crisis of trust. AccountAbility is here one of the bigger "players". One of their last publications ("The Materiality Report") aims at the alignment of strategy, performance and reporting (AccountAbility 2006). Similar developments can be seen in theory, e.g. looking at the new management model of the University of St. Gallen, Switzerland (Fig. 2), demonstrating the necessity of a stakeholder approach (Rüegg-Stürm 2005).

Coming back to total quality management now with its stakeholder definition based on ISO 8402 from 1992 (see above) and a result oriented European Excellence Model for measurement and documentation of stakeholder results, understood as "cornerstone of any improvement strategy" (Conti 2007), it is becoming obvious that these (old) approaches could play an important role on the changed agenda of business.

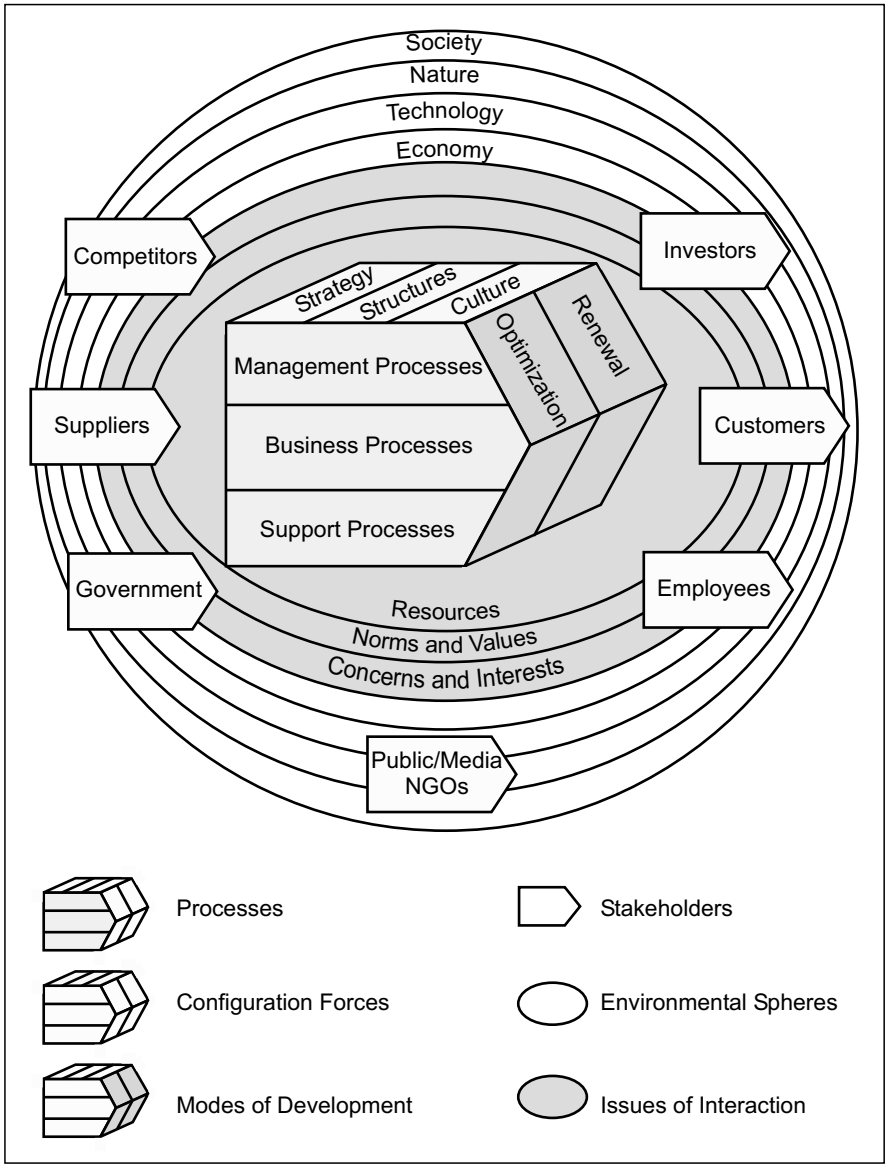

Fig. 2. The New St. Gallen Management Model (Rüegg-Stürm 2005, p. 12)

Based on the three pillar model of sustainability the results criteria could be "regrouped" in seeing the key results as precondition for economic sustainability, the society and people results as representatives of social sustainability and the society results enlarged by CSR results as the third ecological pillar. Taking the time dimension but also the resources view the

idea of continuous measurement and improvement combines change with sustainability on a meta level. To reach even better results the assessment models could be customized (Conti 2007, p. 126). The value or ethics dimension is a part of the leadership criteria – and could be included in the people dimension. The enabler criteria are based on a resource based approach (Ignacio et al. 2005).

