Between Collaboration and Competition in Modern Technology Management and Innovation

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Executive Summary

This chapter promotes the discussion about the impacts of technological innovations on technology management and its future trajectory and also takes into account socio-economic dynamics.

From make-buy-ally to cloud, the conflict between having to compete and the need to collaborate continues unabated. However, the complexity and challenges of collaboration have increased, commensurate with various simultaneously coexisting powerful business models in today's global business world.

These contemporary business models require a radical rethink in the way technology is managed. All of them redefine the boundaries and locus of the firm. It is useful to distinguish between product and process innovations. The bottom line, that is, profitability, requires constant attention. Open innovation, user-led innovation, automated environments, and cloud business coupled with mobility each need different techniques and responses to ensure the survival of individual organisations and firms. Different models and responses are analysed and discussed in their contexts and the implications for technology management outlined in detail. Collaboration and innovation are central themes. It emerges that technology management has an exciting and extremely challenging future ahead, however, with many research questions as yet unanswered.

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While trust continues to be a paramount value for the functioning of collaboration in technology management, governance – that is, the exercise of power and control – must be achieved in new ways too, including the proactive and dynamic use of influence rather than authority.

New Business Models Require New Responses

Ten years ago, the European Engineering Association ewf brought together major industrial players from manufacturing to take stock of the status of collaboration and competition in the manufacturing industries which then felt on the threshold of new forms of collaboration (Sachsenmeier and Schottenloher 2003). At the time, the industrial landscape in the automotive and aircraft industries was already replete with alliances, strategic partnerships, and collaborative networks of excellence all intended to manage increasingly complex partnerships. These partnerships were primarily formed so as to achieve competitive advantage, shorter development cycles, and innovation.

Today's plethora of business models ranges from make-buy-ally to cloud, yet many of the questions posed then remain relevant today:

- How will companies manage the complexities between being in competition on the one hand and striving for partnership on the other hand, in practical terms?
- How will companies position themselves strategically in new networks in order to survive?
- What tasks and roles can be adopted by management and staff in the newly emerging networks?
- What are the new value systems in these networks? How do we achieve trust, openness, transparency, and fairness?

Ten years later, a number of tectonic changes have occurred, namely:

- Pervasive globalisation (a) of sourcing, innovation, markets, and supply chains, coupled with an always-on economic and social world
- Open innovation (b), as anticipated, linked to a preference for open systems with diverse partners
- Crowdsourcing (c) of talent and technologies created through social media and other channels, ranging from ideas to financing, and linked to terms such as *user innovation* or *mass innovation*
- M2X sensors (d), cyber-physical systems, and self-managing intelligent environments
- Cloud and mobile businesses (e), both of which change all models again

These tectonic changes pose new and extraordinary challenges for global collaboration and competition, especially in technology management and its pinnacle discipline, innovation. All of these approaches redefine the boundaries and the locus of the firm, each in a different way.

The Traditional Scope of Innovation Management and the Need for Profitable Business Models

It is useful to distinguish between product innovations and process innovations. To the public, new innovative products are generally much more visible than process innovations. However, if we look at innovation cycles, process innovations exert a much stronger influence on business change.

As humans, we typically overestimate short-term changes effected by product innovations and at the same time underestimate the medium- and long-term changes arising from process innovations!

The traditional framework of reference for innovation management in firms and organisations has its valid and well-known foundations. These include the formulation of goals and strategies, the management of innovation processes, the creation of an innovation-friendly enterprise culture, and the creation of a supporting information infrastructure.

However, the real test for the innovation capability of organisations consists in overcoming the insecurity about success or failure of the chosen path, in managing the multi-organisational complexity and the dynamics of innovation, as well as in overcoming the unavoidable and necessary conflicts among all the stakeholders, the challenges of working in geographically and organisationally distributed teams, the continuing conflict between the intended developments and existing products and services, the arguments about the image of the company, and the issues of public opinion and compliance. The higher the degree of novelty and the higher the uncertainty and the risks of failure, the higher the possible profits! If organisations cannot welcome conflicts as a welcome side effect of the business and cannot overcome them, they will also not establish a true innovation culture.

The traditional view of innovation processes – divided into phases such as situation analysis, creation of ideas, systematisation, evaluation, selection, implementation, and market introduction – shows important elements but is no longer enough.

Today's markets require a much more holistic view of entire value networks and much more agile rapid research and development. Potential gains through new or improved products and processes are not enough; business models to create real profits must be provided simultaneously and become an integral part of innovation. If necessary, these models can take the form of entire business ecosystems within which innovations can be marketed, developed, and deployed. Apple's iTunes and mobile devices are a good example.

