Shuichi Fukuda *Editor*

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Chapter 1
Experience Engineering: Age of Process Values

Shuichi Fukuda

Abstract It is pointed out that there are two kinds of experience. One is well known experience. Things we undergo in the course of time. This is past or extrinsic experience. In the past we accumulated pieces of experience and organized them into knowledge. But this approach has been effective because the situations did not change very often and extensively. Changes, however, occur very often and extensively these days and these changes are sharp so that they are unpredictable. In the day of smooth changes, knowledge based or rational approaches were effective, because we could predict the future. But today we cannot make any predictions. What becomes increasingly important today is how we can adapt to the changing situations quickly and flexibility. Thus, fast adaptability becomes a key word today. In order to gain fast adaptability, and to satisfy our customers at the same time, we have to pay attention to the other experience, intrinsic experience. In fact, experiment and experience come from the same Latin word experiri =try. To achieve this goal, we have to let our customers create experience and let them learn how to adapt to the situation quickly and flexibly. In other words, we have been focusing our attention to product values, but from now on, we should pay more attention to process values or value of creative experience.

1.1 What Is Engineering for?

There are many definitions about human (Fig. 1.1). But what characterizes human most would be *Homo Faber*. Why does human take trouble to make a tool? From the standpoint of optimization of energy consumption, the optimum way is to eat when you get hungry and to sleep for the rest of the day.

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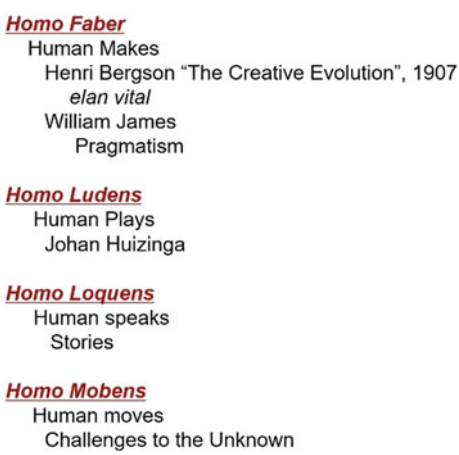

Fig. 1.1 Definition of human

Biologists tell us that only humans can see the future. We can dream. Animals can use tools. But they pick up tools from nature to meet their immediate needs. They do not take trouble to make a tool. Humans make a tool to make their dreams come true. Engineering is an activity of creation. Engineering is here to make our dreams come true or to create our future.

Engineering, however, has been focusing its attention to making tools. We make them because we would like to make our dreams come true. But we forgot why we make tools. For example, we invented airplanes, because we wanted to fly. But once airplanes were invented, we focus our attention on how we can make better airplanes. Airplane is a tool. Then, what was our dream? It was to travel freely without any trouble. But we forgot our dream and paid our efforts to improve airplanes.

We wanted to fly, because birds can travel, no matter it is water, air or land without any trouble. What we wanted was to travel like a bird! But airplane industry, railroad industry, automotive industry, ship industry, etc. are developing their industry independently without too much collaboration among them. They are all transportation industries. What we dreamed was integrated transportation vehicle, not separate transportation vehicles.

In other words, traditional engineering has focused its primary attention to develop products. But, we have to remember products are tools to make our dream come true. Products themselves are not our dreams.

Let us take mountain climbing for example. If we would like to get to the top of the mountain, we can ask a helicopter to take us there. But people walk to the top. And mountain climbers take more difficult routes. Why? If achieving the goal itself provides satisfaction, then asking a helicopter would be the best choice. But people choose to walk. They walk and mountain climbers challenge more difficult routes. Why?

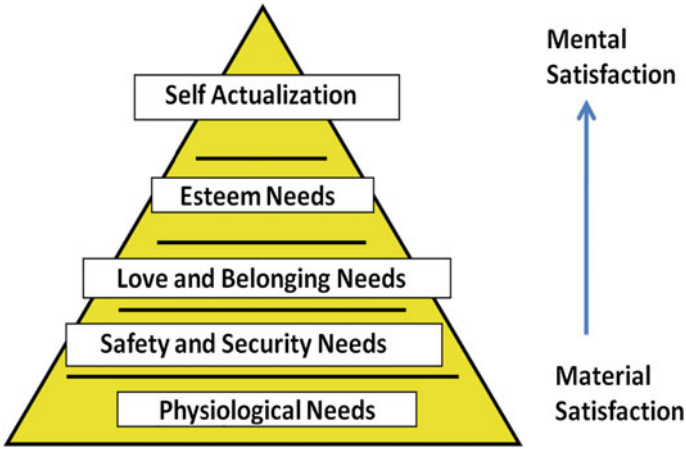

Fig. 1.2 Maslow's hierarchy of human needs

Maslow proposed the hierarchy of human needs (Maslow 1943) (Fig. 1.2). He pointed out that at the lower level, people look for material satisfaction, but as they go up, they look for mental satisfaction. And at the top of the pyramid, people would like to actualize themselves.

About 40 years later, Deci and Ryan proposed Self Determination Theory (Deci and Ryan 1985; Ryan and Deci 2000). They pointed out there are two kinds of motivations, extrinsic and intrinsic. They pointed out that more often we pay more attention to extrinsic motivation and we do not pay enough attention to intrinsic motivation.

Up to now, our society has been a reward system. We do jobs to get a reward or a reward is offered as an incentive. Our traditional engineering based on product development is a reward system. We prepare rewards to get money and we develop better products to get more money. It is entirely based on extrinsic motivation.

Let us come back to mountain climbing. If the fact that the peak we reach is higher than other mountain tops provides us with great satisfaction, then that is extrinsic motivation and if we are happy with such a reward, then the current way of product development is on the right track.

But is this really true? Why people prefer to walk to the top? And why mountain climbers select more difficult route the next time they climb. That is because people would like to actualize themselves to use Maslow's words. Self Actualization is nothing other than our desire to demonstrate our capabilities. We would like to challenge. Challenge is the core and mainspring of all human activities.

Deci and Ryan described Self Actualization as Intrinsic Motivation. As Maslow pointed out, humans are satisfied if better tools or products are provided in the early stages, because they look for material satisfaction. But once these needs are

satisfied, they will move toward looking for mental satisfaction, which comes from intrinsic motivation. With the very rapid progress of technology, we are now entering the stage of Self Actualization or the stage to satisfy intrinsic motivations of our customers.

1.2 Experience and Emotion

Experience is often interpreted as something we underwent, i.e., something related with the past. But the word experience comes from the Latin word, experiri =try and we should remember that experiment comes from the same Latin word. So experience and experiment are deeply related and experience is not passive at all. It is very active and it means what we get after we try.

Like motivation, there are two kinds of experience, extrinsic and intrinsic. Extrinsic experience is what we undergo and feel from the outside world. This is passive experience. Intrinsic experience is more related to experiment. We try and we have experience. It is very active.

Emotion comes from the Latin words e=ex=out and movere=move so it literally means to move out. Motivation comes from the same Latin word movere. So motivation and emotion are very closely associated. When we are motivated, we do some actions to the outside world and we get emotions.

Motivation and experience are very closely related. In the case of past or extrinsic experience, experience leads to motivation, but in the case of intrinsic motivation, motivation leads to action and to experience (Fig. 1.3).

The word experience has been accepted something as outside in. We have been thinking that experience is something we observe, encounter and undergo in the course of time. We have regarded experience something related to the past and in the very passive way.

But its etymology gives us another interpretation as discussed above. We have another experience, which is something to explore and it is the thing of the future. What mountain climbers look for is experience. It is their experiments. Once they succeed, they look for more challenging route. Therefore, engineering tomorrow should move more toward creating experience.

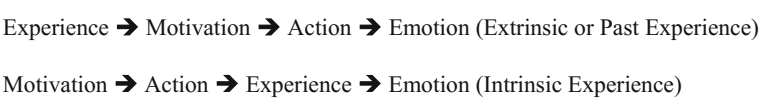

Fig. 1.3 Extrinsic experience and intrinsic experience

1.3 Customization and User Experience: Their Difference

To meet the quickly expanding market, mass production was introduced widely around 1926. But soon market expansion brought about diversification of customer requirements. To respond to such diversifying requirements, mass customization is proposed (Pine 1992). The idea is to make mass production and satisfaction of diversified requirements compatible. But we have to note this idea is basically Product Out. It focuses its main attention on products. It is basically producer-centric and product-value focused.

User experience (UX) (Norman et al. 1995; International Organization for Standardization 2009) is totally different. It is user-centric and process-value oriented. In fact, behavioral economists opened our eyes to the importance of process values. Until UX is pointed out, everybody discussed about product values. How we can produce better products which meet the customer expectations. But customers are not passive users. They are very much active and creative.

For example, children invent many different ways of sliding down (Fig. 1.4).

This is another user experience. Children try other ways of sliding down. This is experience and it comes from their intrinsic motivation to explore the new ways.

Thus, customization and user experience are different. We can customize our products to meet the use conditions or the preferences of users. But it only pays attention to extrinsic motivation. User Experience, on the other hand, pays attention to intrinsic motivation. So it also includes development of new ways of using a product.

In this sense, today's engineering is going further and further away from true engineering. Everybody has his or her own dream and it varies from person to

Fig. 1.4 Children invent many different ways to slide down

person. And it should be emphasized this dream is very much associated with experience. What they would like to have is a new experience. That is their dream. Products are only tools to help make their dream come true. Their dreams are associated with processes. What processes they select will give them different experience. It is a try and an experiment. But such a challenge gives them a joy of creation and fulfilment.

1.4 Lego: Creation of Process Values

Then, do we have a product that is sold because it provides process value? Yes, we have. Lego is the most typical example (Fig. 1.5).

Lego sells only blocks. But people enjoy combining these blocks and come up with different things. What Lego sells is process. Not product. But people enjoy because they can satisfy their intrinsic motivation.

IKEA introduced modularization and sells ready-to-assemble furniture. Although they are selling products, they pay more attention to the intrinsic motivation of their customers.

1.5 Modularization

Modularization is getting wide attention these days and is quickly introduced in many industries. This is another mass customization. In fact, modularization has a long history. For example, kimono is modular. It is said that kimono was established as clothing in about 800 A.D. Kimono is composed of long strips of fabrics and we combined them into kimono. Such ideas of modularization can be observed

Fig. 1.5 Lego

in the old age. The lack of technology to produce a body fitting garment may be the reason,

It is interesting to note that there are two ways of developing clothing. One is to develop a well fit clothing for each person's body. The other is to wrap modules of fabrics around the body. Kimoto is the typical example of the latter.

But such module-based clothing has many advantages. It does not need too sophisticated tools, but we can produce many different styles by combing them in a different way. In fact, the same strips of fabrics grandma wore are often re-assembled into another kimono, and granddaughter enjoys wearing it. We have to note that this gives them a joy of challenge and fulfilment. They challenge to change the design and combination into the one she or he likes. Thus, kimono motives people intrinsically.

Most discussion about modularization today is about functional modularization. But we have to be aware that modularization is not just to make production easy to meet the diversifying requirements. It motives people intrinsically.

Another example in the field of garments which sells process-value is sari. It is just a long strip and you can enjoy how you can wrap it around your body and wear it. Sari pays attention more to the intrinsic motivation than the extrinsic motivation.

In fact, fashion industry has much longer history with respect to modularization. And their modularization is more related to emotion than to functions. For example, every lady would like to wear a wedding dress just for her. But not every lady is rich so they have to compromise for the rental dress. But rental dress makers cannot prepare one-of-a-kind dresses. So they hold a fashion show and observe where ladies are paying attention to. They prepare a wide variety of these feature parts and they produce the common platform in mass (Fig. 1.6). This is the same as what is being done in automotive industry.

We have to remember even if we can satisfy our customers by preparing a very wide variety of selections, it is one time value. And if a customer picks up one, then the other products will remain unsold unless other customers buy them.

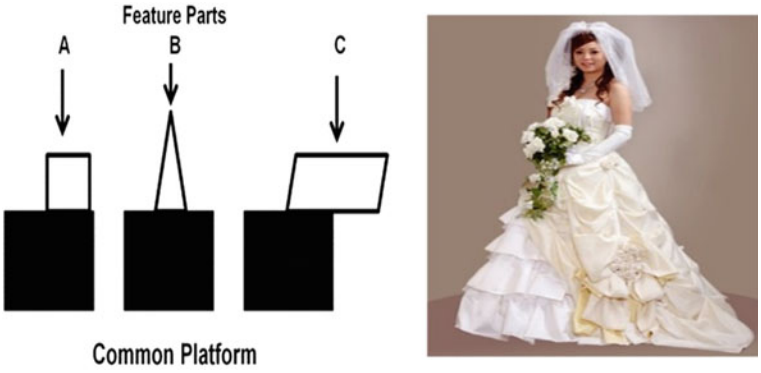

Fig. 1.6 Wedding dress

And customers do not stay. They move from one product to another and from one company to another. Thus, often it leads to large waste.

To solve such a problem, we have to note another need of human. What differentiate humans from animals is human has a need to grow. This is another important need Deci and Ryan pointed out. In addition to satisfy intrinsic motivations of our customers, we have to pay attention to this need to grow.

Fashion industry is going ahead in this point, too. They sell accessories. And what we should note is that many ladies develop accessories themselves. In fact, in Japan, many ladies learn brazing to produce accessories. Ironically enough. Many brazing workers leave their jobs. Ladies pay to learn brazing, but these workers are paid but they leave. This is another good example of intrinsic and extrinsic motivations. Even if it is the same job, you feel happy if you do it out of your mind, but you do not feel happy if you are told to do that.

Aren't there any system that satisfy our intrinsic desire and our need to grow at the same time?

1.5.1 Software Development as Seen from Emotional Engineering

Let us compare hardware development and software development. Hardware products are developed to meet the design specifications and when hardware products are realized, almost nothing is left for customers to satisfy their needs for growth. Functions of hardware products remain the same. Or it is the other way. As hardware is physical, they soon start to deteriorate once they are delivered (Fig. 1.7).

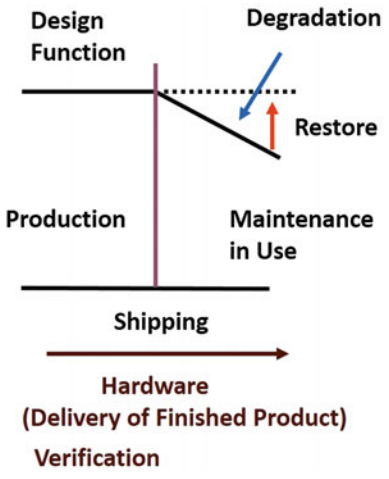

Fig. 1.7 Hardware development

Then, how is software developed? It is developed in a continuous prototyping way. Software developers provide very basic functions at first and as users get accustomed to the system and get confident, they upgrade the functions a little bit. Thus, software is developed step by step in response to the progress of users. In fact, the growing or evolving function curve is nothing other than the learning curve (Fig. 1.8).

Thus, software development satisfies not only our intrinsic desires but also our desire to grow. Why do we learn? It is because we would like to grow. Continuous prototyping is nothing other than learning. Therefore, it satisfies our desire to grow.

Software is developed step by step in response to the user expectations so at each step users feel their expectations are met and feel satisfied. And it is upgraded only after users get accustomed to the system. So users feel confident and thus put trust in the system. Although we use different words confidence and trust in English, they are expressed by the same word "Vertrauen" in German.

And it should also be noted that reliability and trust are different. There are many researches on reliability, but most of them are discussing reliability of a group of products. They discuss how reliable the products are which are being produced. They are not discussing individual product or your product. What they are concerned is how reliable their products are. Trust, however, is reliability of an individual product or your product. If your product is reliable, you put trust in it. Reliability and trust can be compared to doctor's health and your health. Doctor's health is health about all of us. But if you like to drink and even though you may drink too much from the eyes of a doctor, you are healthy if you enjoy your life and you feel healthy. This is your health.

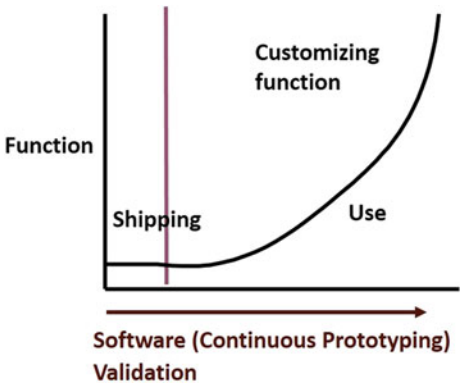

Fig. 1.8 Software development

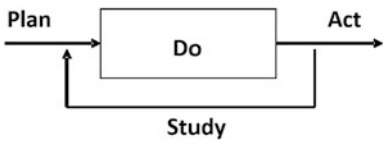

Fig. 1.9 Closed loop

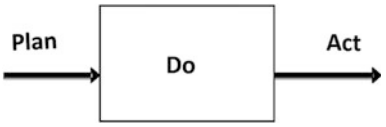

Fig. 1.10 Open loop

Then, why does software development satisfy our intrinsic desire and our desire to grow? It is because continuous prototyping is based on a closed loop system (Fig. 1.9). User experience is continuously fed back. Hardware development, on the other hand, is an open system, without feedback (Fig. 1.10).

1.6 The Connected Society: What Will It Bring to Us?

1.6.1 Our Intrinsic Desire and Our Desire to Grow Will Be Fulfilled

IoT (Internet of Things),[1] CPS (Cyber Physical Systems),[2] etc. are getting wide attention these days. And with the remarkable progress of sensor technology, we are now getting into the connected society.

Let us consider what the connected society will bring to us. The connected society means that our society or it would be more exact to say here our engineering has been an open loop system (Fig. 1.10) Apart from individual systems, our engineering as a whole has been an open loop. There were no feedbacks from users in the holistic sense. And these feedbacks took much time to reach producers, and most of them are very much individualistic. Thus, substantially there has been no feedbacks. But the emerging connected society will turn our engineering into a closed loop system in the holistic sense, where feedbacks are immediate (Fig. 1.9). In other words, what we see in software development will be observed in every corner of engineering.

Therefore, the connected society will bring us the society where our intrinsic motivations and our desire to grow will be fulfilled. The society will grow not physically as we discuss today, but it will grow emotionally.