Therefore corporate sustainability based on a stakeholder approach would be a future oriented concept to include the contents of TQM.

4.2 Human Factors and Sustainability (Steimle and Zink 2006)

In Western countries the discussion about sustainability first had a strong emphasis on the natural environment and did not consider human factors issues for a long time. In almost the same manner the growing societal and political importance of sustainability was recognized relatively late in ergonomics and human factors literature. Only recently sustainability of "human resources" has become an explicit topic of significant research (see e.g. Docherty et al. 2002).

In principle the ecological idea of saving resources and maintaining or increasing natural capital can be transferred into the social context. According to this work is sustainable if taking physiological and psychological limits into account and considering the need for sufficient recreation i.e. the "human resources" ability to regenerate, but also to keep and enlarge the personal competencies. Sustainable work design makes a contribution to preservation (or even increase) of human and social capital instead of consuming it. It is obvious that in most of the less developed countries this is not yet realized.

But even in the industrialized countries human resources are not always used in a sustainable way (see e.g. Lawler III and O'Tool 2006). In these countries the relevance of sustainability for ergonomics especially arises from a changing business environment. To accomplish the challenges of a turbulent environment most business strategies currently result in an increase of work intensity. New forms of work, new coordination mechanisms and a long extension of working hours often lead to an increase of mental and social stress (see e.g. Price 2006). In these cases work will get more consumptive instead of sustainable.

The explicit reference to the concept of sustainability is relatively new to human factors but not the approaches behind it. The sustainability of human resources is based on enduring workability and employability which have been dominant elements in human factors ever since. Social sustainability is realized in concepts such as preventive occupational health

and safety, human-centered design of work, empowerment, individual and collective learning, employee participation, or work-life-balance. All these concepts aim to preserve or build up human capital and they represent a conscious way to deal with human resources.

In addition they are conducive to a trustful corporate culture and so are an investment into the corporation's social capital. In this sense human factors contributes towards a social sustainable development and accommodates business goals.

Regarding its history, human factors is mostly focused on workplace level and on the individual worker, considering social and economic issues but less environmental questions. Since several years macroergonomic approaches are expanding the perspective (see e.g. Hendrick and Kleiner 2002).

The vision of a sustainable development leads to the obligation to include all three dimensions and their interaction in analyzing and designing work and organizations. In doing so prerequisites and impacts of work become relevant which are not part of the individual level or a single corporation but refer to society or the biophysical environment. The multidisciplinary character of human factors enables this discipline to analyze and solve complex problems with multi-dimensional goals that go far beyond "traditional" areas.

Sustainability-oriented human factors is based on a broad societal discourse about the present and future development of the "working society", about opportunities and risks resulting from this development and about the contribution of human factors for an economic, social and environmental process of innovation (see e.g. Zink 1999b).

Therewith human factors expands its focus beyond corporations and employees. This broader perspective is for example reflected in a memorandum of the Gesellschaft für Arbeitswissenschaft (GfA – the German society for ergonomics and human factors). Referring to the present and future problems of the "working society" the following main topics of research are included in this memorandum (see Zink 2002, p. 350):

- Securing employment by
  - designing innovative products and processes by using ergonomics and ecology as factors of competitive advantage
  - helping organizations to deal with change processes (and, therefore, to survive)
  - creating new working time systems (e.g. part-time concepts to employ more people)
- Saving workability and employability
  - finding new ways of competence development and preservation

  - developing new concepts for the integration of work and health
- Rating work in a new way by
  - including unpaid work (at home and in society) and
  - personified services
- Designing the work of tomorrow by
  - dealing with the possibilities and consequences of information technology
  - considering the changes in individual (work-life) careers and biographies

Finally this broader perspective promotes human factors in the context of a corporate sustainability strategy. Especially the macroergonomic approaches can add value for different stakeholder groups. Zink (2002, pp. 356–358) shows various examples for (macro-)ergonomic approaches and their benefit for employees, customers, shareholders and society.