Pertinent questions are the following: How can an organisation change or redefine the rules of an entire industry? How can money be made from the newest tools, from an improved product, from a well-targeted services offering, from a fabulous logistical effort, and at which point, at which price, and without the competition immediately copying such offers, or, worse, leapfrogging them?

Satisfactory responses include flexibility and agility, fine-tuning of the antennae in the markets, and a readiness for radical changes while maintaining motivation and credibility.

How will you earn money with your innovations? Who will you be for whom? The answers change as innovations leapfrog each other, in irrational jumps, across the life cycles of products and services. Business intelligence combined with modelling and simulation tools help to deal with the painful experience of such jumps and help to explore promising scenarios.

Open Innovation

Open innovation (b) is a term originally associated with Henry Chesbrough (2003) of Berkeley University. The basic idea was that since knowledge is widely distributed in the world, companies had better no longer solely rely on their own research but should instead obtain licences and processes (including patents) from other companies. Additionally, proprietary inventions not needed in a firm's business should be proactively offered outside through licensing, joint ventures, and spin-offs.

In contrast, closed innovation refers to processes limited to the company, with little or no use for external knowledge.

With today's communications systems, it seems impossible to prevent an exchange and transmission of information, and the open innovation community actively advocates taking advantage of outside knowledge. The business models of firms then determine which external information to bring in and which to take outside.

The important cultural change is an ability to partner and to deliberately disregard the old NIH, the *not-invented-here* syndrome. This will work if there is management attention and endorsement, and a process for finding, vetting, and leveraging outside sources of information. Greater permeability is needed to become not only a guardian of intellectual property rights but also a broker and seller of such rights to others.

Numerous top companies – as well as their suppliers – are now in open innovation mode, among them many consumer goods and electronics companies. Some of these, such as Procter & Gamble, have established innovation networks for conveying their mission and requirements; others have developed open innovation into part of the way they do business.

Several patterns for the use of open innovation have emerged, each building on the others:

- Some firms agree to use open innovation on principle and encourage their staff to find answers outside the organisation.
- Others have nominated a person to coordinate all open innovation aspects of a company.
- Yet others have nominated a person to actually implement an open innovation strategy.

– Finally, some have defined multiple points of contact for open innovation in all departments, businesses, and/or technical domains.

Typical stages in open innovation are idea formulation, product design, production, and distribution and sales. Idea formulation involves issues of trust within your network. Product design is the sweet spot of open innovation; written specifications and customer requirements can more easily be defined than in other stages and posed to multiple innovation partners. Global production is a significant reality. Some of the most innovative products and services achieve their success at the stage of distribution and sales, with innovative shipping, sales channels, merchandising, and other marketing effects.

Before reaching out to a wider public, vendors and customers are brought into the system. An example is Innovia Technology's innovation need for increased passenger comfort on long-haul flights with the Boeing 787 and the open innovation result of advanced LED lighting which adds to a sense of space and enhanced comfort in the cabin.

The SAP Co-Innovation Lab (COIL) and its industry partners (Cisco, HP, Intel, NetApp) try to find a way to integrate hardware and software innovation and yet be protective of intellectual property. Work is done in a collaborative but safe environment, in a SAP facility in Palo Alto, California. Recently, facilities in Tokyo, Bangalore, and Sao Paulo have been added.

German pharmaceutical firm Merck & Co. (in Darmstadt, Germany) which accounts for about 1% of biomedical research in the world decided as early as 2000 to open up its innovation processes, stating *to tap into the remaining 99%, we must actively reach out to universities, research institutions and companies worldwide to bring the best of technology and potential products into Merck. The cascade of knowledge flowing from biotechnology and the unraveling of the human genome – to name only two recent developments – is far too complex for any one company to handle alone* (www.anrpt2000.com/innovation2.htm).

This author leads several projects in which companies cocreate and co-market products and services as part of *federal product development and marketing* efforts.

Many formal and informal mechanisms have been deployed for pre-qualification for participating in open innovation by third parties, so-called accelerators. These, in turn, have become an industry of their own. They vet large numbers of innovators, handle intellectual property issues upfront, support innovation-against-specification and mission innovations, and generally position themselves as reasonable for any size company. On the downside, they add an additional layer of administration.