1.6.2 Module-Based Engineering: Integration of Industries

Up to now, our engineering has been linear and final product based (Fig. 1.11). But the progress of the connected society will lead us to realize how many common

[1] http://www.rfidjournal.com/articles/pdf?4986, Retrieved 30 Oct 2016

[2] http://www.nsf.gov/pubs/2008/nsf08611/nsf08611.pdf, Retrieved 30 Oct 2016

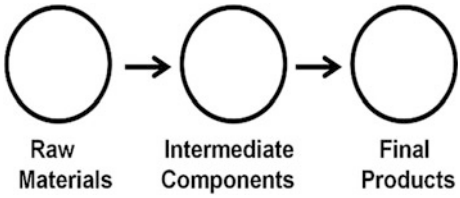

Fig. 1.11 Final product centric industry framework (traditional linear engineering)

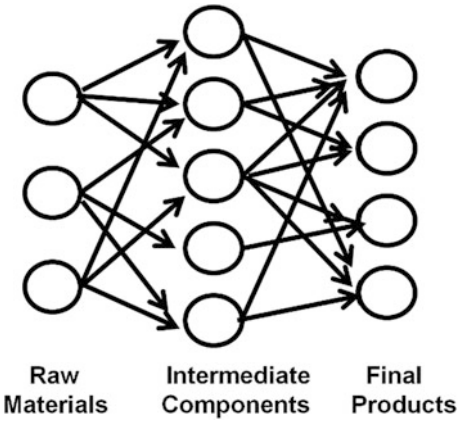

Fig. 1.12 Parts centric industry framework (module-based engineering)

modules are used in many different industries. Although it may not seem there are many common modules, it is because final products has been developed independently without almost no regards to other industries. Transportation industry is a typical example. Although they share the same goal of transportation, they developed their own parts or modules. But if things are connected, we would learn how much functions we have in common across industries. If we develop such common and versatile modules, then our industry framework will change from the current tree structure to a network structure such as shown in Fig. 1.12.

As is well known, a tree structure has only one output node (Fig. 1.13). Our traditional engineering is tree-structured. But in the case of a network, any node can be an output node (Fig. 1.14). Thus, a network can adapt to any changing situations or requirements. Fast adaptability is a keyword today, and the change of our industry framework into a network will bring us fast adaptability in our engineering.

In addition to its benefits of emotional aspects, we have to remember if we can introduce such module-based industry framework, we can reduce energy resource consumptions a great deal and we can reduce time and cost in product development.

Thus, it will make our society greener and more sustainable.

Prof. Calestous Juma, Harvard Kennedy School said in his talk at the University of Tokyo that sustainability does not mean to keep the current level but to keep up growing. In this sense, the connected society will bring us true sustainability.

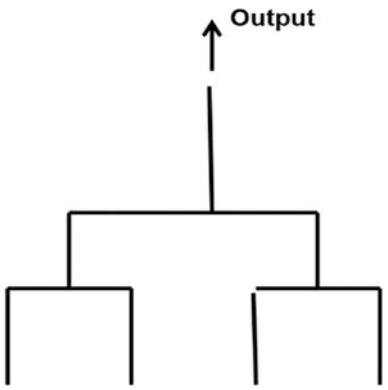

Fig. 1.13 Tree

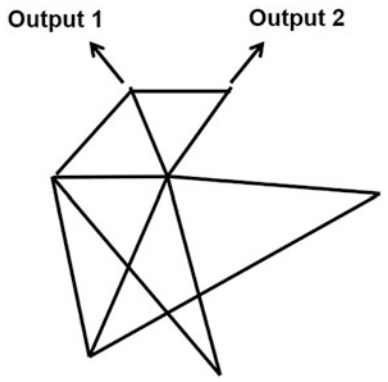

Fig. 1.14 Network

1.6.3 Parts Centric Industry: Thick Intermediate Layer

Our engineering has been final product centric. Thus, our industry framework has been tree-structured (Figs. 1.11 and 1.13). But if we can develop common and versatile modules, it will change our industry framework into parts centric network (Figs. 1.12 and 1.14).

It not only helps to integrate industries but it also changes our industry framework into the one with thick Intermediate Layer. Our traditional industry framework has put main focus on the top layer, or the final product layer, so it is top heavy and it is in fact fragile when the society changes. But if our industry framework changes into the one with thick intermediate layer, it will be more robust against any changes in requirements or in economic needs, because these parts industries have much broader markets than final product industries, if they produce common and versatile parts.

1.6.4 From 11 Best to Best 11

Knute Rockne, famous American Football coach said "11 best players do not make up the best team. The best team is made up of players who plays for the team" and he demonstrated this by bringing University of Notre Dame up and they are now winning the game always. But when they climbed to the top, nobody knows who are in the team.

What Knute pointed out is that when each player knows his capabilities and play the needed role and form a team adaptively from situation to situation. Thus, the role of each player changes and the team formation varies to adapt to the situation. This is nothing other than fast adaptability.

In soccer, too, fast adaptability became a key word. Der Kaiser Franz Beckenbauer introduced Libero system. Until then, each player was expected to play his role well. But Franz realized that in recent soccer, fast adaptability becomes more important than playing the specified role very well. On the contrary, players have to change the role quickly to adapt to the changing situations. He was a midfielder, so he can see the whole game and how the situations change. Thus he gave instructions to his fellow players what roles they should play and led the team to victory many times.

The Connected Society will be Best 11 society. We have been making efforts how we can bring up Best Players in each field. But the group of these Best Players cannot adapt to the quickly changing society now. We have to be more adaptive and cope with the changing situation. Parts centric industry is nothing other than Best 11. They can work together and adapt to the quickly changing society.

1.7 From Product Value to Process Value

The transition into parts centric industry framework will also change our evaluation of values. In the days when industries focused their attentions to final products, the value of final products was most important. Engineers paid their efforts how they can develop products with better functions and better qualities.

But as Weber-Fechner law points out, we need proportional amount of increase when the level goes up.

$$\Delta R/R = \text{Constant} \tag{1.1}$$

Our product quality is improved so much that it is approaching its ceiling (Fig. 1.15).

To let our customers recognize how quality is improved, we have to improve quality greater and greater as the level of quality goes up. This is impossible.

Thus, the other way to attract our customers is to explore the new market. In fact, our world has expanded so much. We used to live in a closed world where there

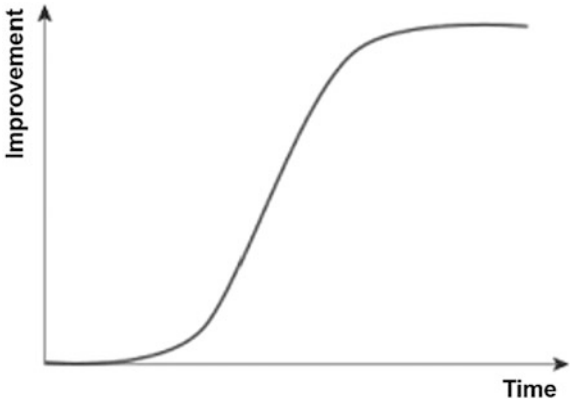

Fig. 1.15 Quality improvement

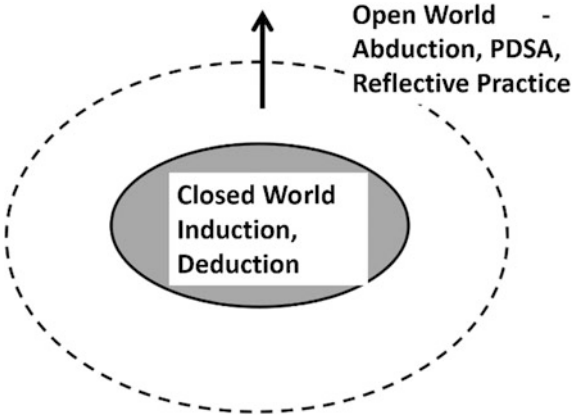

Fig. 1.16 Closed and open world

were boundaries, but boundaries are disappearing and we are now living in an open world (Fig. 1.15).

In a closed world, we have to fight on a red ocean, but in an open world, we can look for a blue ocean (Kim and Mauborgne 2005). The new market does not mean a new product. Let us take cell phones for example. Cell phone developers used to develop new functions and they competed to add more functions in shorter time. They thought this would satisfy their customers. Reality is on the contrary. Even young ones who are capable of using these functions got irritated, because next new functions were added before they learned and mastered these functions. Customers did not have time to master them, so that irritated them because they believe they are capable of using them, but they could not demonstrate their capability. Thus, they quickly lost trust in these cell phones.

Smart phones are very much different. The common platform is composed of basic functions and users add apps when they feel they need them and after they feel they mastered the uploaded apps, they upload the additional apps. So users

have time to learn and they can upload what they want, It is very much intrinsic motivation-driven and it also satisfies their desire to grow.

Parts centric industry enables customers to select modules and combine them as they like, just in the same way as Lego. Even if they cannot do the job themselves, they can ask experts and they will feel their internal motivation is satisfied. And they can satisfy their desire to grow by learning how they can combine parts better to have better products they really wish to have. Thus, parts centric industry framework will bring greater emotional satisfaction. And we have to remember, we can come up with many different final products by combining parts or modules in a different way.

Daihatsu developed Copen (Fig. 1.17). This car is composed of interchangeable parts. Although currently, parts have to be changed by experts, we can change them as we like and we can even produce parts, if we can simplify the design and use new material engineering as will be described in the next chapter. Tomorrow, we may have car code in addition to dress code.

The Connected Society is expected to bring us such parts-centric industry framework and immediate feedback information will contribute to meet personalization requirements. People can enjoy Lego in their own way, although they use the same blocks. This is because blocks themselves are just tools for them. They enjoy the processes or experiences of combining them in many different ways.

Thus, the progress of modularization will bring us such parts-centric industry framework and it will change our value evaluation from product to process. But these processes are not simply processes. They will provide the joy of creating experience which comes from our intrinsic motivations and they will also satisfy our desire to grow.

Our traditional engineering has focused on product development, but from now on, what we should develop is experience. We should develop industry framework where customers can create experience, or in other words, where they can try and enjoy.

Fig. 1.17 Daihatsu Copen

1.8 New Material Technology

Additive Manufacturing and 3D Printing (Lipson and Kurman 2013) are getting wide attention these days. But we have to note that in addition to them, new material technologies are emerging.

These quickly progressing material technologies contribute to the development of the new network structured industry framework described above.

Yesterday, we could not get away from the limitation of the idea that each material is an aggregate of attributes and most of them accompany with the material in nature. In short, we could improve natural materials, but we could not invent new ones. But emerging material technologies are totally different. We can organize and combine attributes very flexibly as we wish. Thus, truly new material can be developed.

Thus, we are now entering the age of material invention. It removes the limitation of selection of materials so it will make our new network industry framework very flexible and adaptive.

1.9 Customer Engagement

Therefore, what is emerging tomorrow as most important in industry is how we can create experience. In other words, how we can engage our customers in product development will become most important.

To achieve this goal, we have to look at things from a very different perspective.

Our traditional engineering has been restaurant cooking. We bring up good chef, provide him with good tools and produced good dish. But what is needed more today is home cooking. How we can have a delicious dish with leftovers in the refrigerator becomes more important.

Theodore Roosevelt said “Do what you can, with what you have, where you are”.

This holds true with exploration. And he was a great explorer. We have to remember his words and open up the new age of exploration in the field of engineering.

What our customers want is they would like to be the player of the game, too. They would like to enjoy the game by playing. In order to achieve this goal, we have to make our engineering simpler so that even customers can join or at least can virtually join as a player. Tomorrow is the age of creative combinations and just as Web technology advance from Web 1.0 to Web 2.0, engineering will also move from Engineering 1.0, where there is clear distinction of roles as producer and user, to Engineering 2.0, where there is no walls between them.

1.10 Summary

The importance of creating experience is pointed out to flexibly and quickly adapt to the frequently and extensively changing situations. It also is important in terms of satisfying our customers' intrinsic motivations and their needs to grow. We have been focusing our attention on product values. But in this age of frequent and wide changes, process values will become more important than product values. In addition, product values are one time, but process values are life time. Process or experience values will turn our users into lifetime customers. To put is in another words, experience engineering is another effective way of establishing brand in an age of frequent and wide changes.

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Chapter 2
Machine Team Management

Shuichi Fukuda

Abstract It is pointed out that such emerging technologies as IoT, CPS, etc. will dramatically change our relationship with machines. Relationship between humans and machines has long been basically master-slave. But machines will communicate with each other in the coming Connected Society so that they will behave like humans. The group of machines are no more just a group of physical entities. We have to deal with them just as we do with humans. Thus, machine team management becomes very important in the Connected Society and the problem of leadership will emerge to better control and manage these machine teams.

2.1 Machine Team

IoT, CPS, etc. are now quickly transforming our society into the Connected Society.

It is pointed out in this chapter that in the Connected Society, we have to deal with machines (Machines, here, include systems and products) as a team and a group of machines in the Connected Society are no more just a group of traditional machines which operate individually under human instructions. In the Connected Society, machines exchange information among them.

Until now, when machines work as a group, they do not change their structure and they follow human instructions. They do not have any information or knowledge of their own. Thus, most of these groups are tree-structured, because tree structure has only one output node and if the instruction does not change from case to case, it is the most effective structure to cope with the contexts and situations (Fig. 2.1).

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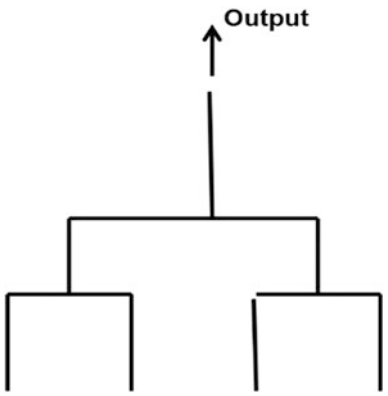

Fig. 2.1 Tree structure

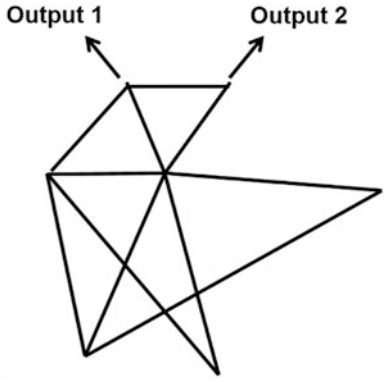

Fig. 2.2 Network structure

In fact, in the 20th century, there were changes, but they are small and smooth. Therefore, engineering designers can foresee the operating conditions and could prepare instructions for the user to use their machines appropriately.

As we come close to the end of the 20th century, changes come to take place more often and extensively. This calls for a change from a tree to a network, because if it is a network structure, any node can be an output node so that it becomes easier to adapt to the frequent and extensive changes of the outer world (Fig. 2.2).

As we enter the 21st century, changes occur more frequently and extensively. So we have to change a network structure flexibly and adaptively in response to the changes of the outer world. But at that time, machines were not connected in the sense of the Connected Society today. They may have been connected, but their roles are fixed. Machines were expected to play their assigned roles exactly as they were instructed.

The Connected Society changed the whole scene. Machines are not only connected, but they are now able to communicate. Machines can store information and with the accumulation of information, they can have knowledge of their own. In other words, machines come much closer to humans.

Thus, until very recently, even when machines worked as a group, their roles were fixed so we could give instructions to the group easily. And even if we had to re-organize the group, we could take time, because changes were slow and smooth.

But recent frequent and extensive changes make such a strategy no more effective. Such changes make it impossible for engineering designers to foresee the operating conditions. Today, only a user knows what is happening now. Thus, what becomes increasingly important in these days of frequent and extensive changes is how we can help our users judge the context and situation correctly and let them make an appropriate decision.

2.2 From 11 Best to Best 11

If we turn our eyes to the world of sports, it affords a good lesson for us, engineers.

Knute Rockne, famous American Football coach, said that even if we have 11 best players, they would not make the best team. The best team is composed of 11 players who do their best to change their roles to adapt to the situation. Rockne demonstrated this by bringing up University of Notre Dame to the ever winning team. Until then, University of Notre Dame was at the bottom. But almost nobody knows who played in these games, which brought the University to the top.

This example is American Football. But in soccer, too, Der Kaiser Franz Beckenbaur introduced Libero system, in which midfielders give instructions to other players what roles are expected from them and how they should move. Forwards are concentrating their focus only on the goal and it is the midfielder who really can see how the game is going on and what strategy should be taken to win. In other words, fast adaptability is the key element in today's soccer.

In the traditional team sports, most efforts were paid to bring up best players. These best players were best indeed in their own position, when the formation or the organization did not change.

But today, what is expected from players is versatility and flexibility. They are expected to play many different roles as required. They do not have to be the best player. What is required from them is how quickly and flexibly they can adapt to the situation and how well they can play the new assigned role in the continuously changing team formation or organization,

Traditional team sports were a tree structured, but today in order to win, we have to introduce a network structure, which changes continuously in response to the frequently and extensively changing flow of the game (Fig. 2.3).

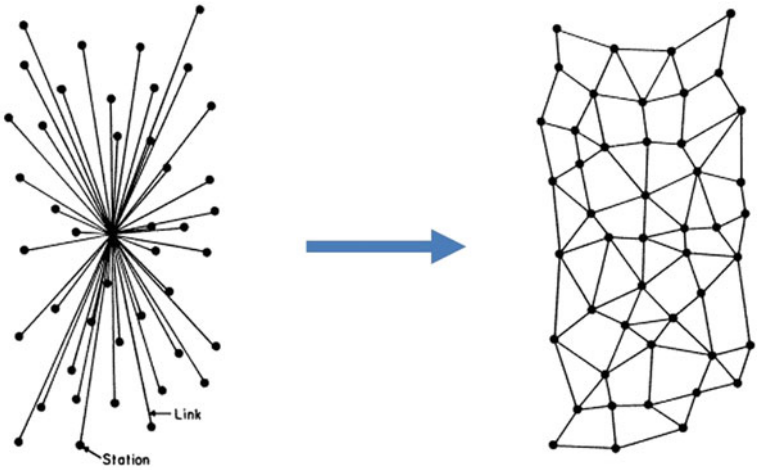

Fig. 2.3 11 Best to Best 11

In the traditional engineering, we have paid our efforts to make an individual machine best. We have been producing Best Playing machines. But what is needed today in an age of frequent and extensive changes is how flexibly and adaptively we can vary their formation or organization at any given moment. Each machine may not be the best individually, but as a team, they work together most effectively and adaptively to cope with the frequently and extensively changing contexts and situations.