Employees:

- The history of ergonomics shows a mass of ergonomic interventions, also described under the heading of occupational health and safety, to make the workplace compatible with people's needs, abilities and limitations.
- The still young approach of macroergonomics has a lot to offer to employees. Taking participation as one example these concepts are not restricted to physiological aspects but also aim at the realization of personal growth.

Customers:

- Sustainability-oriented products consequently focus on customer needs. Ergonomic approaches on consumer oriented product development – e.g. through Kansei Engineering (Nagamachi 1994) – can be successfully used to meet these needs.
- New approaches of an integrated product and process development combining ergonomics and ecology can help customers to get ergonomically and ecologically optimized products.
- Certifying the quality of use of ergonomic tools and procedures in the product development and manufacturing process gives the customer the security that he or she is buying a product that includes all the ergonomic knowledge available at the moment.

Shareholders:

- A core macroergonomic method is participation of employees in a continuous improvement process which leads to cost reductions and other savings – also caused by employee motivation.

- The use of ergonomic principles in product development pays off: Customer oriented products can constitute competitive advantages leading to bigger market shares. This potential is far from fully realized and could be increased by combining ergonomic and ecological design. Besides direct positive economic effects, companies could also improve their corporate sustainability image.
- All the above mentioned examples can contribute to the shareholder value by strengthening the durable survivability of a corporation. Without denying the possibility of conflicting interests it can be stated that in a long-term perspective shareholders' concerns are in many cases compatible with the expectations of the other stakeholder groups.

Society:

- It is in the interest of society to ensure that working conditions do not result in any health problems causing financial problems to the social security insurance, for instance due to early retirement.
- Using ergonomic principles to prevent problems in the handling and control of complex systems (e.g. power plants or traffic), which otherwise could lead to human suffering and enormous ecological and economic consequences.
- Newer approaches of an integrative health management in industry are using concepts which could also be used within community or state activities.
- The approach described by Smith et al. (2002) under the title "Community Ergonomics" shows macroergonomics as a discipline with a holistic approach that can help solve social problems.

Traditionally gainful employment is the main area of ergonomic research and design. However people also work in other settings that have not been appropriately dealt with by human factors yet (see e.g. GfA 2000). The above mentioned example of "community ergonomics" shows that ergonomic approaches can contribute to solutions in different contexts.

Satisfaction of human needs is not only based on dependent employment and the resulting earnings. In many less developed countries only a small percentage of the supply results out of formal employment. In Western societies informal work such as household work, volunteering or neighbourly help account considerable for individual and societal wealth.

The main part of social capital in a society (e.g. trusting relationships, social cohesion, and social security) is the result of informal work. This shows the importance of the informal sector for sustainable development.

On the other hand, in the context of informal work, mental and physical stress and strain can be created that is not compatible with the idea of so-

cial sustainable work. E.g. this is often the case with the double burden of dependent employment and informal work for working mothers. So far human factors does not acknowledge these problems adequately. In particular work design approaches are not dealing enough with the informal sector.

But there are also changes in this area. Previously fixed gender roles are being transformed and the consequences for unpaid domestic work are extensive. The importance of volunteering is also changing. The active engagement in political parties and unions is for example declining, meanwhile new social movements are gaining supporters and an increasing number of self-help groups is getting established (Putnam 1995, pp. 67–73).

Informal work opens up a new research and design area that has rather been neglected so far. If human factors commits itself to the vision of sustainable development informal work needs to be considered more in the future.

As both concepts, TQM and human factors based on a stakeholder approach and in the last chapter the connections between human factors (especially in organizational design and management) and TQM (also realized within excellence models) have been shown, there is no doubt that both approaches could be linked under an umbrella of sustainability and contribute positively to future challenges of global competition.