A distinction can also be made between using (1) business partners as an open innovation network, (2) using suppliers, and (3) using customers. Each subgroup has its own characteristics, with advantages and disadvantages (Blackwell and Fazzina 2008).

Initial experiences with open innovation and the new alliances indicate that companies with a stated focus on open innovation are more easy to partner with. Also, the logistics for open innovation can be expected to be ill-defined; it is

therefore useful to focus on the intent, or mission, and not on the process. Our findings from action research indicate that it helps to signal a willingness to look for disruptive technology since open innovators will readily attempt to reinvent processes. Participation modes in innovation networks differ greatly, and participants must expect diversity rather than uniformity. *Old-school* caution – evident in the outsourcing of R&D to countries such as India and particularly China – dictates that collaboration be modularised; more recent approaches advocate communicating the mission aggressively, while details are to be communicated more slowly.

Important questions remain: What are the performance implications of open innovation? What appropriate metrics are there for measuring and managing open innovation? What failure cases exist that show the limits of open innovation or its boundary conditions? How does open innovation change the role of IP in the firm? What new practices do we need to develop in order to become more successful in open innovation?

Crowdsourcing and Social Media Creation

To many, crowdsourcing (c) is no longer a foreign concept. This model has become very visible in the creation of new knowledge and software over the Internet. Examples are Wikipedia and Linux or the Firefox browser.

Social media provide new avenues to global talent, and many see crowdsourcing, mass sourcing, user-led content, and product creation as the inevitable path towards a super-democratisation of processes and internal decisions in the corporate environment. This assumes that companies will be giving more and more space to outside people's opinions during all stages of technology production. Retail has been particularly successful with such an approach. Amazon, Skype, and Google have used parts of this model with success, albeit not in terms of equality. Starbucks involves customers in decisions, and Lego empowers its fans with a personalised input channel.

Dedicated websites such as InnoCentive have sprung up to tap the mass innovation market.

The author anticipates that communities such as LinkedIn, Futurecom, Xing, Facebook, Twitter, Goggle+, and many others will position themselves as conduits to consumers for the mass creation of products and services. A growing industry has already been established and handbooks written on how to use social media, coupled with lots of advice for the implementation of company-specific social media policies (e.g. Robert Wollan et al. 2011).

Pharmaceutical companies have started to cocreate with patients, with the help of social media. An EU project, PatientPartner, promotes the role of patient organisations in clinical trials.

Thousands of new consulting firms have sprung up in recent months promising to deliver the fruit of user-generated content and products to the many bewildered companies whose business model this very same movement challenges and threatens.

Questions remain: How relevant is crowdsourcing for us? Which models work? How do we need to behave? How do we need to change ourselves as companies and organisations for the most advantageous use of crowdsourcing? How do we maintain the quality of our crowdsourcing beyond initial contact and ideas? Can we use captive crowds interested over the life cycle of our products and services? How do we give feedback? Can we sustain our crowdsourcing and social media efforts?

M2X, Self-Managing Intelligent Environments, and Cyber-Physical Systems

M2X (d) stands for machine-to-machine or machine-to-human or other combinations. Essentially, cyber-physical systems (CPS) are a disruptive technology with a huge potential for entirely new business models (Geissberger and Broy 2012).

Many benefits are expected from such networked intelligent technology, ranging from simple to complex:

– Embedded systems (e.g. in car airbags)
– Networked embedded systems (e.g. the autonomous flight of a drone)
– Cyber-physical systems (e.g. an intelligent networked street junction)
– Internet of things, data, and services (e.g. the Smart City)

Possible uses for cyber-physical systems in the smart city, for example, exist in transport, energy, health, governance, management of buildings, production, and logistics and are connected to buzzwords such as smart mobility, e-mobility, smart grid, micro grid, ambient assisted living, e-health, smart home, smart factory, smart logistics, and many others.

At some stage in the future, sensor-based autonomous systems are expected to deliver tailor-made, individual services or entire support environments to (human) individuals.

The characteristics of cyber-physical networks determine the quality of the technology management associated with their use. The relevant dimensions are:

– The degree of interconnectedness, possibly in real time, and the dependence on the co-operation of subsystems.
– The nature of the man-system interaction. In industrial contexts, this implies complex management, control, and monitoring tasks. In the private sphere, one would expect such technology to adapt itself interactively to the context, needs, and capabilities of users; sensors would interpret situational data and then coordinate delivery of the required services.
– The degree of openness and autonomy in tasks related to communications, coordination, control, and decision-making, with important implications for reliability and trustworthiness vis-à-vis users and associated systems.