2.3 From the Connected Society to the Communicating Society

To achieve such flexibility and adaptability, it is not enough that machines are connected. They have to communicate. If information is passed from machine to machine one way, the machines may be connected in the sense of data transfer, but they are not communicating. Communication has to be both ways. And not only data, but their meanings have to be conveyed. Such emerging technologies as IoT etc. are quickly making it possible for machines to communicate.

Once they are able to communicate, they can accumulate their experience and share the knowledge with other machines. In other words, the Connected Society at this stage should be called the Communicating Society, where machines behaviors become very close to those of humans.

2.4 Machine Team Management

The advent of the Communicating Society brings to us a new problem, i.e., how we manage a machine team. We have to organize and manage our machines to get our task done at any given moment. Before the advent of the Communicating Society, we organized our machines, but that was carried out once at the beginning because the outer world did not change appreciably. And substantially the problem of management did not exist. Machines were there to listen to our instructions.

But machines are becoming closer to humans in their behaviors so that their management becomes increasingly important. Machines are no more just physical entities, but they are putting on personalities beyond individualities, because machines grow with accumulation of experience.

And in the age of frequent and extensive changes, there are many different ways to deal with the problem. Yesterday, even if there were several ways, we could select the best way in an easy and straightforward manner. But a user in the Communicating Society has to lead the team of machines in order to get his job done as he wants.

2.5 Leadership

There are many researches on leadership in human behavior science. But the problem of leadership in a human-machine mixed team emerged as a new issue in the Communicating Society. Until now, the relationship between humans and machines has been master-slave so that how adequate instructions can be prepared is important. But the relationship between human and machine and between machine and machine change from situation to situation. So just like Rockne or Beckenbauer, we have to be a good team leader to fully utilize a machine team. We have to develop another leadership theory which can be applied to mixed human-machine teams.

2.6 Summary

The importance of developing leadership theory to apply to mixed human-machine teams is described in an age when not only humans, but also machines communicate with each other.

Chapter 3
From Inside Out to Outside In: Needs for Holistic Sensing and Comprehensive Engineering

Shuichi Fukuda

Abstract In the 20th century, engineers paid efforts to realize products which customers wanted. In short, engineering in the 20th century was inside out. Engineers focused their attention to the quality of a product. As situation did not change appreciably, they could foresee the use conditions and good quality was evaluated adequately by customers. But as we enter the 21st century, changes come to occur very frequently and extensively. Engineers cannot foresee the use condition anymore. It is a user who knows what is happening now. In order for them to flexibly and quickly adapt to these changes, users have to sense what is happening and make an adequate judgment. Then, they can make a right decision to cope with the changing situations. For this purpose, holistic sensing is necessary, but current sensor technology is application- or case-specific. But if we look back, there are examples which give hints for developing such holistic sensing. And to secure fast adaptability, we have to develop comprehensive engineering at the same time to fully utilize the information from holistic sensing.

3.1 20th Century and 21st Century: Their Difference

20th century and 21st century can be compared in many ways. Here, let us discuss their difference from the standpoint of inside out and outside in, with main attention paid to engineering.

Engineering in the 20th century paid efforts to realize what we want. This holds true in all fields of engineering. We built and developed many buildings, bridges, ships, airplanes, automobiles, etc. to satisfy our wants. In these years we did our best to realize what customers have inside. Thus, it may be called the age of inside out.

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But as we enter the 21st century, situations changed rapidly. The new century brought about frequent and extensive changes in our environments and our life is quickly globalized and our areas of living expanded rapidly. Thus, our environments themselves are quickly diversified and in addition, or accordingly, our wants, too, are diversified and personalized.

This transition introduced such an approach of mass customization (Pine 1992) to satisfy the growing needs for diversification and personalization of our customers.

At this stage, we, engineers, were trying to satisfy what customers want, without paying much attention to the changing world outside. In short, these are years of inside out. We made our efforts to put out what customers want inside.

But recently situations are changing very quickly. Our outer world changes frequently and extensively so that how fast we can adapt to these changes becomes crucially important. In the past, speed and efficiency were important, because customers would like to have products as early as possible. But these years, how they can cope with the changing contexts and situations become more important.

This difference between the 20th century and the 21st century can be compared as trains and ships. In the case of trains, once you make a right decision at first, i.e., you select the right destination and select the right line, then what you want is how fast you can get to your destination. You don't have to worry about anything else. But in the case of ships, it might be very fine today, but tomorrow hurricane might hit your ship. So, you have to be very much adaptive to the changes of situations (Fig. 3.1).

Thus, what matters today is fast adaptability. We have to watch outside and we have to take necessary information in order to cope with the changing situations. Thus, now is the age of outside in.

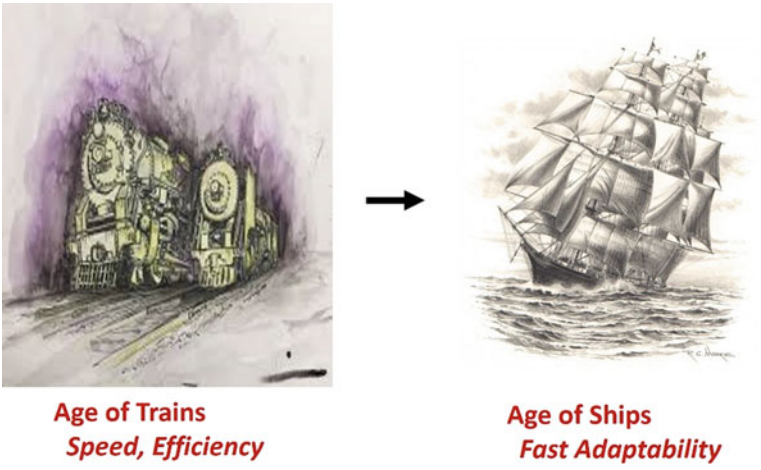

Fig. 3.1 Difference between the 20th century and the 21st century

3.2 Two Types of Engineering: Inside Out and Outside in

If we look at our engineering, we will soon realize there are two types of engineering. One is to utilize nature as much as possible and the other is going artificial as much as possible. The former may be called Outside In Engineering and the latter Inside Out Engineering.

Let us take some examples and discuss. In the old days, we had no other choice than to utilize sunlight or moonlight. But gradually we introduced candlelight, electric light, etc. to enjoy life as we like. These inventions led us more and more closer to inside out way of life. We are building up a wall between nature and our life. Our life went more and more further away from our life in nature and moved more and more to personal needs or preferences.

When we want to read a book, we will use a table lamp today. This is very much convenient and satisfy our personal needs. But the move toward such inside out way shuts us from the outer world.

We built houses to protect us from nature, such as rain, wind, etc., but these engineering separate us from nature. We are now living in a very artificial atmosphere with almost no disturbance from nature.

This has been good when our outer world did not change appreciably. Even if there were changes, they were small and life tomorrow was almost the repetition of today.

But now our outer world changes so frequently and extensively so we have to adapt to these changes flexibly. In other words, days of outside in are coming. We have to observe what is happening outside and we have to take necessary information in order to adapt quickly and adequately.

In 2014, Philip Lighting proposed the idea of Ambient Lighting at Frankfurt Messe. This idea is very much revolutionary. They asserted the importance of ambience and how lighting influences it.

3.3 Emotions

Coming back to emotion, we have been discussing emotion with our chief focus on products. Although in the field of architecture, ambience or atmosphere has been discussed, but architects care about ambience because it is closely related to the evaluation of their architecture. In this sense, we all have been focusing our attention to the issue of emotions related to products. In short, we have been discussing emotion from the standpoint of inside out. This is natural because as etymology shows, emotion is related to our intrinsic motivation.

But if we pay our attention to the outer world and if we interpret emotion in a broader sense, we will realize there are issues of emotions which are more related to the outside than the inside. For example, if you find shade under a tree, you are attempted to take a rest or take a nap. Thus, you are motivated from the outer world.

This is something like Affordance. In Affordance Theory (Gibson 1979), a rock or something outside attracts us to sit. Thus, the outer world provides us with extrinsic motivation. This extrinsic motivation is different from such social extrinsic motivations as money, etc. We all are born with this motivation. It is extrinsic and it is deeply associated with the atmosphere of the outer world.

3.4 Architecture

Let us consider architecture here. Charles Rennie Mackintosh, architect, designer and artist at Glasgow School of Art introduced Japanese way into his design. What attracted him was naturally dimming lighting in old Japanese houses. In these old Japanese houses, lights came in through shoji or paper wall. And light dimmed gradually as we went further in. As the sun went down, people in the house could *feel* the lapse of time and enjoyed the atmosphere or ambience. They felt the same way as they did spending the day outside. He emphasized the importance of lighting from the standpoint of generating atmosphere (Fig. 3.2).

This is the advantage of old Japanese houses, but even Japanese forgot how lighting is deeply associated with generating atmosphere. Of course, mood is discussed in relation to lighting. But most of these discussions are focused on particular products. What attracted Mackintosh is the holistic nature of lighting in the old Japanese houses. Even in these days, Japanese used candles to read books, etc.

Fig. 3.2 Shoji or Wall Paper (http://cdn.amanaimage.com/preview640/09501010295.jpg)

Such for-the-purpose lighting was not attractive to him. Lighting which generate atmosphere attracted him.

Shoji, wall paper, is also interesting from the viewpoint of outside in. Today, walls shut us from the outer world. But Shoji, wall paper, not only penetrates outside light, but it also conveys the changes of the outer world. If the shadow of trees shakes, we know that the wind is blowing hard outside and if light becomes darker, we know it is close to the sunset. In short, Shoji, wall paper, works as a holistic sensor. Today, sensors are progressing remarkably, but these sensors pick up particular signals. Shoji on the other hand provides us with information we do not anticipate. And today's sensors are dealing with data or information individually, but Shoji provides sensing in the holistic sense.

3.5 Holistic Sensing

In the case of NDI (Non-Destructive Inspection), we can identify the flaw with very high accuracy, but that is when we know what kind of a flaw it is. If we do not have any idea what kind of a flaw, we have to apply all kinds of testing. For example, When we enter a room, and feel something wrong, we often find out, for example, there is a crack on the wall. Such sensing that we feel something is wrong is still impossible in today's NDI. That is why pilots and repair team inspect a plane visually before flights and why there are still walkaround inspections carried out at plants. Today's NDI is superb when we know beforehand what flaws are expected. But their capabilities are surprisingly low when we cannot anticipate what kind of a flaw there is.

This holds true in medical area, too. Let us assume you feel you are not well and go to a hospital. Doctors have their own expert field and if your symptom agrees with their field, then they will give you an excellent treatment. But if your symptom does not agree with any one of them, you cannot get a satisfying diagnosis.

It is pointed out widely that we are entering a sensor-based society. It is mandatory because changes occur so frequently and extensively and we have to sense what is happening now to adequately judge and to make a right decision to adapt to them. But today's sensor technology is application-specific or case-specific. One sensor works best for a particular case, but not for other ones. All sensors work for particular applications, and there is no holistic sensor yet. But in order to secure fast adaptability, such holistic sensing is mandatory. We should remember that atmosphere or ambience provides a very important cue for such holistic sensing.

3.6 Concluding Remark

Our society is changing quickly. Inside out used to be very important, but to cope with the frequently and extensively changing contexts and situations, we have to be flexible and adaptive. In order to secure such fast adaptability, we have to take outside information in as quickly as possible. But current sensing is application-specific. We should develop holistic sensing as soon as possible.

And engineering is also application-specific. We should develop comprehensive engineering to deal with these holistic sensing information and we should apply these approaches to cope with the rapidly changing society.

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Chapter 4
Cognitive Mechanism in Selecting New Products: A Cognitive Neuroscience Perspective

Kazuhiro Ueda

Abstract Potential needs and preferences of consumers are often difficult to evaluate with questionnaires. Numerous studies have indicated that in reality, people do not necessarily recognize the influences on their own preferences and misrecognize the rationale for their preferences. Neuromarketing, which is the application of neuroscientific findings to marketing has been gaining attention as a method of exploring concealed consumer needs. This chapter summarizes research that is representative of neuromarketing (McClure et al. 2004), and then introduces the author's studies exploring the application of findings on the cognitive background of individual differences in behaviors when purchasing unknown products. Furthermore, the chapter discusses the possibilities of neuromarketing as a method of exploring hidden consumer needs and preferences.

4.1 Consumer Needs May Be Misunderstood

Analyzing consumer needs or user trends and applying these findings to next generation products and service development are extremely important for companies. Therefore, every company puts much effort into marketing research to determine consumer needs. Various methods of marketing research, such as quantitative studies using questionnaires, qualitative studies by group interviews and in-depth interviews (one on one interviews), and evaluation grid method[1] have been used in the field. Many of these methods require consumers to somewhat correctly verbalize their needs. In other words, they are based on the assumption that the consumer needs can be verbalized. Is this true? The question arises when those who are in marketing in the business world often say, "we want to apply *the*

[1]See details for Burns et al. (2016).

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consumers' voice expressed by questionnaire surveys for improving and developing products; however, often this technique doesn't work".

A person's own *preference* is the most influential factor when making choices, and this is not only related to making purchases. If people can accurately verbalize their own preferences, we could easily find consumers' needs by using the methods described above; however, numerous recent studies in cognitive and social psychology suggest that individuals do not necessarily recognize factors affecting their preferences and often people misunderstand rationales for their preferences. For example, Wilson and Nisbett (1978) asked people passing by a department store to choose the best pair of stockings from four pairs of nylon stockings. Participants did not know that all the stockings were actually identical. However, many participants (about 40%) chose stocking placed at the right-hand side. Similar studies conducted after Wilson and Nisbett (1978) have also replicated the same results; people more likely to choose products placed at an edge. This phenomenon, which is called the *position effect*, is not recognized by consumers; furthermore, many of them fluently reported their reasons for making their choices.

The phenomenon of blindness for the dissociation between intentions and choice outcomes is known as *choice blindness* (Johansson et al. 2005). In choice blindness experiments, the researcher presents pictures of female facial pairs to 120 participants (70 female) and ask them to choose the most attractive face. After a participant selects a picture, it is hidden and then presented again and the researcher asks participants to state their reasons for choosing the particular picture. Before presenting the picture again, the researcher tricks the participant by using the magic card trick and switch the selected picture with the other picture that participant did not select. When this trick is used, less than 30% of participants realized that the picture presented the second time was different from the one they had selected. Moreover, many participants stated the reason *why they had chosen the picture that they had not chosen*, including it having attractive eyes, having a good hairstyle, and wearing nice earrings, among others. This study suggests that, although they supposedly chose the picture based on their own preferences, they did not realize their own preference, or the dissociation between their intention and the outcome of their choice.

Previous studies in cognitive and social psychology have attributed the dissociation between rationales and outcomes to possible misconceptions about the cause of preferences. Therefore, it is possible that consumer needs extracted by questionnaires do not reflect the true needs of the consumers.

4.2 Unconscious Effects on Consumer Preference

4.2.1 Mere Exposure Effect

In the previous section the possibility of manipulating individual preferences at an unconscious level was discussed. In fact, numerous studies have explored these

possibilities, and the most well known method of controlling preferences is known as the *mere-exposure effect*. The mere exposure effect proposed by Zajonc (1968) suggests that repeated exposure to certain stimuli could alter attitudes toward that stimuli (generally becoming more favorable). Zajonc, in his experiment, showed Turkish words to participants that were naïve to Turkish language. The number of presentations of the words varied from 0 to 25 times, and participants rated their preferences for the words using a seven points scale ranging from 6 (*good*) to 0 (*bad*). Results indicated a positive correlation between the number of exposures and preference. Similar effects have been reported not only for Turkish words, but also for Chinese characters, faces, names, pictures, sounds, paintings and so on (Bornstein 1989).

The mere exposure effect has also been observed for product preferences (Janiszewski 1993; Obermiller 1985; Bornstein 1989). For example, it has been demonstrated that the repeated presentation of a product logo can shape preferences to that product. Moreover, people that do not recognize this effect, attribute their product choice to other factors, regardless that the preference was induced by repeated presentation of the logo. Yamada and Toyama (2010) demonstrated that people develop strong preference for a product when they use reasons to justify their preferences. They prepared laundry detergents with a product logo and a product effects message. At first, they repeatedly presented two detergents to participants for differing numbers of times: the high and low exposures detergents. Then, participants were asked to select the detergent that they were most likely to purchase. There were two conditions, one in which the detergent had only a logo and one in which it had a logo and a message. Finally, participants were asked for the reason for their choices. The results indicated that the high exposure detergent was better preferred by participants than the low exposure detergent. This finding confirmed the mere exposure effect. Furthermore, the effect was more salient when the detergent had a product effects message. Moreover, the participants did not necessarily realize the effects of exposure frequency, and they responded that they chose the product based on the content of the message.

4.2.2 Effects of Product Naming

There is a proverb, “names and natures do often agree”, meaning, “names of things and people often accurately depict their characteristics”. From the perspective of cognitive science and cognitive psychology, this proverb reflects the effects of naming on behavior and thinking. There are many examples in the field of marketing; the Japanese clothing company, Renown Inc. changed the name of their men’s antibacterial deodorant socks from “fresh life” to “tsuukin kaisoku (meaning fresh feet for commuting in Japanese, homophone for an express train that office workers use for commuting)” and the first year sales of the product increased from about a hundred million yen to 1.3 billion yen and the second year to 4.5 billion yen. The naming of the bottle green tea by Ito En, Ltd., the Japanese beverage

company, is another example. Name of the green tea was changed from "sencha (name of one type of green tea)" to "o-i, ocha (meaning, 'hey, tea')", which yielded four billion yen in sales, six times the original. These sales figures of course include the effects of advertising in addition to the effects of the name change. Nevertheless, these cases illustrate how naming of products not only serves as a mere label of distinction, but also greatly affects unconscious thinking and behavior.

Previous studies in cognitive science and social psychology have also reported an interesting phenomenon in which names affect our thinking and behavior at an unconscious level. For example, Pelham et al. (2002) reported that many dentists' names in the U.S. start with D and lawyers names with L. Moreover, Nelson and Simmons (2007) reported that baseball players in major leagues in the U.S. whose name starts with K tend to have more strikeouts (strikeouts are recorded as K in baseball score books). Other interesting studies on the effects of names include the fact that cover letters with Caucasian names get more interviews than those with names of black people, regardless of their achievements (Bertrand and Mullainathan 2004). Moreover, the easiness of pronouncing a name affects impressions regarding people (Laham et al. 2012).