5 Conclusion

This paper tries to show that human factors or ergonomics and total quality management as a synonym for comprehensive management approaches are both valuable concepts. But they lack – based on different causes – the acceptance they should have. As human factors or ergonomics in business is mainly seen as just cost consuming and prescribed by law (see e.g. Zink 2006), its full potential has never been developed on a broad scale, as for example described as “high-involvement-workplaces” by O’Tool and Lawler III (2006). TQM especially in industry is loosing its importance because new headlines driven by consultants are replacing this approach (Zink 2007).

Based on the assumption that both concepts are valuable and needed for the future and having seen that on the one hand authors dealing with TQM or organizational excellence approaches realize more and more that the human factors part is of immense importance for a successful implementation and continuous further development, and on the other side representa-

tives of human factors in organizational design and management (ODAM) or macroergonomics realize that TQM approaches are helpful for their design concepts, the question arises what could be done to promote the success of these two fields in the future.

Seeing more and more the (also negative) consequences of globalization and the need for respective concepts especially – but not only – in industrially developing countries (representing the majority of people living on this globe) a future oriented approach is necessary in taking our responsibility for future generations.

The growing number of discussions about climate change and its consequences illustrate the necessity of changing our behavior individually and globally – but also within working systems (in the broadest understanding). Therefore the idea of sustainability is a need – and will get a growing importance in the future. If this becomes reality – and there is no doubt about it, one can ask whether other stakeholder oriented concepts can profit from this development. As we have seen that both human factors and TQM or organizational excellence approaches are based on a stakeholder concept, they will fit in a sustainability concept. But the realization or implementation of sustainability itself may also profit from change management concepts based on human factors in organizational design and management or total quality management.

Taking the field of human factors the concept of corporate social responsibility which is very much related to sustainability, could moreover be used to promote this discipline in the sense of improving its management relevance (see e.g. Zink 2003b).

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national Labour Office, and the University of California. He has lectured or consulted in 19 countries regarding ergonomics and safety.

His work focuses on helping people and organizations change to improve productivity, safety and work systems. His work in organizations takes a systems approach in solving organizational problems and examines processes that prevent organizational cultures from achieving their goals. Projects he has been involved in have made dramatic changes in reducing motor vehicle accidents, industrial injuries and improving organizational functioning. This approach to changing industrial organizations has earned recognition and been awarded the Liberty Mutual Medal and Fellow status in the International Ergonomics Association and Human Factors and Ergonomics Society. His work has been published widely and is known and respected internationally.

Professor Gopal K. Kanji

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Gopal Kanji, who is the Director of Kanji Quality Culture Ltd., is also Emeritus Professor of applied statistics at Sheffield Hallam University. He is also the founder editor of the two international journals namely, Journal of Applied Statistics and that of Total Quality Management. With a career spanning 40+ years in the field of statistics and quality, incorporating teaching, publishing journals and books, writing technical papers and presenting research findings around the world, Gopal Kanji is an enthusiastic teacher, trainer, researcher and innovator.

Having published more than 90 research papers and 15 books in statistics and total quality management, Gopal Kanji is a very active fellow member of the American Society for Quality (ASQ) and a promoter of ASQ in the UK. He was appointed as Vice Chair of the International Chapter of the ASQ for Europe and the Middle East. In addition to presenting papers at other high profile international conferences he presents papers at the Annual ASQ Congress. He is a fellow of the Institute of Statisticians and of the Royal Statistical Society, a member of the International Statistical Institute and an academician of the International Academy for Quality (IAQ). As a renowned teacher and consultant, his lectures have inspired audiences and individuals around the world and as Chairman of the

EMPTQM group he has helped to develop a European Masters Programme in Total Quality Management under the umbrella of EFQM.

Gopal Kanji has organized and chaired ten World Congresses for Total Quality Management in the UK, Russia and Italy, UAE and Canada and has been appointed by the European Commission to act as a technical expert for the development of the European Customer Satisfaction Index. Through his company, Kanji Quality Culture Ltd., he has introduced Kanji's Business Excellence Measurement System to measure stakeholders' satisfaction within organizations for many companies.

He has been appointed President of the European Society for Organisational Excellence (ESOE), Vice-President of the International Foundation for Customer Focus (IFCF) and Visiting Professor at Leicester University. He is also Vice-President of IAQ.