Much like nanotech materials allow us to build new materials on an atom-by-atom basis, the promise of sensor-based networked environments is that they would allow

us to build entire business models from scratch, based on sensor-based networked environments, and enhance our human capabilities.

Associated technology management challenges are the establishment of networked infrastructures, application architectures and CPS platforms, data capture and interoperability, establishment of knowledge domain models, establishing and maintaining security, ascertaining the participatory interaction of man and machine, the creation of trust in the reliability of such systems, and, above all, putting them into productive practice.

In short, innovation will come with even more complexity and uncertainty, as well as a good deal of political baggage (security, privacy, risk, participation, inclusion). Enormous engineering challenges will require international collaboration and will also lead to a massive domain convergence in order to profit from the new opportunities, that is, to a rearrangement of the competitive landscape.

Living labs will flourish and showcase innovations and in order to gain competitive advantage and market share through swift deployment.

Cloud and Mobile Computing

Cloud computing (e) has arrived with a vengeance and – combined with an increase in the mobility of users and a plethora of mobile devices – signals yet another shift in the business model. Cloud computing, now a major IT (and implicitly, services) movement, is steadily expanding its scope. This scope was initially described in IT terms as:

- Commodity infrastructure as a service (IaaS)
- Enterprise IaaS
- Platform as a service (PaaS)
- Software as a service (SaaS)
- Cloud storage
- Hybrid clouds
- Private clouds

The infrastructure and offerings of the cloud are still being built by start-ups, practitioners, consultants, and many big-name companies.

In the architecture of cloud computing, laptops, servers, desktops, tablets, and phones remain outside the cloud, while content, monitoring, collaboration, communications, finance, object storage, identity, queues, databases, computing, storage, and network are part of the cloud platform infrastructure. The foundation of cloud computing is the broader concepts of converged infrastructure and shared services. The holy grail of the cloud is the delivery of business services, just as it was the case with its precursor, outsourcing.

Cloud computing was made possible by the availability of high-speed networks, low-cost computers and storage, and the widespread practices of hardware virtualisation, service-oriented architecture, and the increasing perception of computing as a utility. In Europe, privacy and data security reservations as well as legal compliance requirements have slowed the growth of general cloud computing, in favour of private or hybrid clouds.

While the providers of cloud services attempt to make it easy for users to onboard, there still exist technology management challenges in cloud engineering. Cloud engineering is the application of engineering disciplines to cloud computing. It brings a systematic approach to the high-level concerns of commercialisation, standardisation, and governance in conceiving, developing, operating, and maintaining cloud computing systems. It is a multidisciplinary method encompassing contributions from diverse areas such as systems, software, web, performance, information, security, platform, risk, and quality engineering.

The technology management buzzwords from the point of view of users are agility (in provisioning), APIs as interfaces, cost (typically, a usage model), device and location independence, virtualisation, multitenancy (centralisation, peak load capacity, efficient utilisation), reliability (especially suitable for continuity and recovery), scalability and elasticity, open standards, open source, performance, security, and easy maintenance.

However, cloud technology will not solve all of a company's problems. One needs to leverage this technology around the right strategy and with the right people. Training should be a huge part of the deployment plan for cloud management tools, and firms will want a policy to constantly monitor their effectiveness.

Persistent questions remain: Is privacy assured? Data integrity? Is my version of the cloud compliant with my industry rules and regulations? What about data leakages and cross-national data transfers? Is cloud computing sustainable, green? Can cloud computing be used for criminal activities? How can companies switch providers or regain control? How reliable is the system? What is its availability? What about data ownership, business continuity, and disaster management?

Governance: Power, Conflicts, and Influence

Governance is absolutely necessary in any collaborative venture, be it explicit or implicit. For the more traditional forms of collaboration, well-known formats have been established which enjoy great reputation, such as those advocated by Prince, the Project Management Institute, and many others.

Rules and procedures have been successfully introduced for *governance in hierarchical industries*, with tier 1, tier 2, and tier 3 suppliers, and good models exist for communities of practice in which people work on a common theme. Governance elements for these particular business models include:

- Business requirements negotiated among stakeholders, often driven by the major partner/OEM/financier
- Agreed and constantly maintained information confidentiality, integrity, availability, reliability, efficiency, effectiveness, and correctness
- Multilateral planning of data, applications, technology, equipment, and personnel
- Controlling in order to coordinate, react, adapt, assure operations, and safeguard against risks

– (endlessly discussed) Resources and their availability
– Arrangements upon dissolution of the network

One level up is *large programme management*, that is, the management of very large or many related projects. Various attempts are being made to capture the specific requirements and formalise adequate techniques to master such large programmes. For example, Said Business School in Oxford has established an institute, prodded and supported by telecommunications monopolist British Telekom. Brandenburg Technical University is currently in negotiations to establish an international centre for large programmes management, with this author as its founding director.