An interesting perspective of the Japanese language is that notation in Japanese can take three formats: Chinese, Katakana, and Hiragana characters. Therefore, the authors examined whether differences in Japanese notations of particular Chinese and Katakana characters affected thinking (categorization) by using city names (Honda et al. 2016). It was found that the typical bias, regional bias, was observed for the city names written in Chinese characters, indicating that regional information about cities affect categorization. Here the regional bias means the psychological tendencies that cities close in location to each other are simultaneously seen in newspaper texts and so on than those far apart in geographical distance and that people tend to group cities by region. In contrast, the regional bias was attenuated for the city names written in Katakana. Since city names are typically written in Chinese characters, it is possible that city names might reduce regional biases when written in Katakana characters.

The above discussion clarifies how naming can greatly affect our thinking and behavior at an unconscious level, and thus it is highly possible that product names also affects our purchasing behavior. We might mistakenly buy products thinking that a product is of good quality, because the naming of the product emphasizes its quality. Such behavior again points to possible misconceptions about rationales for our choices.

4.3 What Is the Voice of the Consumer?

4.3.1 Consumer Attitudes Affect Preferences

As has been discussed above, people do no necessarily recognize actual factors affecting their preferences and often misrecognize the rationale for their preferences.

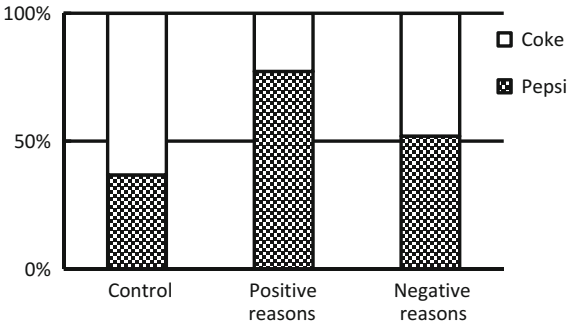

Fig. 4.1 Preference ratio for each type of cola in control, positive reason analysis, and negative reason analysis groups. This is a partially modified version of Fig. 2 in Yamada et al. (2014)

This suggest that *consumer's voice* might not be reliable. Moreover, the authors have shown that people may be dominated by their own voices or attitudes during consumption" (Yamada et al. 2014). Of particular, the effects of consciously analyzing one's preference for beverage were examined by utilizing two types of cola drinks, Coke and Pepsi. Participants were randomly divided into three groups: the positive reason group in which participants analyzed their reasons for liking a cola, the negative reason group in which participants analyzed their reasons for disliking a cola, and the control group that did not conduct any analysis. Then, all participants tried Coke and Pepsi and chose the cola that they liked the best. Results indicated that participants in the control group tended to select Coke more often than Pepsi, whereas participants in the positive reason group showed a strong preference for Pepsi. Moreover, the negative reason group did not show differences in preferences between Coke and Pepsi (Fig. 4.1). Furthermore, reasons for liking Pepsi seemed easier to describe than reasons for liking Coke, but there were no differences in reasons for disliking Coke, or Pepsi. These results indicate that outcomes can differ from intuitive evaluations when people consciously analyze their taste preferences. Moreover, easiness of describing reasons affects fluctuations in evaluations. That is, the easiness of describing evaluation criteria possibly works as a bias that distorts preferences and tastes. As discussed, previous studies have shown that consumers might have difficulties in accurately verbalizing their needs and desires, thus validating the statement made by marketing researchers described above.

4.3.2 Meaning of User Innovation

Then, is it merely a dream to develop products and services based on consumer's potential needs?

User Innovation often happens when users of services and products cause innovation to achieve their goals, instead of suppliers, research centers of enterprises, or product development teams making the innovations. Von Hippel first

pointed out this phenomenon.[2] He described that most initial developments and important changes to technically novel and commercial successful physical and chemical appliances are produced by advanced users called *lead users*. He has shown that one important source of ideas for such new industrial goods (B2B or Business-to-Business goods) might be the users, and not the suppliers. Furthermore, the authors found that user innovations could also take place for consumer goods (B2C or Business-to-Consumer goods), and that ideas for new products tended to be generated by *early adopters*, who are those users that adopt new products and services relatively early, after (but not right after) the products are put in the market (Ueda et al. 2010). Their ideas could include new or unconventional ways of using existing products, which are often beyond the imagination of suppliers. The authors have called this "*unexpected product usage*". In other words, the potential needs of users are expressed as actual actions of using products, or unexpected uses for existing products, not as written answers in questionnaire surveys. For this reason, it is difficult to examine the potential needs of consumers and users by using a questionnaire (linguistic method).

4.4 Neuromarketing

If verbalization of desires and needs of consumers is difficult, is it possible to manifest these concealed needs of consumers using brain or physiological measurements? This idea has lead to the field of neuromarketing which has currently gained much attention. Neuromarketing is a field of research that examines consumer psychology and mechanisms of purchase behaviors from the perspective of brain science, by measuring brain activities and physiological changes in consumers, and applying the findings to marketing.[3]

The study by McClure et al. (2004), which utilized the Pepsi challenge, and which is probably familiar as a TV commercial, made neuromarketing famous. The participants made a choice between Coke or Pepsi, and the study examined how label information (which is a kind of brand information) influenced their choice. Chemical ingredients of Coke and Pepsi are similar, making them optimal for examining the effects of brand information on consumer choice. When the participants were made to drink Coke or Pepsi with the labels hidden, they chose either one with equal probability with no bias in their choice. Also, no bias was seen when participants were given two cups of Pepsi, one with the Pepsi label and the other without the label, (participants did not know that both cups contained Pepsi). However, when participants were given two cups of Coke in the same situation, one cup with the Coke label on and the other without the label, (participants again did not know that the contents of the both cups were identical, Coke) they showed a

[2]See von Hippel (2006) for more details.

[3]For further readings about neuromarketing, see Ramsøy (2015).

strong bias for choosing the cup with the Coke label. Therefore, Coke and Pepsi were chosen with the same probability from the pure perspective of taste, but the Coke label had a strong influence on people's choice, demonstrating that people have a strong preference for the Coke brand.

Further, McClure et al. (2004) compared brain activities using functional magnetic resonance imaging (fMRI)[4] when the participants drank Coke and Pepsi with and without labels. In short, the results indicated that participants who preferred Coke based on the taste showed a significantly higher activity in the ventromedial prefrontal cortex, which is related to the reward prediction, when the Coke label was presented than when the Pepsi label was presented. This indicates that taste preference is related to the reward system in brain activities. Furthermore, the comparison of brain activities when participants drank Colas after providing label information and without providing label information indicated that brain activities differed between with and without providing label information for Coke but not for Pepsi. Of particular, when the participants were presented the Coke label, brain regions related to higher cognitive function and memory was activated. These results indicate that brand information is associated with memory images and higher cognitive functions affecting the reward system. Therefore, it is possible that a brand functions as a type of reward.

The above study suggested that Coke has a successful brand strategy compared to Pepsi because cultural familiarity created by advertisements affects memory and higher cognitive functions as well as essentially affects people's choices. The study by McClure et al. (2004) has gained attention as a study showing the quality of a brand strategy by using brain activities. However, the ventromedial prefrontal cortex that was focused on in their study is strongly activated not only by physical reward prediction, but also by the prediction of familiar products. Thus, higher brain activities might have been observed due to the familiarity of Coke and not because of its successful brand strategy. We do not have to again mention the mere exposure effects discussed in the Sect. 4.2.1 to infer that people tend to choose products with high familiarity, which is a well known concept in the marketing. Therefore, it is difficult to directly apply the findings of McClure et al. (2004) to practical marketing.

4.5 Meaning of Choosing a Novel Product

4.5.1 Which Is More Important: Exploitation or Exploration of Knowledge?

Although many of the products sold in the world are highly familiar to consumers, some products are unknown to consumers, for example, consumers are rather naïve

[4]fMRI is a technique to visualize the brain blood flow on the image obtained by MRI. It is frequently used to measure brain activities since it is non-invasive.

to novel products. As mentioned earlier, people tend to prefer familiar products. So, why do new products get sold even temporarily?

Buying new products can be considered as a part of the psychology of pioneering[5] and pioneering consumers might value gaining new information. In animal psychology, the idea of gaining new information is considered to be advantageous for gaining food in the future, and therefore this concept has been traditionally investigated. Of particular, making correct decisions is important when information changes quickly while looking for new food and new places to search for food. That is, *exploration* becomes important, though explorers have to use information that they already have. Thus, *exploitation* also becomes necessary. This problem is called *the dilemma of exploration and exploitation*. Studies have focused on how people solve this dilemma and when they give priority to exploration. The authors hypothesized that people who tend to buy new products have a higher tendency for exploration and conducted brain measurements as well as psychological experiments.

4.5.2 *Analyses of the Bandit Task and the Water Selection Task*

The bandit task is often used to assess whether a person is exploration dominant or exploitation dominant (Daw et al. 2006). The participants choose a slot machine under a condition in which multiple slot machines change reward rates with time. When the environment (in this case reward given by slot machines) is stable and reward by a selected slot machines were higher, a person would continue selecting the same slot machine by using that information. However, when the environment changes and there is no guarantee that the slot machine with a high reward rate would continue to be the same, then the person must also look at other slot machines, which requires exploring for information. The bandit task examines the degree of information seeking behavior, and it is expressed as parameter β.[6] Notice that smaller is β stronger would be the exploration tendency.

In our experiment, the participants at first engaged in the four-armed bandit task, and we estimated the value of parameter β. Next, participants engaged in a water selection task, in which they chose one bottle of mineral water among four bottles. The brands of water bottles ranged from familiar brands in Japan, such as Evian and Volvic, to unknown brands that are not usually seen in retail stores. The four brands of the four water bottles consisted of one to three familiar brands (or moderately familiar brands) with the rest being unknown brands. We calculated the rate of selecting unknown brands by each participant. Then, we examined correlations

[5]Other perspectives of psychology of buying new products are omitted here.

[6]It corresponds to the inverse temperature parameter in reinforcement learning. See Sutton and Barto (1998) for more details in reinforcement learning.

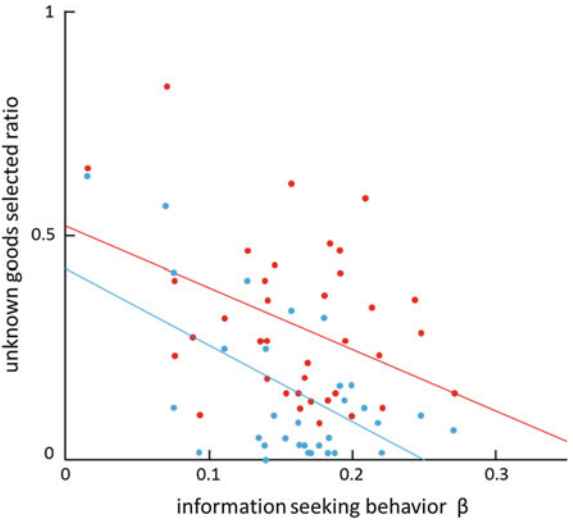

Fig. 4.2 The relationship between the ratio of selecting unknown goods and information seeking behavior (parameter β). *Red circles* denote the ratio of selecting unknown goods among well-known goods whereas *blue circles* denote the ratio of selecting unknown goods among moderately familiar goods. Both *red* and *blue lines* indicate respective regression lines

between exploration parameter β in the bandit task and the rate of selecting unknown brands in the water selection task. The correlation coefficient for the condition in which the participants chose unfamiliar bottle of water among familiar one was −0.52, and for the condition in which they chose from moderately familiar bottles was −0.39 (Fig. 4.2), which were significantly correlated. The negative correlation coefficients suggest that smaller was the exploration parameter β, higher was the exploration tendency of selecting unfamiliar products.

4.6 Conclusion

The findings presented in the Sect. 4.5 indicate that, in the daily task of choosing of products, selecting unfamiliar, new products is a choice that is made to obtain information to maximize future rewards. This finding from the perspective of psychology and brain science supports market theory suggesting that consumers who like to explore new information are open to new brands, and to new fields.

However, the study described in the Sect. 4.5 has a limitation in that participants merely selected the bottles of water; they were neither going to purchase the water with their own money nor actually drink it. The limitation is the study design that did not involve an actual purchase. Therefore, the findings presented in the Sect. 4.5 needs to be further investigated for their application to actual purchase behavior. Neuromarketing would finally become a worthwhile pursuit when we are able to identify causes of phenomenon that marketing personnel are interested in knowing, from the perspective of brain science by using the actual data on purchasing behaviors.

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Chapter 5
The Nostalgic Brain: Its Neural Basis and Positive Emotional Role in Resilience

Yoshiaki Kikuchi and Madoka Noriuchi

Abstract People sometimes experience an emotional state known as 'nostalgia', which involves experiencing predominantly positive emotions while remembering autobiographical events. Nostalgia is thought to play an important role in psychological resilience. Here, we examined the brain activity and subjective feelings associated with nostalgic experiences, using childhood-related visual stimuli. We confirmed the presence of nostalgia-related activity in both memory and reward systems, including the hippocampus (HC), substantia nigra/ventral tegmental area (SN/VTA), and ventral striatum (VS). We also found significant HC-VS co-activation, with its strength correlating with individual nostalgia tendencies. Factor analyses showed that two dimensions underlie nostalgia: emotional and personal significance and chronological remoteness, with the former correlating with caudal SN/VTA and left anterior HC activity, and the latter correlating with rostral SN/VTA activity. These findings demonstrate the cooperative activity of memory and reward systems, where each system has a specific role in the construction of the factors that underlie the experience of nostalgia. Based on these findings, we propose a "nostalgia-related network", and discuss its functions during nostalgic experiences and its effects on human resilience. Furthermore, we discuss the possibility that nostalgia is one of the defensive mechanisms which we developed "towards independence" from a caregiver in childhood. That is, we have an exquisite brain mechanism by which our own memory can stimulate our own reward system in adversity, and recalled memories can be overwritten more positively after nostalgic experiences.

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5.1 History of Nostalgia

When we encounter something, whether physically or mentally, that cues memory retrieval, we sometimes experience a distinct emotional state called "nostalgia". This term was coined by a Swiss physician, Hofer (1688/1934), as a compound of the Greek *nostos* (return) and *algos* (pain). From the outset, nostalgia was equated with homesickness and was also considered a bad omen. In the 17th and 18th centuries, speculation about nostalgia was based on observations of Swiss mercenaries in the service of European monarchs. Nostalgia was regarded as a medical disease confined to the Swiss, a view that persisted through most of the 19th century. Symptoms that included bouts of weeping, irregular heartbeat, and anorexia were attributed variously to demons inhabiting the middle brain. By the beginning of the 20th century, nostalgia was regarded as a psychiatric disorder, with symptoms including anxiety, sadness, and insomnia. By the mid-20th century, nostalgia was considered to be a subconscious desire to return to an earlier life stage, and was therefore labeled as a repressive compulsive disorder. Soon thereafter, nostalgia was downgraded to a variant of depression, marked by loss and grief, though still equated with homesickness (Sedikides et al. 2004). By the late 20th century, nostalgia was regarded as different from homesickness (Davis 1979). Whereas homesickness research focused on the psychological problems that can arise when young people transition beyond the home environment (e.g., separation anxiety), nostalgia transcends social groups and age. Nostalgia is found cross-culturally and among well-functioning adults, children, and dementia patients (Sedikides et al. 2004; Zhou et al. 2008a). Currently, nostalgia is regarded as a predominantly (but not exclusively) positive emotional experience that has been described as positive sentiment or bittersweet and wistful pleasure, an experience that accompanies autobiographical memory (AM) retrieval (Davis 1979; Wildschut et al. 2006).

5.2 Psychological Significance of Nostalgia

Nostalgia has been conceptualized variously as a negative, ambivalent, or positive emotion (Sedikides et al. 2004). Although the simultaneous expression of happiness and sadness has been shown to be more common in narratives of nostalgic events than in narratives of ordinary events, nostalgic events feature more frequent expressions of happiness than of sadness and also induce higher levels of happiness than of sadness (Sedikides et al. 2008). Many narratives contain descriptions of disappointments and losses, and some touch on such issues as separation and even the death of loved ones. Nevertheless, positive and negative elements are often juxtaposed to create redemption, a narrative pattern that progresses from a negative or undesirable state (e.g., suffering, pain, exclusion) to a positive or desirable state (e.g., acceptance, euphoria, triumph) (McAdams 2001).

The most frequently reported trigger of nostalgia is negative affect ("I think of nostalgic experiences when I am sad, as they often make me feel better").

Loneliness is the most frequently reported discrete affective state ("If I ever feel lonely or sad, I tend to think of my friends or family whom I have not seen in a long time"). Nostalgia elevates positive self-regard, increases the implicit accessibility of positive self-attributes, and attenuates self-esteem defense (Sedikides et al. 2008). Nostalgia is a social emotion; it has been said that, during nostalgic reverie, "the mind is 'peopled'" (Hertz 1990). Nostalgia strengthens social bonds (Wildschut et al. 2006) and magnifies perceptions of social support, thus counteracting the effect of loneliness.

It is even possible that nostalgia imbues life with meaning, which facilitates coping with existential threat. One of the primary human challenges is carving out a meaningful existence. Yet awareness of inevitable mortality presents a major obstacle on the path to psychological equanimity. According to terror management theory, one can mitigate existential anxiety through shared beliefs about the nature of reality that imbue life with meaning (Sedikides et al. 2008). Nostalgia may thus contribute an overall sense of enduring meaning to one's life.

5.3 Neural Basis of Nostalgia

What are the neural mechanisms underlying nostalgia, which exerts such palliative benefits? Few neuroimaging studies have attempted to answer this question. A functional magnetic resonance imaging (fMRI) study of the neural substrates of listening to music that evoked high valence/low arousal emotions, such as peacefulness and nostalgia, revealed that experiencing such emotions activates various brain regions, including the HC, parahippocampus (pHC) and VS (Trost et al. 2012). In addition, a positron emission tomography study that examined odor-evoked AMs accompanied by a sense of nostalgia showed that such AMs involve activation of the precuneus and medial orbitofrontal cortex (Matsunaga et al. 2013). Although both studies showed activation of memory and reward systems during nostalgia experiences, it remains unclear how memory-reward relationships are actually correlated with the subjective experience of nostalgia, what neural mechanisms underlie it, and what its significance is.