Professor Waldemar Karwowski

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Waldemar Karwowski, Ph.D., D.Sc., P.E. is Professor and Chairman, *Department of Industrial Engineering and Management Systems* at the University of Central Florida, USA. He holds an M.S. (1978) in Production Engineering and Management from the Technical University of Wroclaw, Poland, and a Ph.D. (1982) in Industrial Engineering from Texas Tech University. He was awarded D.Sc. (dr habil.) degree in management science by the State Institute for Organization and Management in Industry, Poland (2004). He also received Honorary Doctorate degrees from three European universities. He is the author or coauthor of over 350 scientific publications, and is *Certified Professional Ergonomist (BCPE)*. Waldemar Karwowski was named the J. B. Speed School of Engineering *Alumni Scholar for Research*, University of Louisville (2004–2006). As Immediate Past President of the *Human Factors and Ergonomics Society* (2006–2007), he was also a member of the Board of Directors of the *American Association of Engineering Societies* (2006–2007), and was recently elected to the Executive Board of the *Council of Scientific Society Presidents*, Washington, D.C. (2007–2009). Waldemar Karwowski currently serves on the *Committee on Human Factors*, National Research Council, the National Academies, USA (2007–2009), and as Editor of the *Human*

Factors and Ergonomics in Manufacturing journal and *Editor-in-Chief of Theoretical Issues in Ergonomics Science journal.* He is Past President of the International Ergonomics Association.

Dr. Kazutaka Kogi

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Kazutaka Kogi, Research Adviser of the Institute for Science of Labour in Kawasaki, has been active in occupational health and ergonomics at international level. Born on 26 February 1933, he graduated from the University of Tokyo Faculty of Medicine in 1957. He conducted applied research at this institute until 1983 when he joined the International Labour Office as Regional Adviser for Asia and the Pacific. During 1988–1993, he worked as Chief of the Occupational Safety and Health Branch and Director of the Working Conditions and Environment Department of the ILO headquarters in Geneva.

From 1993–1999, he served as Director of the Institute for Science of Labour. Through his international work, he contributed to developing international standards and practical measures. He was Chairman of the Scientific Committee on Shiftwork of the International Commission on Occupational Health (ICOH) until 1996, and served as Treasurer of the International Ergonomics Association (IEA) from 1997–2003. He is currently Vice-President of the ICOH.

Working in technical cooperation projects for developing countries, he developed training packages, including checklists and manuals, for work improvements in small enterprises and agriculture and for participatory ergonomics. In this context, he has promoted the application of cost-effective ergonomic measures including low-cost solutions. He is particularly interested in promoting international cooperation for workplace improvements and participatory programs for small-scale sectors and for industrially developing countries.

Professor Patricia Ann Scott

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Patricia Scott was Professor and Head of the Department of Human Kinetics and Ergonomics at Rhodes University (1994–2005), where she has established the first full time degree in ergonomics in South Africa. She received her Ph.D. from the University of Stellenbosch in 1990. Patricia Scott has dedicated the last 20 years to the promotion of ergonomics in South Africa specifically, and more recently to industrially developing countries (IDCs) in general. To this end she has lectured, run workshops and given conference presentations in Southern Africa, China, India and South America.

Patricia Scott is the immediate past Chairperson of the South African Society of Ergonomics, and is currently the Editor of the journal of "Ergonomics: SA", where she has encouraged papers specifically focusing on work in IDCs, which is now publishing an increasing number of international IDC papers. She was a member of the International Ergonomics Association (IEA) executive committee for two terms (1997–2003), during which time she chaired the Industrially Developing Countries subcommittee, where her main drive was to gain international awareness of the need for ergonomics in IDCs. In 2003 she received the IEA Award for the promotion of Ergonomics in IDCs, and in 2004 was made a fellow of the IEA.

The main focus of her research is on ergonomics in IDCs where manual labour remains dominant, necessitating the investigation of both musculoskeletal and cardio-respiratory problems of workers having to cope with sub-optimal working conditions. Numerous consultancies with the forestry and automotive multinational industries, plus smaller local industries have resulted in a drive to promote both field and laboratory research in order to establish effective *in situ* intervention strategies to address the plight of millions of workers in IDCs around the globe.