The challenge in large programme management is typically to manage large, dispersed, and culturally diverse and virtual project teams. Dissimilar procedures, practices, and tools often lead to integration issues. Risk perception is complex, and risk management tends to be inadequate and inconsistent, leading to unknown events. The integration of the interdependent components offered by different teams provides great challenges and often leads to failures. Management therefore needs to be adaptive, preferably with a multicultural background and experience and with the will to establish a similarly experienced core leadership team. Above all, in large programmes, one needs to leverage the power of teams and build great, empowered, agile teams. While using edge-of-chaos management when innovating and experimenting, the teams must be instilled with a culture of discipline. It helps to see virtual teams as strategic assets, and – from personal experience in large programmes – it pays to insist on face-to-face meeting for planning and decision-making. Contractor teams must be led but not micromanaged while at the same time using standard procedures and tool as appropriate. Collaboration and open communication must be proclaimed as important virtues, and management must provide the best example.

In the cases of the *crowdsourcing*, *self-managing sensory environments,* and the *cloud/mobility* (c–e) models, governance is mostly untried. The technology management issues remain, that is:

– Process optimisation: How does one coach, facilitate, collaborate, train, and bring multidisciplinarity to bear, combine inputs, and expand the partnerships?
– Enhanced knowledge transfer: How do we do this effectively? How is knowledge disseminated? Rules? Techniques? How about cross-fertilisation?
– Enhanced technology transfer: What are effective ways to do this? To what purpose? Dissemination? Cross-fertilisation?
– Protection of intellectual property: How important will this be? Shall we be exploited? What contexts fit which sort of behaviour?
– Achievement of long-term goals: How can we renew, direct, support, coach, intervene in crises, settle conflicts, and measure productivity and growth quantitatively and qualitatively? Can we sustain our presence in this space?

These questions provide a rich seam to be mined for for research and development.

Basically, power is a latent resource which must be unleashed by other processes. The key unleashing process is influence, which uses interpersonal and social skills to make others voluntarily change their attitudes. *That is* why people are our most important resource.

Enabling Collaboration and Teams with Technology and a Culture of Encouragement

We consider collaboration as an interactive process among two or more people who communicate with each other and work together, towards the achievement of common goals. The term "collaboration technologies" has come into use to denote a whole raft of products and services designed to enhance organisational performance and productivity in industries and markets. These include specifically voice, video conferencing, content sharing, telepresence solutions, social networking, shared workgroup sites, discussion boards, blogs, wikis, IM, and text messaging. We can expect many more.

Collaboration technologies, too, must be selected and deployed aligned with the business model which they are to support.

Culture can be the worst innovation killer. If a company's leadership and culture focus on criticising new thinking and new methods, then innovation is doomed. Risk-encouraging enterprise cultures reward and value innovation, value knowledge, and reward project work (rather than core work); they advocate the sharing of information and are open to informal power. Only with mutual encouragement will we all be able to stand the pace of change.

Summary

Demands for technology management skills will increase dramatically, as business models and technology models continue to evolve and proliferate.

Lifelong learning of technology managers will have to be coupled with character traits which foster innovation, such as a yearning for better thing and things that do not as yet exist, tolerance for uncertainty and ambiguity, a willingness to take risks, a belief in the value of new things in general, a belief in the ability to obtain valued benefits from innovation, participation in richly connected social networks, a willingness to experiment, and an ability and willingness to go the extra mile and invest in various kinds of resources in the new thing – and a head for finance and business plans.

Each of the five tectonic changes (a–e) mentioned above creates its own research questions and technology management challenges. These models – while coexisting simultaneously and legitimately – show a great diversity, on a continuum from decentralisation to centralisation. They also differ greatly in the way they involve their users and define the boundaries of the firm.

Looking forwards, we shall be seeing even more complexity, even more powerful and globally integrated technology platforms offered by third parties, and also an ever greater competitive scramble for successful business models based on advanced forms of collaboration. Successful companies will keep their ears to the ground and listen carefully to their customers.

Courage and determination will be needed in order to exert influence, survive, and flourish.

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