We conducted an fMRI study using visual stimuli related to childhood that were highly likely to evoke nostalgic feelings but were not inherently rewarding (e.g., food, money and sexual stimuli) (Oba et al. 2015). Participants were 14 healthy female undergraduates (22.1 $\pm$ 0.6 years of age). We assumed that nostalgia would be induced by triggers common to a relatively homogeneous subset of individuals within the same culture, age and sex groupings. Because most Japanese people experience similar events during six years of compulsory elementary school education, memories of these times should contain common features. All such individuals spend large amounts of time among friends of the same age in a school building with a typical appearance and use certain types of school stationery, typically depicting animated characters. Almost all of these experiences are limited to elementary school and are not encountered after graduation. We therefore created

visual stimuli for the fMRI task that depicted objects and scenes that were emotionally neutral by their nature but would be expected to induce nostalgic experiences associated with the participants' childhood (nostalgic pictures); control stimuli comprised similar pictures that should not induce nostalgia.

5.3.1 Psychological Aspects of Nostalgic Experiences

After the fMRI scan, participants were asked to view all of the pictures on a computer screen and to retrospectively evaluate their experiences during scanning. These evaluations included: (i) two items pertaining to the object or scene depicted in each stimulus ('recognizability' and 'familiarity'), (ii) four items assessing the emotional experience that occurred when participants saw each picture ('nostalgia', 'happiness', 'attachment' and 'sentimentality'), and (iii) four items assessing AMs retrieved in the scanner ('personal significance', 'vividness', 'age of memories' and 'age of last recall'). We conducted a multiple regression analysis with subjective nostalgia intensity as the dependent variable and the nine items as independent variables, using forward stepwise selection. We then selected significant explanatory variables and performed an exploratory factor analysis to convert these variables into uncorrelated factors and to extract interpretable subsets constituting the nostalgia construct. We also calculated a mean nostalgia score across all stimuli for each participant, and we deemed this value to represent an individual's 'nostalgia tendency', reflecting the general tendency to experience subjective feelings of nostalgia.

Participants rated the nostalgic pictures significantly higher than the control pictures, confirming that genuine nostalgic experiences were evoked in the scanner although participants received no explicit instructions. We also confirmed that nostalgic pictures reminded participants of their remote past. Participants viewing the nostalgic pictures recalled events they experienced around 12 years ago (when they were in elementary school), while they reported that the control pictures were associated with reminiscences of an average of 5 years ago (around when they were in high school). A multiple regression analysis showed that age of memories, happiness, attachment, sentimentality, personal significance and age of last recall were significant predictors of nostalgia, whereas recognizability, vividness and familiarity were not. A subsequent exploratory factor analysis including the six significant predictors of nostalgia scores revealed that these predictors converged on two factors. The first factor contained the four items of attachment, happiness, personal significance and sentimentality, and was termed 'emotional and personal significance'. The second factor contained age of memories and age of last recall, and was termed 'chronological remoteness'. This result is consistent with the notion that nostalgia is predicted by mixed, but predominantly positive, emotions, and is associated with 'getting back to old times' (Davis 1979; Wildschut et al. 2006; Barrett 2006).

5.3.2 *Neural Activities Associated with Nostalgic Experiences*

During the fMRI experiment, nostalgic and control pictures were randomly presented for 8 s each. All pictures were presented only once each and were interleaved with 8 s fixation crosses. Participants were not explicitly informed that they would be shown pictures specifically designed to arouse nostalgia, but were only instructed to view the pictures attentively.

Nostalgic pictures, but not control pictures, evoked significant activation of HC and reward-related areas (VS and SN/VTA), indicating that nostalgic experiences involve both reward and memory systems. Moreover, right VS activity was significantly correlated with bilateral anterior HC activity, and left VS activity was significantly correlated with left pHC activity, showing that there are significant correlations between the HC and VS during nostalgic experiences. Furthermore, left anterior HC-right VS co-activation scores were correlated with nostalgia tendency (Fig. 5.1), indicating that HC-VS co-activation makes an important contribution to the experience of nostalgia. In addition, emotional and personal significance scores were correlated with caudal SN/VTA and left anterior HC activity (Fig. 5.1). On the other hand, chronological remoteness scores were correlated with rostral SN/VTA

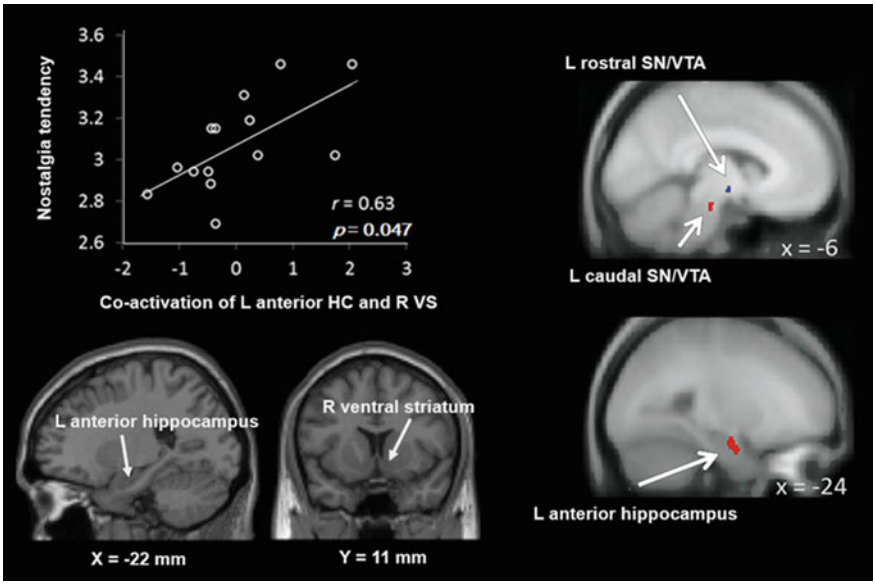

Fig. 5.1 Left anterior HC-right VS co-activation scores were correlated with nostalgia tendency (*left*). Emotional and personal significance scores were correlated with caudal SN/VTA and left anterior HC activity (*red*), while chronological remoteness scores were correlated with rostral SN/VTA (*blue*) (*right*)

(Fig. 5.1). Thus, different aspects of nostalgia are underpinned by a fine, differential spatial pattern of neural activation within the memory- and reward-related brain regions.

5.4 Memory Processing in Hippocampus

Given that the HC plays a crucial role in AM retrieval (Fink et al. 1996; Ryan et al. 2001; Maguire and Frith 2003; Markowitsch et al. 2003; Addis et al. 2004; Cabeza et al. 2004; Gilboa et al. 2004; Piolino et al. 2004; Viard et al. 2007), the HC activity we observed suggests that observing nostalgic events requires more AM retrieval than does observing non-nostalgic events. Such HC activity without intentional retrieval demand implies that involuntary AM retrieval (Berntsen and Hall 2004) is involved in nostalgic experiences. Furthermore, our behavioral results are compatible with anterior HC activation. The anterior HC has been found to play a role in the pattern completion of gist-like representations (Nadel et al. 2013; Poppenk et al. 2013), and most of the objects and scenes depicted in our nostalgic stimuli had been long forgotten and stored in long-term memory, such that associated details were relatively degraded. The CA3 region of the hippocampus is believed to act as an auto-association memory which enables episodic memories to be formed and stored in the CA3 network (Fig. 5.2). Extensive, recurrent connectivity of collaterals allows for the retrieval of a whole representation to be initiated by the activation of some small part of the same representation (the recall cue) (Fig. 5.2). In fact, vividness scores did not predict nostalgia intensity. This is probably because we used generic (rather than specific) visual stimuli to trigger nostalgic experiences and did not explicitly ask participants to recall specific AMs from elementary school. Accordingly, nostalgic experiences may be triggered by retrieval of gist-like AM representations, which are modeled at an early stage of the AM reconstructive process (Conway and Pleydell-Pearce 2000), before vivid and specific AM remembering occurs.

5.5 Schematic Neural Model of Nostalgia

Based on these findings, we propose here a schematic model of the neural process of nostalgia (Fig. 5.2). This model is fundamentally based on the "hippocampal-VTA loop" (Lisman and Grace 2005). After information which contains some cues for inducing nostalgia is input to the brain through the sensory organs, it is automatically processed from the primary cortical area to the higher ones. These processed results are also input to the dentate gyrus through layer 2 of the entorhinal cortex. This sensory cue triggers a process within the dentate gyrus and CA3 that predicts the events to be retrieved from stored memory (Lisman 1999). These predictions are then sent to CA1 via Schaffer collaterals. CA1 cells also receive a

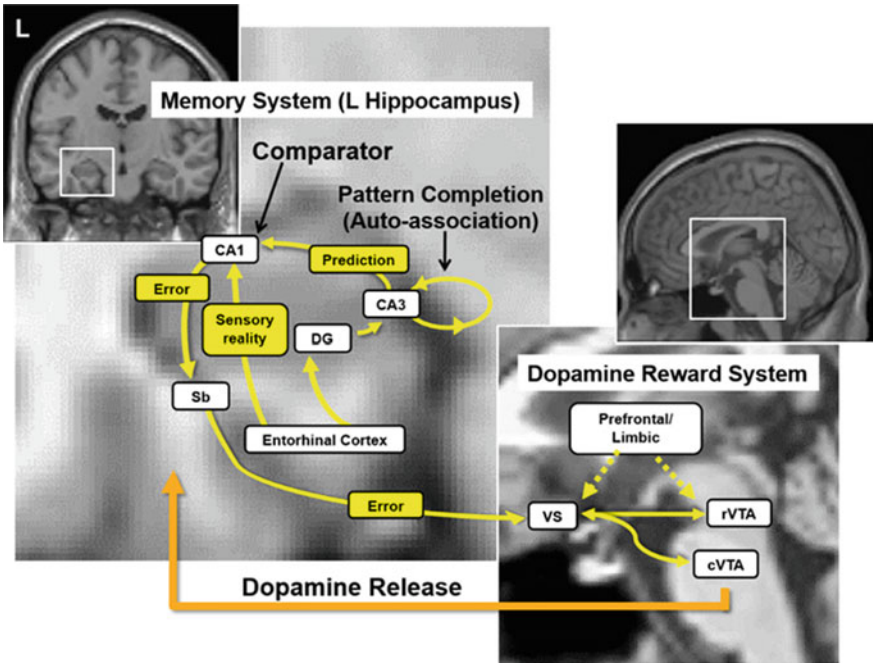

Fig. 5.2 A schematic model of the neural process of nostalgia ("Nostalgia-related network"). This model is fundamentally based on the "hippocampal-VTA loop" (Lisman and Grace 2005). Information which contains some cues for inducing nostalgia is input to the hippocampus. The CA3 retrieves originally stored information patterns by cues (pattern completion) and predicts the events to be retrieved from the memory (Lisman and Grace 2005). The CA1 acts as a comparator that computes error between the prediction and sensory reality that arrives directly from the cortex, and outputs it through subiculum to the dopamine reward system (*DG* dentate gyrus, *rVTA* rostral ventral tegmental area, *cVTA* caudal ventral tegmental area, *VS* ventral striatum, *Sb* subiculum)

second major input that comes directly from the cortex and carries sensory information (Vinogradova 1984). An attractive possibility suggested in many computational models (Hasselmo and Wyble 1997) is that novelty is computed in CA1 through a process that compares the predictions that arrive from CA3 with the "reality" that arrives directly from the cortex. In this view, CA1 acts as a "comparator" that computes novelty. The novelty signals from the CA1 comparator pass to the nearby subiculum, then to basal forebrain structures, and from there to the midbrain dopamine cells of the VTA. The loop is completed by ascending dopamine fibers that innervate the hippocampus. This loop constructed by the hippocampus and VTA is called "the hippocampal-VTA loop" (Lisman and Grace 2005). Its primary function is known to be novelty detection, however, it is possible that this loop is also activated even if the event is not novel. Nostalgia can be easily induced by viewing or listening to something which is not perfectly new but has access to our significant AMs. This is because the gist-like AM that is unintentionally retrieved during nostalgic experiences can produce a difference between

prediction and sensory reality adequate to activate the loop. Moreover, the factor 'chronological remoteness' indicates that nostalgia is involved in a long-forgotten, remote memory. That is, the retrieval of remote memories should be experienced as novel relative to the retrieval of the more recent past. Rostral SN/VTA is involved in such ambiguous and imperfect memories that are caused, at least in part, by chronological remoteness.

In this loop, the VS is a major target of excitatory input from the subiculum, and it is required to relay information from the hippocampus to the VTA (Floresco et al. 2001). In addition, there are other important routes from prefrontal cortex and the limbic system that send information about goals and salience to the VS and VTA. These routes play a critical role in evaluation of the reward and motivational values. Accordingly, 'emotional and personal significance', which is another important factor in nostalgia, may be evaluated there. The left anterior HC also plays a specific role in the retrieval of emotionally and personally significant information. Caudal SN/VTA activity is additionally involved in this aspect of nostalgia. Furthermore, the fact that strength of individual memory-reward interrelationships was correlated with individual subjective experience of nostalgia indicates that the memory and reward systems coproduce subjective nostalgic experiences.

5.6 Nostalgia Strengthens Resilience

Our study suggests that the VTA plays a specifically critical role in nostalgic experiences, because the caudal and rostral VTA are involved in 'emotional and personal significance' and 'chronological remoteness' respectively, and both factors produce the nostalgia construct. Recent studies have shown that the VTA strengthens immunological host defense (Ben-Shaanan et al. 2016), and there is a causal relationship between the activity of VTA and the immune response to bacterial infection (Frost and Lukens 2016) in animals. Moreover, in humans, a PET study has shown that nostalgia can decrease levels of peripheral proinflammatory cytokines such as the tumor necrosis factor-α and interferon-γ (Matsunaga et al. 2013). This evidence suggests that nostalgia strengthens human immunological resilience based on the memory-reward interactions in which the VTA plays a core role.

In the ascending route from the VTA in the hippocampal-VTA loop, dopamine is released within the hippocampus, producing an enhancement of LTP (long-term potentiation) and learning. Dopamine is highly relevant for the modulation of hippocampus-dependent synaptic plasticity and memory (Jay 2003; Lisman et al. 2011). Some studies have shown that reward-triggered involvement of this loop can enhance memory consolidation (Wittmann et al. 2005). Although these studies have primarily focused on memory encoding processes, it has recently been suggested that involvement of this loop in retrieval could provide modulatory effects, such as the re-encoding of the retrieved memory in accord with its expected utility and reinforcement learning (Scimeca and Badre 2012). Based on this function of the

hippocampal-VTA loop, the nostalgia-related neural network may be involved in human resilience, as follows. Whenever nostalgia occurs, the association between the retrieved AM and its reward value as represented in the nostalgia-related network would be reinforced by dopamine transmission, such that the AM would be re-encoded and re-stored in the network. When nostalgia recurs after this association is reinforced, experiences that are more positive and rewarding than before should be induced. Such experiences may act as a means of resilience in overcoming adversity and providing support for a strong motivation to live (Routledge et al. 2008; Zhou et al. 2008b). In fact, episodic memory is conceived as a fundamentally constructive, rather than reproductive, process that is prone to various kinds of errors, illusions and distortions (Schacter and Addis 2007). However, some types of memory distortions reflect the operation of our adaptive mechanisms. The resilience mechanism associated with nostalgia may be one of the abilities by which human beings adapt to our varying environments.

Attachment theory emphasizes the fact that human infants exist for an extended period of time in a state of dependency wherein proximity to a caregiver is essential for both physical survival and the development of psychological health (Bowlby 1982). When the young child begins to separate the "me" from the "not-me" and evolves from complete dependence to a stage of relative independence, he/she uses transitional objects which are important as a defense against anxiety. Finally, the child develops a true independence of the caregiver with a separate and personal existence that Winnicott (1963/1965) called "toward independence." We consider that nostalgia is one of such defensive mechanisms "towards independence" from a caregiver. That is, we have an exquisite brain mechanism by which our own memory can stimulate our own reward system in adversity, and recalled memories can be overwritten more positively after nostalgic experiences (Noriuchi et al. 2008; Kikuchi and Noriuchi 2015, 2016; Kikuchi 2012, 2013).

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Chapter 6
Universal Design—An Old-Fashioned Paradigm?

Susan Gretchen Zöller and Sandro Wartzack

Abstract Universal Design is a strategy that intends to consider the heterogeneous needs of users in our societies. Initially appearing during the civil rights movements in the 1950s, it focused firstly on physical accessibility and equality. Nowadays, subjective values addressing social inclusion or self-actualization are becoming more and more important. Stigmatization especially plays a major role in Universal Design's acceptance, which is mainly emotion-driven. Therefore, modern Universal Design must aim for both the objective and the subjective well-being of users. In product design aspects of quality of life as a concept of successful user centring can help in considering various aspects of product quality, including subjectivity in particular. In this context an approach is provided to integrate attitudinal differences in users' perception. Its impact on the modern Universal Design strategy is further considered by introducing a hierarchical product structure.

6.1 Universal Design—A Strategy to Include All Users

Nowadays almost every seventh American is aged 65 years or above (American Fact Finder 2016). In the European Union, every fifth citizen is in the same age class (Statista 2016). It is our social responsibility to ensure the financial protection and health care of this growing part of our population, which has widely retired after having worked for decades. Besides, this demographic change demands greater sensibility regarding the technical environment in which we want to live. With the ageing of our society, which will increase further within the next years, the heterogeneity of users will rise as both demographic and individual characteristics expand. The individual abilities of users and thus their demands rely on personal

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factors but are also time-dependent. From a technological perspective, particularly older persons pose special design challenges in technical product design, as their physical and cognitive capacity can differ strongly from the standard values. In contrast, older persons can look back on a wealth of experience that sensitizes their perception in product user interaction (Kroemer 2006).

The increasing mechanisation of our living environments offers the potential to deal with this heterogeneity of needs and the expansion of demands towards technical product adaptability. Driven by the equal rights movements since the 1950s and the progressive sensitization of older or disabled people, ideas have been developed to overcome this challenge (Story et al. 1998). Thus, *Universal Design* was born, defined as "the design of products and environments to be usable to the greatest extent possible by all people, without having to be adapted or specially designed" (Catanese 2012). Whereas mainly physical barriers with regard to architectural design dominated this movement in the early days, especially assistive technology is the focus these days to address special needs and to promote social inclusion (Story et al. 1998).