Professor Xavier Tort-Martorell

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Xavier Tort-Martorell is the Director of the Statistics Department of UPC and develops his teaching, research and consulting activities at the Barcelona Industrial Engineering School. He has a degree in Industrial Engineering and was awarded a Ph.D. in the same field in 1986, by the UPC (Technical University of Catalonia). He also holds a Master's degree in Industrial Statistics by the University of Wisconsin (USA). Previously, he has developed his professional activity in two consulting firms, SISTECAL and Roland Berger and Partner as manager of the quality activities in Spain.

He is Co-Founder of the Centre for Quality and Productivity Improvement of Catalonia. He has been assessor of the European Quality Award and is Member of the Jury of the Catalan Quality Price since 1993. Xavier Tort-Martorell was a member of the team that revised the EFQM (European Foundation for Quality Management) Excellence Model in 2003. He is the Director of the Master Programme in TQM organized by UPC in Barcelona and Santiago de Chile and of the Six Sigma Program at the same university. He is a member of many professional societies and has been Chairman of the Academic Board of the European Master Programme in TQM and vice-president of ENBIS (European Network for Business and Industrial Statistics).

Xavier Tort-Martorell has been a consultant in quality management, quality techniques and six sigma to many firms and has taught seminars for many private and public organizations, among them: Gallina Blanca Purina, Nissan, HP, Ajuntament d'Esplugues, Ultramar Express (group TUI), Samsung Electronics, Alstom Transport, Chep, Zanini, Braun, Pius Hospital, BBVA, ITP (Rolls Royce group) and Siemens VDO. He is co-author of three books and many papers and has been invited speaker at many national and international conferences and serves in the editorial board of several journals.

Professor Peter Vink

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Peter Vink has written more than 200 papers. Some 34 in peer reviewed journals. At this moment the main topic of his publications concern participative design. Since 1998 he is Head of the Department Ergonomics and Innovation at TNO, where he motivates now 20 researchers and consultants active in the field of environment, health and design. In 2002 he became also a professor at the Delft University of Technology at Industrial Design where he guides Ph.D. and M.Sc. students in designing products that contribute to better health, more productivity and better comfort. A good overview of his work is published in his book "Comfort and Design: Principles and Good Practice", 2005.

Professor Klaus J. Zink

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Klaus J. Zink studied Technical Business Management at the University of Karlsruhe. He then was working as a research assistant at the Institute for Production Economics and Human Factors (University of Karlsruhe). In 1975 he finished his Ph.D.-Studies (Dr. rer. pol.) and received the "Fritz-Giese"-Award for his doctoral thesis. After his habilitation at the School of Economics and Business Engineering, University of Karlsruhe in 1978, he became Professor at the University of Wuppertal. Since 1980, Klaus J. Zink is Professor at the University of Kaiserslautern (Chair for Industrial Management and Human Factors). Since 1995 he is also Head of the "Research Institute for Technology and Work" at the same university.

In cooperation with the "Distance and International Studies Center at the University of Kaiserslautern" he is scientific director for European and German post graduate studies referring to "Total Quality Management", "Human Resource Development" and "Economy and Management".

In a great number of books, essays and articles he discussed concepts for the development of quality management including the quality of work and holistic management concepts. Recent topics are – among others – stakeholder oriented assessment and design of organizations, integrative management concepts, change management and participation, sustainability and inclusive design concepts.

Besides being a member in several national and international committees, Klaus J. Zink has represented Germany in the jury of the European Quality Award from 1992–1999. As Chairman of the jury for the German Excellence Award "Ludwig-Erhard-Prize" from 1997–2005 he has participated decisively in the development and introduction of this award in Germany since 1997.

From 1994–2001 he was a member of the board of the German Human Factors and Ergonomics Society (Gesellschaft für Arbeitswissenschaft (GfA)), from 1997–1999 as President and from 1999–2001 as Past President. He is a member of the Council for the International Ergonomics Association (IEA) since 1995, and served as a member of the Executive Committee from 2000–2003. He received the IEA Fellow Award in 2000 and the Human Factors and Ergonomics Society (USA) 2006 Distinguished International Colleague Award. He is also a member of several national and international editorial boards.