Amongst other things, the high number of invalids after two world wars in the early days, the empowerment of disability rights and the progressing demographic change later on led to comparable circumstances in different Western societies. Therefore, different streams of Universal Design occurred almost in parallel. Although the facets of motivation and hence the names of these streams are slightly different, the thought of "one design for all different users" is followed by all of them. The research by Clarkson and Coleman (2015) showed the origins of the influences and ideas on Universal Design and is illustrated in Fig. 6.1.

Universal Design has long since ceased to be a pure rights movement. It has also become a matter of competitiveness in times of globalization. As illustrated in Fig. 6.1, Universal Design is not only driven by the public sector or due to the rise

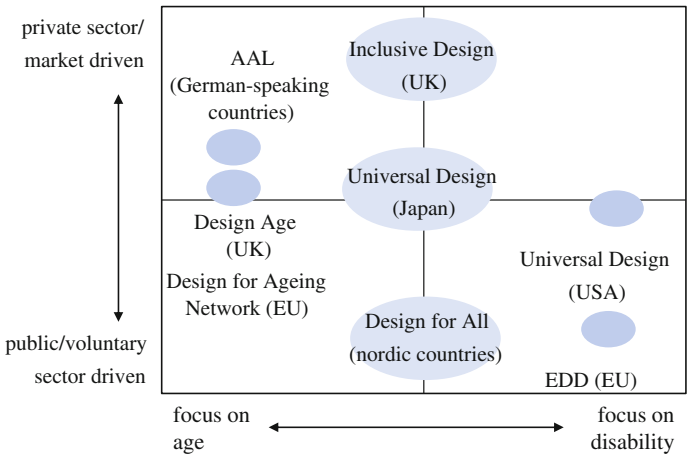

Fig. 6.1 Different streams of universal design (after Clarkson and Coleman 2015)

of social responsibility but is also a result of economic thoughts. Whereas segregated accessible features for certain users appeared to be expensive, the idea of "one design for all users" also became a reasonable market strategy (Story et al. 1998).

In the following *Universal Design* will be used compendiously as a representative term to address all these streams from an overall standpoint.

6.2 The Need for a New Understanding of Inclusion

With users' physical abilities declining over their lifetime, it is a noble idea to design products that can compensate for these functional impairments. However, functional impairments do not decline equally. While normally locomotion and bending decrease by about one-third, hearing and seeing decrease three times less (about one-tenth) (Kroemer 2006, after Nayak 1995). Besides the general phenomenon of social heterogeneity caused by demographic changes, these differences in human ability changes over time further extend users' heterogeneity.

Initially driven by rights movements to ensure physical accessibility for everybody, nowadays Universal Design is more a general question of quality of life ever after. Of course, if a person is not even able to access the functions of a product, he might not profit from its use at all.

The thought of designing products for the user himself as an individual with possibly increased physical demands to be considered also comprises an important aspect that further affects the Universal Design strategy.

> A young man will never buy an old man's car and neither will an old man buy an old man's car. (Alessandro Coda: Co-ordinator, Fiat Autonomy Project, found in Coleman 2007).

This quote highlights that quality of life is not composed merely of the fulfilment of physical or material needs. It is more a question of the user's overall satisfaction, which also includes the user's motives and feelings towards a product or environment. As illustrated in Fig. 6.2, there are also aspects of social and emotional well-being as well as the need for development and activity to ensure a good life

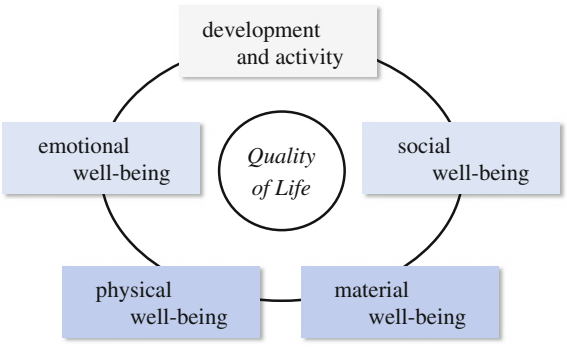

Fig. 6.2 The five domains of quality of life (Felce and Perry 1995)

from a psychological point of view (Felce and Perry 1995). Thus, the aspects of *product use* for a person originate not only from the product's ability to serve physical needs but also from its ability to address subjective values.

6.2.1 Universal Design and Quality of Life

The *added value* of quality of life experienced through a product can be understood by objective and subjective indicators. As an exemplary problem especially regarding physical ability, seeing is the main sense of perception (Dörner et al. 2013). Considering that seeing ability declines three times less than locomotion or bending, the user sees himself declining physically, whereas the perceptive faculty of himself in social environments remains almost the same. This phenomenon often leads to stigmatization that is even worse when the individual is pushed to use technical products especially designed to address his physical impairments, for example cell phones for motor-impaired people. In the worst cases, this may even lead to social isolation and thus to a massive loss in quality of life (Janny et al. 2013).

To conclude, to design products *universally* for the greatest extent of users with heterogeneous abilities, the understanding of the user himself also needs to become more holistic and *universal*. Therefore, Universal Design has to be defined with regard to other aspects of quality of life than just physical or material well-being (Kett and Wartzack 2016). In times of progressive maturation, even in technological markets for the impaired, implicit or subjective user needs become increasingly important (Steinfeld and Smith 2012). In this deeper sense, universally designed products also need to address emotional satisfaction, which can be understood as the evaluation of the product from an implicit feelings-based standpoint.

6.2.2 Designers' Challenges in Designing for Diversity

Product designers are used to translate the needs of users into both objectively and subjectively appealing designs. Moreover, they profit from a wide selection of methods and tools to consider and to address single aspects of the requirements that are imposed. However, with users becoming increasingly diverse and with the rising importance of subjective needs like emotional satisfaction, their talent is brought to its limits. As emotional evaluation is widely tacit and—as part of the product experience—highly individual, it is hard to address (Roto et al. 2011). Taking different types of physical (dis-)abilities into consideration in product design also entails the incorporation of many different types of emotional perception. Physical capabilities and their impact on product design and interaction may be objectified, for example using anthropometric, biomedical/-mechanical or

physiotherapeutic data, as exemplarily described by Steenbekkers and Van Beijsterveldt (1998) or Clarkson (2011). Therefore, physical product evaluation can also be objectified based on this information.

Indeed, differences in emotional perception are hard to manage, as it is impossible to externalize the process of subjective evaluation. Likewise, the product designer will never truly be able to understand the subjective value systems of other users than himself. The question is how products should contribute to a specific user's happiness, his *subjective well-being* (Desmet and Pohlmeyer 2013). *How can a young and fit product designer know how a disabled person experiences the world? How can he evaluate the environments' feedback when using a universally designed product?*

From an economic standpoint, Universal Design is already often experienced as being too expensive, too complex and too time-consuming (Goodman-Deane et al. 2010). Consequently, apart from the doubtlessly important need to consider subjective values like the user's emotions and feelings in the Universal Design strategy, there must also be tools and models to address subjective well-being as transparently, easily and robustly as possible to ensure its adoption into current product design processes.

6.3 Setting the Focus on Subjective Well-Being

Despite the great potential of Universal Design for products that has been proclaimed for decades, it only succeeds when it is not stigmatizing. Therefore, product design has to be seen as part of the process that the user experiences while interacting with the product. To design for diverse users, the subjectivity of product language must be understood against this background.

Considering subjective factors in product design and engineering processes is not a new concept. Mainly driven by marketing calculation, addressing the user's feelings in purchase processes is probably as old as the history of production and trade. Therefore, product design is understood as part of the product experience process. As illustrated in Fig. 6.3, many different disciplines affect the field of product experience. There, a special focus is set on cognitive psychology, the psychology of perception and the psychology of emotion, as all these three aim to gain a better understanding of the user's feelings, from its biochemical origins and physiological transformation processes in the human sensory systems and brain up to psychological descriptions of human emotions as a basis for subjective experience.

To address subjective well-being in product development processes, the generation of satisfaction through design is not a short-term event. Despite the purchasing strategy, in which spontaneous emotions are often provoked, we seek long-term values for the user in technical product development.

There are many models that categorize emotions or break them down into *basic emotions*, assuming that every other feeling or emotion occurs as a sum of these

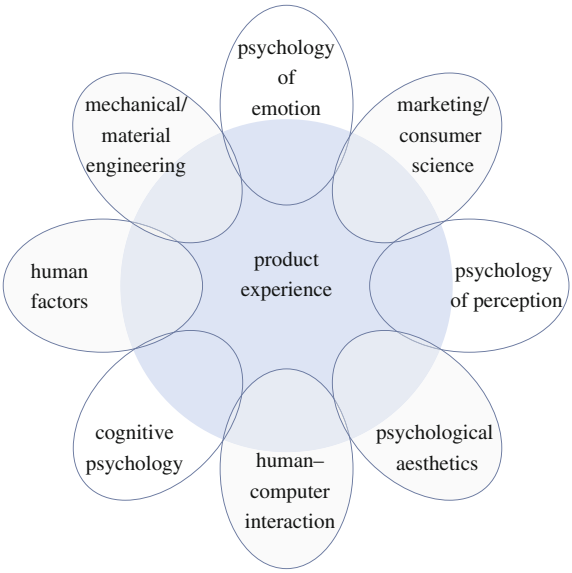

Fig. 6.3 Different disciplines influencing the investigation of product experience (Hekkert 2011)

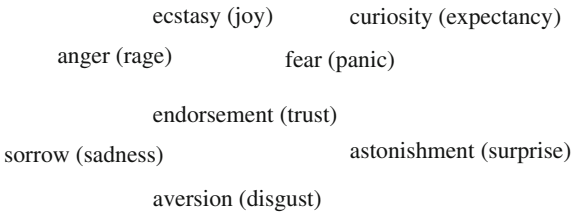

Fig. 6.4 Classes of basic emotions (non-hierarchical illustration) (after Plutchik 1980)

(e.g. Ekman 2004). One of these classifications is illustrated in Fig. 6.4, proposing eight basic emotions.

To bring emotions into the product design context, for example, 25 different positive emotions can be derived to be addressed through product design (Desmet 2012). These positive feelings are proposed to contribute immediately to a positive design that enables and stimulates human flourishing and therefore contributes to subjective well-being (Desmet and Pohlmeyer 2013). As the design for subjective well-being in all its facets is more concept-based and often represented by successful examples, it raises the question of how to introduce this understanding sustainably. In the engineering context, there is a need for a certain methodology to address the user's subjective needs after the idea generation and throughout the entire product development process. Moreover, a certain stage of externalization needs to be reached to serve Universal Design purposes, in which a variety of users with different requirements need to be included. Therefore, their subjective values have to be expressible and comparable.

The quantitative approaches to measuring emotions in the psychological context have profited from the introduction of the semantic differential technique introduced by Osgood (1952). The semantic differential technique basically consists of opposite word pairs, like "technical–natural", in which the level of agreement or disagreement and respectively the tendency towards one of these opposite expressions can be communicated using ordinal scales, for example 1 to 10. Following this quantitative approach seems promising for Universal Design purposes, as a huge number and variety of users can thus be characterized subjectively.

6.4 How to Design for Subjective Inclusion

There are different aspects that form a user's subjective evaluation system regarding product use. In general these depend on the individual's values and norms and develop over time. Consequently, the *attitude towards a product*, and therefore the long-term value of a product for the user, is composed of several experienced situations. In every single one of these situations, the short-term *use of a product* appears and is set into relation to the long-term experience set of the user (Trommsdorff 2008).

In the context of technological product development, the attitudes of users towards the product are important to achieve long-term user satisfaction. These attitudes are as various as the users themselves. Nevertheless, they consist of a few different domains that equally describe any user's evaluation system. Every domain contains several aspects that can be assessed using the semantic differential technique (Frey 1993). By looking for classification algorithms to characterize users efficiently based on these attitudinal domains, the infinite diversity of users' subjective needs may be better understood and more expressible. If this quantitative description can be used to characterize whole groups of users, there is a way to investigate levels of subjective satisfaction driven by products in the same row. Therefore, the domains of user attitudes and their different aspects represented through semantic differentials function as an impressions profile of the product. These impressions can be questioned by the users themselves and are rather consistent (Kett and Wartzack 2017). Figure 6.5 shows a scheme whereby knowledge of attitudinal differences and their impact on the subjective evaluation of a product can explain the different satisfaction levels of user groups.

With the knowledge of level shifts of subjective satisfaction with products for different user groups, product variations can now help to unveil the potential for a subjective Universal Design. A way to calibrate a product's characteristics to raise the satisfaction level generally using just one product is illustrated in Fig. 6.6. The figure shows the general preferences of user groups based on their attitudes. Knowing the specific differences in the different attitudinal domains and their relations observed through product design variations, a product design that better addresses the subjective needs of all groups, to a certain extent, can be extracted. In the example in Fig. 6.6, the two attitudinal user groups would have preferred

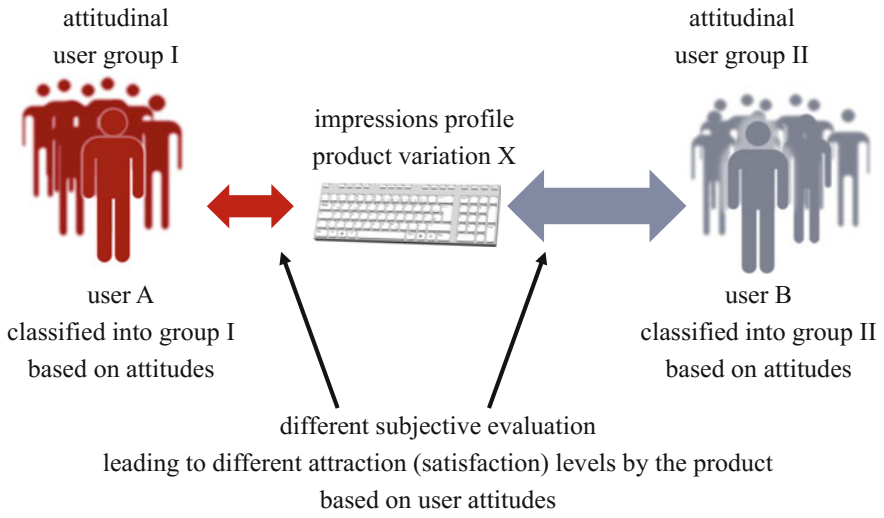

Fig. 6.5 Different user attitudes lead to different levels of subjective satisfaction with the product—user segmentation leads to a better understanding and reduction of attitudinal typologies

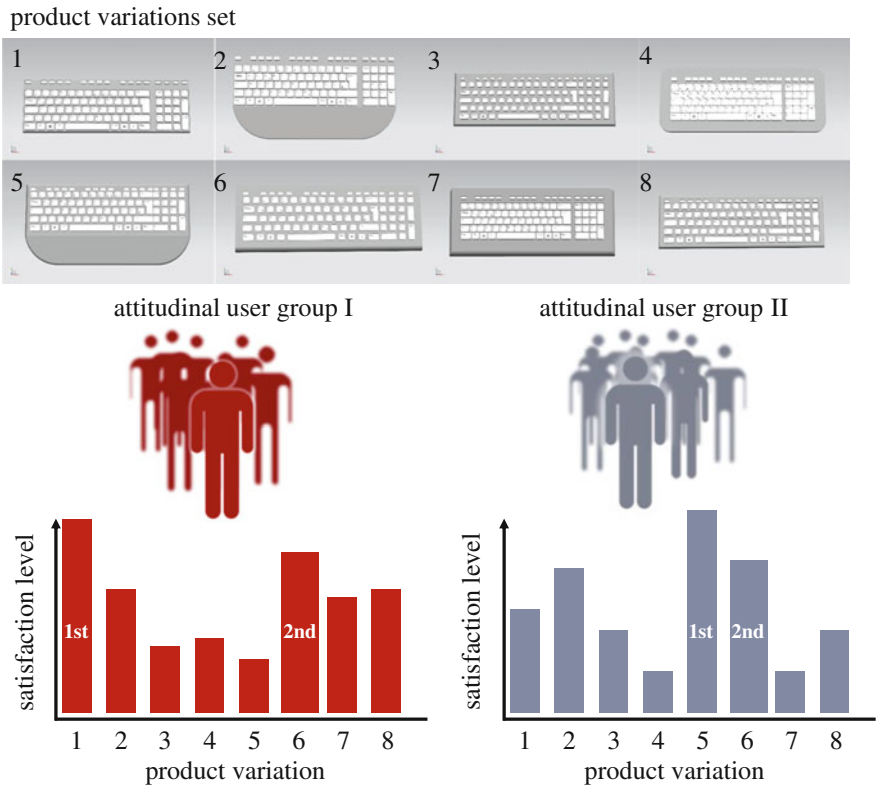

Fig. 6.6 Levels of satisfaction of attitudinal user groups regarding different product variations (based on Kett and Wartzack 2017)

different product variations based on their subjective evaluation (product variation 1 for user group I and product variation 5 for user group II). However, in the same row, and with only a slight loss of satisfaction, a third product variation can be identified that suits both subjective expectations better (product variation 6), whereas the single preferred variations would probably have been avoided by the respective other group (e.g. product variation 5 has a high satisfaction level in group II but only a low one in group I) (Kett and Wartzack 2017).

Knowing that there are different segments in subjective product evaluation amongst users but, in the same row, there are only a few of these segments into which the users may be clustered, Universal Design is also applicable subjectively. Similarly to objective aspects of product design, subjective Universal Design demands an adequate level of user satisfaction, which may be lower for a single user but effectively raises the overall quality of life for everybody.

6.5 Universal Design as an Inclusive Strategy of Objective and Subjective Well-Being—Is There Really "One Design for All"?

This chapter so far has shown the importance of subjective well-being for sustainable Universal Design. Universal is not a question of "accessibility" or "barrier-freeness" any more, but it should address all the domains of quality of life for users, however diverse they may be.

However promising it seems to be to include objective and subjective well-being in Universal Design considerations, the system of influencing factors is thereby remarkably extended. This leads to the basic assumption that Universal Design starts from a philosophical point of view. It is assumed that every user may be equally satisfied if the product that he uses is able to address his needs equally, regardless of their diversity. Even if a product was able to do so, the concept of needs would not succeed. Although the hierarchy of needs by Maslow has already become old-fashioned, it helps in understanding one of the main limits of the Universal Design strategy. After the fulfilment of basic needs, such as physiological and safety needs, the user himself seeks differentiation amongst others. To conclude, a "one for all" concept may never succeed regarding all aspects of users' needs. Arguing that, from an economical perspective, Universal Design may reduce the cost and enlarge the target group, it remains highly attractive for the product design strategy and methodological product development purposes.

Figure 6.7 expresses the different levels of perspective and provides information on how to integrate the Universal Design strategy successfully into product architecture design. In the following these hierarchical levels will be explained further.

The first and lowest level represents the *hygienic level*. Hygienic factors can be achieved for every user in the same manner. Analogous to the Kano model, these

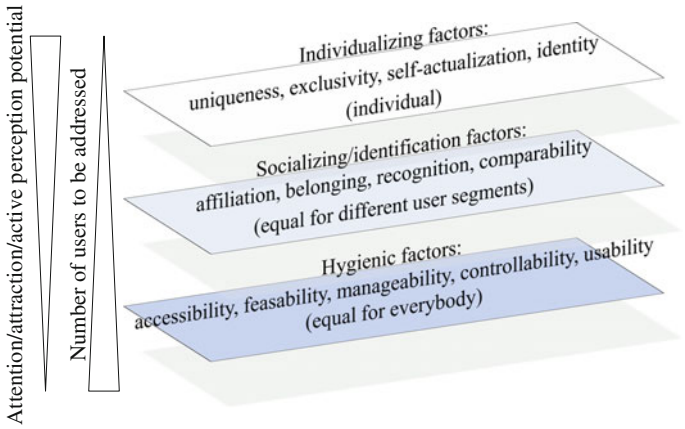

Fig. 6.7 Hierarchical structure of the product design strategy to ensure satisfactory universal design

factors—once fulfilled—are not actively noticed any more. However, if one of them is missing or insufficiently covered, it prevents any product usage and therefore the product will be refused. Accessibility or barrier-free aspects, like button sizes or display design, count among these factors. This level is mainly considered in basic platform design.

The middle and therefore second level of this model is the *affiliation level*. By looking for similarities in specific user groups, the single user always wishes to realize a certain stage of identification with social groups. It is important to *belong* to those social groups that have the same general mindset or way of life. Attitudinal considerations play an important role in this context. Therefore, countable and rather few segments can be identified here as these typologies can be efficiently segmented [e.g. using socio-cultural milieus (Sinus Sociovision GmbH 2015)]. Modularization strategies may be used efficiently to address both objective and subjective needs within the different groups and forms, for example to provide different styling lines or design packages in cars.

The highest and third level is called the *individualization level*. This level addresses the need of a person to be unique and to stand out from his own user group represented through level II. On this level countless design variations are possible, as each user need in this stage is unique, like “the fingerprint of a person”. Customized solutions with high user involvement may fit this level best, such as—to some extent—sports shoe configurators.

A sustainable technological product strategy should follow up this hierarchical model of design: modularization based on core, universally designed elements and a few variable elements based on affiliation considerations. Lastly, it should foresee customization potential.

6.6 The Future of Universal Design—From Accessibility to Social Inclusion and Self-actualization

With the rising living standards in our society and the maturation of technological markets, the focus shift explained through needs models like Maslow's (1987) hierarchy can be determined. Even in classical markets addressing physiological needs like accessibility or safety, the focus of the competitive strategy lies more and more on subjective product experience. The emancipation of the user wishing to be understood as an individual further pushes this trend.

We can observe this phenomenon especially in the medical appliances sector. Traditionally the markets were mainly B2B structured, selling products to doctors or insurance companies. Recently they started to take the end-user and his needs into account. Due to the rising global competition, companies started to sharpen and strengthen their marketing and brand images to address the user's experience-based attitude towards their products. Therefore, subjective values above pure accessibility needs are in focus. Figure 6.8 is an example of a German prosthesis manufacturer that is focusing increasingly on subjective values and therefore taking the user's experience with the product into the centre.

Users do not seek equality through and through but have strong socialization and individualization desires. The user, as part of the market system, is emancipated and allowed to strengthen his role as the one for whom products are designed. It is the challenge of the product designer to answer his needs through his work.

Therefore, Universal Design as an equal design for anybody can only succeed if it also takes aspects of subjective well-being into account. If a user feels stigmatized by a product, he will avoid using it even if it would suit his physiological needs perfectly. Considering that there is a hierarchical structure in the strategy, as shown in this Chap. 5, Universal Design as a strategy for a holistic design for everybody is as modern as ever.

Fig. 6.8 Advertisements of the prosthesis manufacturer Otto Bock directly addressing the user and the user's subjective needs in product experience: "Genium X: Exploring new horizons" (*left*) and "Special: Genium X3—Adventures in Croatia" (*right*)—screenshots (Otto Bock 2016)

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Chapter 7
Considering Users' Emotions in Product Development Processes and the Need to Design for Attitudes

Susan Gretchen Zöller and Sandro Wartzack

Abstract In recent times there has been an increasing need to consider subjective values in user-centred design for technical products. Therefore, the relations between perceived value to the user and different product design elements have been investigated in former research. Although there are many approaches that address this issue, little advice has been given so far on how to use this knowledge truly to consider the users' preference. Even if we know that a product appears to be "sporty" to the user, and even if we know how to design the product to look "sporty", we still do not know "how sporty" he might like it to be. Moreover, studies have revealed that there are huge differences in user groups that cannot easily be detected using only common segmentation criteria like age, family situation or income. Depending on their personal attitudes and values, individuals' preferences for products may differ widely despite the objective user characteristics looking similar. Therefore, an approach called the ACADE is presented, which combines interdisciplinary knowledge of users' long-term evaluation system and preference choice.

7.1 Background: User Satisfaction as the Primary Goal of Successful Product Design

Designers often have a different value perception from the users for whom they design their products. As the designers' motivation usually does not come from a specific personal problem to be solved, their performance evaluation is not limited to concrete context-based restrictions. The more diverse the functionalities of a product are and the more complex or the more accurate its appearance and functionalities are, the more valuable the product appears to be. However, in further

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maximizing technological features in both number and performance, there is a risk of forgetting for whom the product is really being designed. Indeed, a technical consumer product must not be designed for its own sake but for the prospective user. Whereas a designer may be proud to design a car that can achieve 150 mph or more, the user might only be worried about the fuel consumption.

The actual value of a product depends mainly on those who experience it. As a user's experience is the experience of an individual (Roto et al. 2011), it is always necessary to consider users' actual needs to design products successfully. Furthermore, we must not forget that users do not only value products from an objective point of view. In mature markets in which a huge variety of products is available, quality perception increasingly shifts from objective to subjective. Aspects like exclusivity or look may become decisive in questions of whether to use or not to use a product. So far there are approaches that address subjective aspects of value perception. However, an answer regarding how to apply these insights to users' actual product evaluation is still lacking.

7.2 The Black Box: Users' Perception of Product Quality

Product quality is defined as a product's fitness for purpose or the fulfilment of needs (Herrmann and Huber 2009). In product development this definition initially was function-driven or feature-based. Attempts were made to objectify the question of good quality, for example for cost–benefit analysis. However, if we take the user's perception of quality into account, the quality of a product is not only one-sided. As the user's perception of product quality is more complex, the product quality may be more likely to be the satisfaction that the user experiences regarding the product. This satisfaction does not depend only on quantifiable parameters. As an example, the value and therefore the perceived quality of a car are highly dependent on the motives and purposes of the user. If he only wants to travel from A to B on a regular basis, he may value reliability, overall costs or driving comfort. If he also intends to use the car for representative purposes, though, other attributes, like beauty or exclusivity, may arise. Therefore, we also need to take further, non-quantifiable characteristics of quality into account. The concept of quality can thus be divided into two major parts of objective and subjective factors (see Fig. 7.1).

The objective quality characteristics of a product may be measured immediately or represented by quantitative key indicators and focus on the product itself. Common approaches in the product development context (e.g. design for manufacture or sustainability) focus on objective quality characteristics, like reliability, cost or safety. Besides these more process-driven factors, there are objective factors that define the quality of a product for the user. In the last decades and with the rise of user-centred design and ergonomics, the efforts in product development are also manifested in the consideration of product usability, which can be subdivided into the matters of effectiveness and efficiency. As the product and the product development process are rather complex, the different domains indicated here cannot be

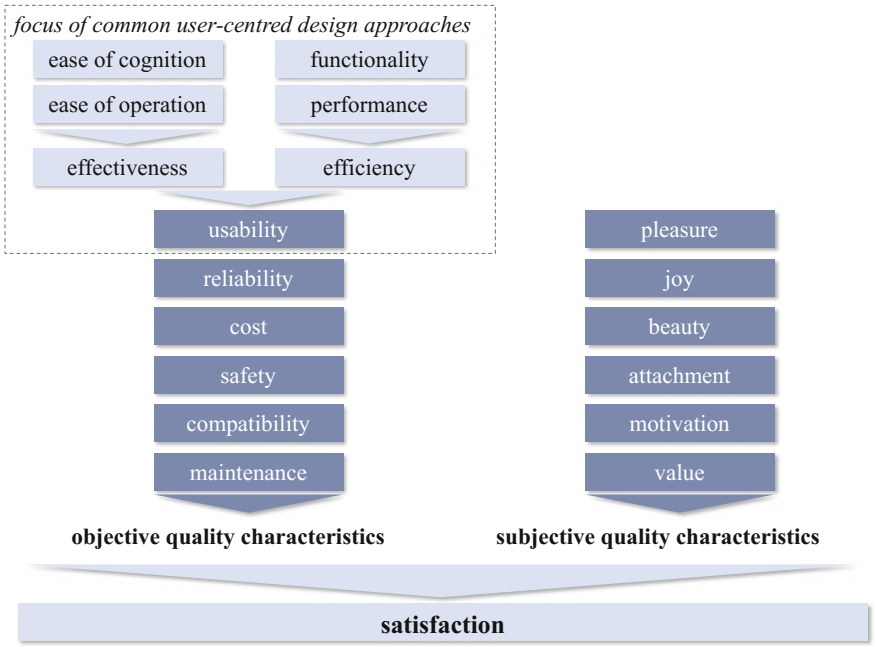


Fig. 7.1 Concept of satisfaction including aspects of product quality (based on Kurosu and Hashizume 2014)

treated separately but influence each other. Maintenance, for example, is one of these objective quality characteristics, as it can be measured immediately or represented by quantitative key indicators that are user-independent. Maintenance procedures often involve mainly manual process steps, which should be easy to carry out. Therefore, they may also be influenced greatly by the ease of use, which is another aspect of objective product quality (ease of operation).

Nevertheless, as indicated in Fig. 7.1, quality also consists of subjective characteristics, such as joy (of use) or the motivation/purpose for the use of the product. These characteristics strongly rely on the user's individual perception. Furthermore, these subjective quality characteristics are widely user emotion-based and hard to assess, as they are intangible, volatile, context-specific and individual (Roto et al. 2011). This leads to the dilemma that common approaches or description models based on quantitative and formally assessable quality parameters cannot be applied directly. As an example, "reliability" as an objective quality characteristic may be expressed consistently through failure rates or robustness. However, for "joy" as a subjective quality characteristic, even a consistent measurement basis is lacking. Moreover, they often do not include the user playing an active role in the product quality context.

Consequently, if we want to understand and to measure subjective quality to address user satisfaction with a product holistically, we have to understand the user first. Therefore, we want to investigate thoroughly the process of value creation from the product's appearance to the user's overall product evaluation.

7.3 Understanding the User to Understand Quality: The Various Facets of the Human Identity

We can describe prospective users objectively in a traditional way: by gender, age, income or family situation. We can even describe them from a physical or biomechanical viewpoint by measuring body size, weight or fitness and putting the user into societal statistics. However, if we look at the subjective characteristics of users, huge differences might appear. As an example, we might focus on healthy 45-year-old family dads with a medium income who live in small houses in the suburbs. In this apparently homogeneous group of users, we can find different typologies. One might like watching Saturday football match on the couch with his son, listening to the Rolling Stones or motorcycling. Another one—with equal characteristics from an objective point of view—might prefer to work in the garden on a Saturday afternoon, listening to classical music or going out for exclusive dinners. From a subjective point of view, there are two very different persons to be considered.

This short example illustrates the importance of an alternative user understanding in product development contexts. If we only take objective characteristics into account, we might misinterpret the users' needs and preferences for product development purposes, especially if the users benefit from a huge variety of choices. There is no doubt that objective characteristics are crucial to describe prospective users. Beyond these, there are further important factors that influence users' perceived value or quality of a product that may—in some cases—turn out to be decisive for the use or non-use of a product.

To understand users from an alternative point of view and to address the subjective factors of product quality, we have to adopt an interdisciplinary standpoint. Considering the influencing factors and inner processes of value perception and users' decision making, we mainly need to consider their psychological background. In market research basic psychological theories have found application, so the knowledge of human psychology has already been aggregated to a more related purpose to understand users' behaviour (e.g. Arnould and Thompson 2005). To illustrate the great weight of subjective factors given to user understanding in other disciplines, Fig. 7.2 shows the descriptive domains recommended in value creation for users from a marketing perspective. This figure describes the influencing factors on the user (left) in the decision-making process regarding whether to use or not to use a product. Starting from a close look at a single person's inner structure (consisting of psychological or personal factors), it enlarges to external factors, such

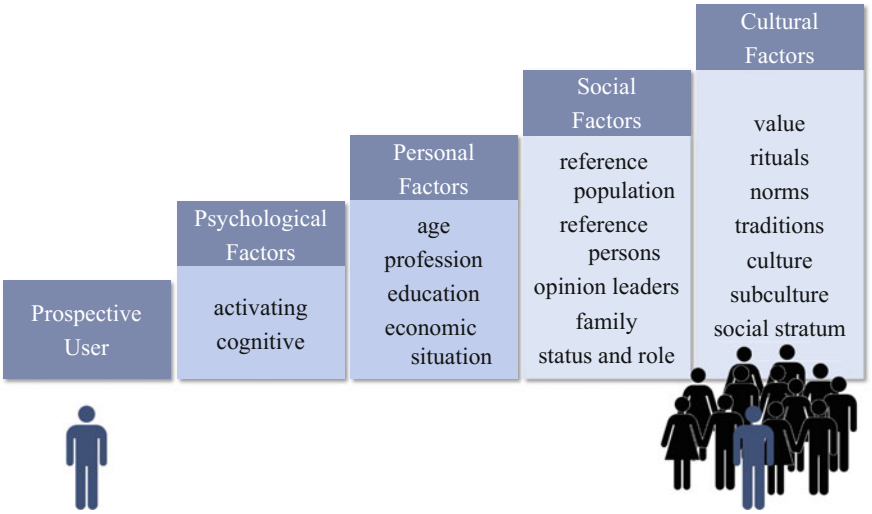


Fig. 7.2 Exemplary user description model in marketing contexts (Hofbauer and Sangl 2011)

as cultural or social ones. Although the direct product user interaction case is influenced less by the outer surrounding, it might affect a user's value perception in an indirect manner. This happens if the user is not only considering his own perception of a product but also reflecting the expectations towards the product and himself regarding other persons and parties (e.g. culture, law) (see 7.5).

So far, user-centred design has focused on personal factors, which are the users' objective factors and therefore can be assessed more easily. However, Fig. 7.2 also shows that, if we want truly to understand current or prospective users, we also have to pay attention to inner psychological processes and factors. These factors are mainly dominated by emotions. To transfer an alternative, mainly psychology-driven user understanding to product development purposes, emotional engineering was introduced into product development processes.

7.4 Quantitative Approaches in Emotional Engineering: The Case of Kansei Engineering

As quantitative numeric information and knowledge representations in product development and in particular product quality contexts are dominant, it is important to preserve this taxonomy in alternative approaches to lower adoption barriers. Therefore, we want to investigate the quantitative methodologies to include user emotion considerations that have been developed so far. Besides marketing-driven

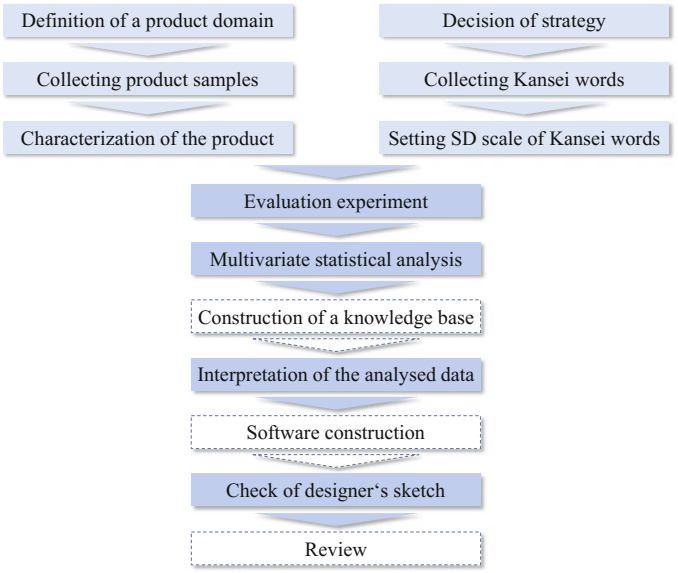


Fig. 7.3 General workflow of Kansei engineering with software implementation or automation potential (after Nagamachi 2016; Schütte 2005)

or psychophysiological approaches (Yannou et al. 2013; Nagamachi 2016), Kansei engineering is an approach to quantifying subjective terms in product perception. So far, several attempts to describe the term *Kansei* exist. It is often translated as the "sensitivity, sensibility, feeling, customers' feeling and need relating to a product" (Lévy 2013). Kansei engineering is therefore an approach to understanding better the relations between the users' subjective value perception and the product's appearance. Kansei engineering follows a general workflow, which is illustrated in Fig. 7.3. Due to its formal structure and data management, automation strategies were introduced in the early years of its development. Based on this general scheme, the literature distinguishes several subtypes of Kansei engineering (e.g. Nagamachi and Lokman 2016).

Starting with the definition of the product domain (e.g. computer keyboards) and the general strategy (the company's focus), Kansei words representing subjective value perception are collected. This can be carried out in different ways, like (group) brainstorming, survey techniques or the analysis of customer feedback (e.g. on internet platforms). At the same time, product samples are collected from the relevant product domain. As Kansei engineering is mainly focused on visual perception, these product samples are commonly prepared so that each product sample is represented by mostly equal pictures. Based on these product samples, the main characteristics and their variations in the product shape are identified and formally

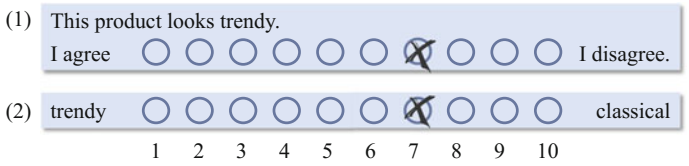


Fig. 7.4 Different types of psychological measurements for Kansei investigations: Likert scales (*1*) and semantic differentials (*2*) (Nagamachi 2016)

described in the next step. Using semantic differential scales, the Kansei words found in the collection phase are represented. This basic scaling method, mainly introduced by Osgood (1952), is initially a psychological investigation technique and quantifies a user's impression of one specific attribute (in this case the Kansei word). As the examples in Fig. 7.4 show, there are different types of questions asking about the level of agreement with a statement (1) or assessing the tendency between two opposite word pairs (2). Besides Likert scales as the first alternative, the second procedure has turned out to be more reliable, as misunderstandings of the terms are reduced in providing opposites. Keeping the example illustrated in Fig. 7.4, in the first case, trendy could also be opposite to "old-fashioned", which is slightly different from the "classic look" proposed in the second case. Thereafter, the answers resulting from this technique can be quantified and introduced into formal processing as each item on the scale may be represented through numerical values.

The next step combines the two collections of product representatives and Kansei words in semantic differentials, conducting a survey on the different product samples. The feedback from this survey can then be used to perform multivariate statistical analysis of the Kansei words' and the product characteristics' changes (e.g. Guo et al. 2014). In doing so, the importance of the different attributes can be assessed based on the changes between the different product samples and their impact on the changes in the Kansei impression. This knowledge is then used to evaluate the designer's sketch of a new product.

This formal workflow may also be supported by introducing a Kansei engineering system (Fig. 7.3, in dashed lines). Therefore, a knowledge base and software architecture can be introduced to manage and automatize the data generation.

Although Kansei engineering considers many important aspects and offers considerable potential for emotional integration, some points need special attention. The fact that the database is mainly project-specific and measures only instant impressions causes the main points of criticism of the Kansei engineering methodology (Bongard-Blanchy et al. 2013). Therefore, sustainable long-term user satisfaction may not be achieved by applying Kansei engineering. Due to its retro-perspective nature, the variation of product characteristics is rather random and hard to comprehend. It also offers no robust evaluation or optimization base for new product development, as it is only based on existing products and is non-transferrable.

7.5 Considering Design Optimization for Subjective Quality in the Product Development Context: How Much Is Enough?

If it is not sufficient to investigate only the relation between product characteristics' changes and their impact on users' value perception, we have to understand how subjective value is created from a psychological point of view. One step back is needed to take a closer look at the human value perception and decision-making process. Therefore, the different terms to assess/describe thoroughly the relevant elements and processes in this context are introduced first. Figure 7.5 illustrates the elementary relation set of a user and a product.

The user's perception of a product firstly relies on his capability to recognize the product with his sensory systems (vision, hearing, smell, touch, etc.) (1). Depending on the amount of information gathered (and therefore depending on the bio-/physiological abilities of the user), a certain impression of the product can be derived (2). As described earlier, these impressions are very important for Kansei investigations. As an inner process, these impressions are translated into the user's spontaneous feelings or emotions towards or against the product (3). Based on these emotions, and taking prior experience into account (both product-related and generally), the user evaluates the situation reflecting his own, inner value systems (4). This product evaluation has a rather long-term character.

Figure 7.5 illustrates the complexity and sensitivity of the user's value perception process for products. Moreover, it unveils the potential for further investigations. Whereas approaches like Kansei engineering focus on product impressions and users' emotions, one step beyond has to be taken really to understand the user preferences between one product variant and another. This is the product evaluation phase as the basis of user behaviour.

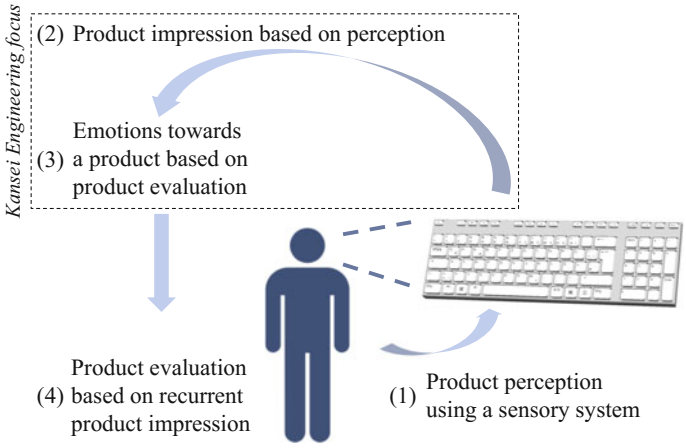


Fig. 7.5 User product perception cycle

7.5.1 Background Processes of Emotions: From Central Nervous Activation Patterns to General User Attitudes

In fields like advertising, in which impulse buying is provoked, efforts are made to address the short-term, spontaneously appearing emotions of the prospective user. This is sufficient if user satisfaction just exists as long as the purchase process lasts. For technological product development purposes, on the other hand, in which long-term user satisfaction is fostered to ensure sustainable product success, this strategy is not sufficient. Thus, we have to think one step ahead and shed light on the user's more long-term-focused evaluation stage and the processes therein.

In this context the general architecture of feelings is investigated from a psychological point of view. Therefore, a process scheme is illustrated in Fig. 7.6. As described earlier, any perception process needs to be initiated by the detection of external activities by our sensory system. In the current case, the relevant activities are those caused by the product. These external activities are recorded by central nervous activation patterns. If a cognitive interpretation, in other words process chains in the brain, follows these patterns, emotion is generated. This rather spontaneous and situation-based process may be underplayed by a certain target orientation, which is quite normal in product evaluation processes (e.g. "I want to communicate with my computer; therefore, I need some kind of input device"). This target orientation produces a certain motivation (towards a product). Subsuming several motivation stages and producing a subject evaluation lead to a more general status, which is called the attitude of the user. Attitudes are formed during a long time span and are therefore less volatile and more context-free. Those attitudes are linked to the user and propose a good starting point for subjective user characterization.

7.5.2 Finding the Link: Attitudes and Use in Product Evaluation Contexts

Regarding the initial aim of long-term user satisfaction and to consider general user evaluation criteria in technical product development, it is highly important not only

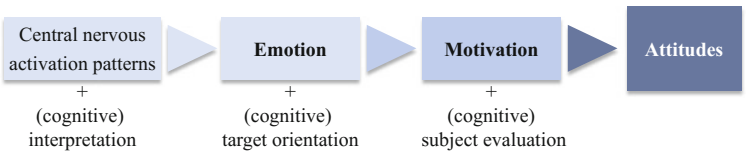
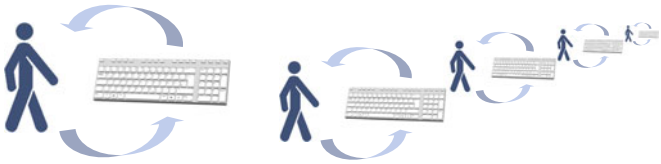


Fig. 7.6 Fostering a long-term focus: from emotions to attitudes (after Kroeber-Riel et al. 2009)



USE OF A PRODUCT
based on single perception case
rationalistic–normative
situation-based
short-term

ATTITUDE TOWARDS A PRODUCT
based on iterations of perception cases
psychological subjective–descriptive
experience-based
long-term

Fig. 7.7 Different viewpoints to define the user product evaluation process (Trommsdorff 2008)

to focus on spontaneously appearing emotions but rather to link those emotions to a long-term context, the attitudes of users.

It seems promising to focus on attitudes for long-term, sustainable user satisfaction. However, it is not clear yet how to link these attitudes to a user's value perception of the product, as they are even harder to assess. Thus, before trying to introduce user consideration from an attitudinal point of view, the theory of attitudes needs to be linked to the product development context.

Looking at the product development vocabulary regarding user-centred design, the (subjective) value of a product is understood as the *use* of a product (see Fig. 7.7, left). In the marketing vocabulary the *use of a product* is defined as the perception of satisfaction or attainment through an object (product). This condition can be characterized as rationalistic–normative. The *use of a product* has therefore found application in product development contexts. Subsuming several situations in which *use* perception cases take place, the consequence results in a solid status (see Fig. 7.7, right). A rather long-term view of value perception by the user is thus characterized. This status may only be changed over long time spans. This phenomenon is defined as a status of willingness to like or to dislike a product resulting from overall judgements of several relevant product characteristics (dimensions or attributes). It is a lasting status produced by *use perception* processes based on the user's experience. This psychological–subjective–descriptive phenomenon is called *attitude* (towards a product). Even though we see that attitudes might originate from the psychological processing inside the human, they are very closely linked to our understanding of *use* in product development contexts. In contrast to the use of a product, the attitude towards a product is more long term and can be characterized as psychological–subjective (instead of rationalistic–normative). Regarding the definition of quality, *use* describes the objective aspects of users' perceived quality whereas *attitude* defines the subjective aspects of it. To conclude, the concept of attitude is suitable for product development purposes in this field.

7.6 From Users' Attitudes to Product Characteristics: The ACADE Approach

So far we have highlighted that the quality of a product has both objective and subjective aspects. It has also been shown that there are quantitative approaches, like Kansei engineering, that are able to link the occurrence of users' specific emotions to product characteristics in an adequate manner for product development purposes. However, the link of these insights to capture users' preferences and evaluation schemes regarding these specific emotions is not clear yet ("How much sportiness does User X really want?"). Furthermore, it is also not known how to integrate the differences of each user into product evaluation, as this is always an individual process of each single user (Roto et al. 2011). Consequently, an efficient management and segmentation strategy is needed. We concluded that there is no optimization strategy based on users' implicit and subjective needs so far. It was also stated that, aside from this lacking optimization approach, a more long-term focus is needed to develop technical products for lasting user satisfaction. Therefore, the psychological concept of attitudes was introduced, as it seems to be promising for technical product development purposes. Although this concept appears to be very suitable for sustainable subjective value creation, there is still no link between psychological knowledge and product development applicability. For this, quantitative description forms are needed.

To overcome this problem, another look at alternative models of user characterization has to be taken. Approaches already exist to segment markets efficiently based on subjective user characteristics (typologies). Each typological segment is associated with a certain profile, consisting of different psychological dimensions. These dimensions, like value, time, aesthetics or belief, compose the attitude of a person. As illustrated in Fig. 7.8, these dimensions can be further divided into single attributes, like exclusivity (referring to value) or elegance (referring to

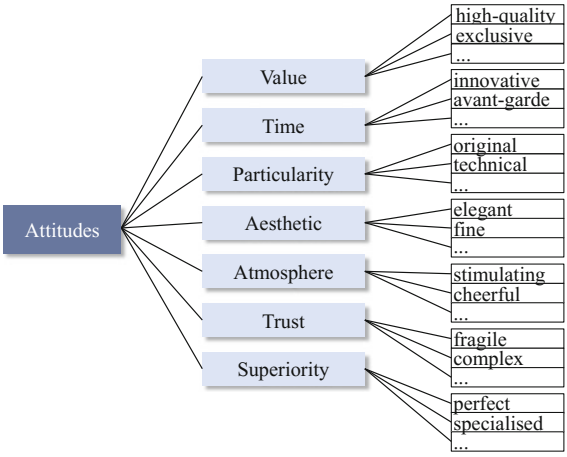


Fig. 7.8 Architecture of an attitude profile (Frey 1993)

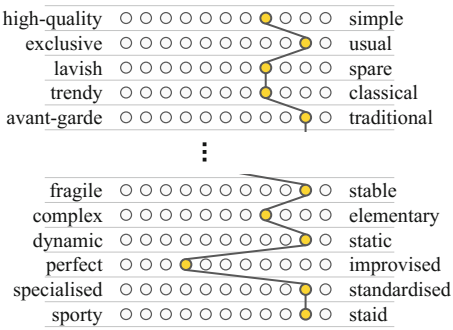


Fig. 7.9 Example of a user profile based on attitudinal dimensions (after Frey 1993)

aesthetics). In addition to the approach to describe simply the general attitude of a person by his individual attitudes, it is possible to group the attitudes into a few meaningful clusters (Frey 1993).

As mentioned earlier, a formal, quantitative representation of attitude is needed. The presented user model based on attitudinal consideration therefore has high potential for integration into product development processes. As the attitudinal profiles consist of a set of several attributes, the semantic differential technique can be applied to them. As in Kansei engineering, the opposite word pairs of the single values are specified, adding interval scales that can be formalized numerically. Through this the so-called impression differential consisting of 30 semantic differentials that represent the attitude profiles of users (see Fig. 7.9) can be found. These profiles may also be linked to product use purposes so that the model of attitude profiling can be applied to user characterisation in technical product development contexts (Frey 1993).

Furthermore, this profiling method can be applied not only to user segmentation but also to the subjective characterisation of products. In the following the ACADE will be introduced, the **A**pplication for **C**omputer-**A**ided **D**esign of **E**motional Impressions.

The ACADE is designed to support subjective quality creation based on users' individual attitudes. In doing so, sustainable long-term user satisfaction and viable characteristic optimization considering user preferences are ensured. The system not only gathers and links relevant product characteristics and user impressions but also enables the consideration of attitudinal differences and therefore differences in the value systems of the relevant user group. In the following the general workflow and the basic elements of the ACADE are introduced before an application example to highlight the most important findings that can be elicited is presented.

7.6.1 The ACADE Workflow

As the ACADE supports design for subjective quality, its workflow consists of three major steps. These three steps are illustrated in Fig. 7.10 and will now be

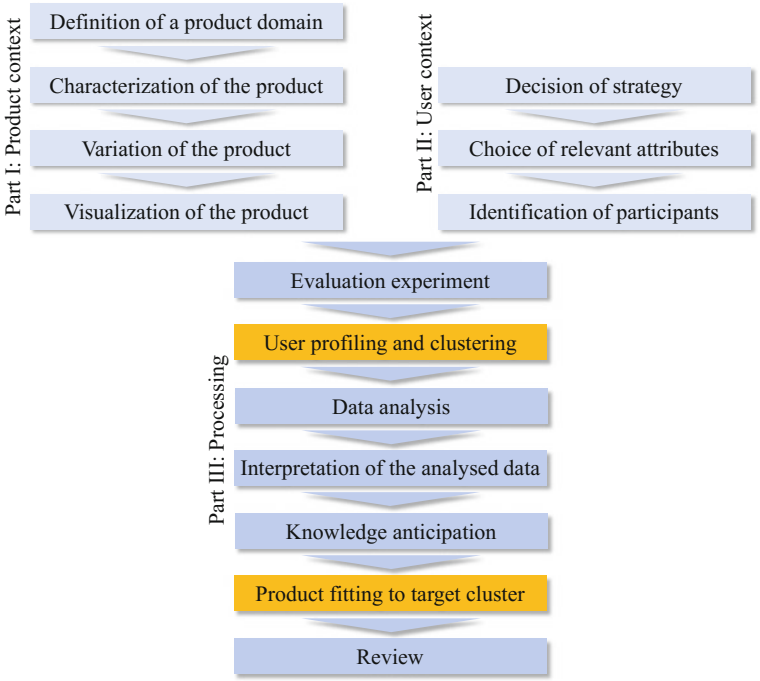


Fig. 7.10 The ACADE workflow

described briefly. Detailed information will be given in the following sequences. Firstly the product and the user context in which the ACADE should provide support are prepared. In the product context, techniques of the product development methodology are used to create adequate product variations sets. In the user context, psychological and marketing knowledge is applied to frame the content of the study. The third part (processing) finally links the two domains in an interdisciplinary integration to gain insights into users' subjective value perception and their individual preference system.

7.6.1.1 Part I: Product Context

Similar to Kansei engineering, the first step in the ACADE workflow (Fig. 7.10) is to define the product domain that is being investigated. Here, the product can be characterized based on, for example, prior product or market studies. If the product domain is clarified, the basic design elements of the product can be identified to process a context-free product characterization. This includes a formal hierarchical description of the product and includes *characteristics* and *properties*. This implies that product characteristics are values or measures that can be assessed and quantified directly (e.g. lengths, radii, colours). The properties of a product are the higher

aggregation of characteristics that cannot be assessed directly but are composed of the specific combination of several certain characteristics. As an example, the roundness of a keyboard is not directly assessable. As a function of several properties, such as radii, angles or proportions, though, it can be influenced indirectly (Weber 2005). To determine the weights of each characteristic in a property function and to extract the principal characteristics to define the shape of a product, principal component analysis may be applied (e.g. Orsborn et al. 2009).

With this formal description, product variations (based on properties and characteristics) can now be applied and visualized, for example by using parametric CAD models. This leads to specific, fully assessable and manageable but also context-free representations, as there are no brands or contexts disturbing the appearance. Moreover, all the product variations are visualized from the same perspective, so a reliable comparison is ensured. Depending on the product domain, several perspectives may be captured.

This step is very important for the upcoming process, as it ensures the context-free and independent definition of the product to be investigated. In particular the elimination of branding and the extraction of special usage situations or environments in combination with a careful variation of product characteristics avoid disturbances on one hand but also open up the solution space for original, newly composed product variations that are not yet existent in the markets. Moreover, due to the stepwise coordinated variation of product characteristics, linear functional dependencies can be investigated later to obtain well-founded information on product characteristics' and user preferences' interdependencies.

7.6.1.2 Part II: User Context

To prepare the user context, the company's strategy has to be clarified first. Two general strategies can be suggested. One strategy could be to define the target user group to be investigated using marketing-based market knowledge. Depending on the overall goal, there might be reasons to focus on the existing customers or to assume the target group to be completely random. Alternatively, in another strategy it could be best if the target group is not supposed to be defined in advance. This can happen if there is no general knowledge of the users so far or in the case of new product development.

To prepare for the evaluation process, the relevant attributes to be investigated need to be defined. Therefore, the user attitude profile is used as a basis. Since the user attitudes should be gathered fully by the survey, it is sufficient only to choose the most influencing attributes of the profile for the product variations' impression profile. To achieve a match making of the users' preferences and to define the design strategy, it is important to include at least one-quarter of the items in the impression profile. Thus, the user attitudes and the product impression profiles are created. Further attributes that are not part of the initial impression profile may be included additionally. It is important not to incorporate too many attributes into the product impression profile to avoid participants becoming fatigued in the evaluation process.

Based on the strategy, the participants in the evaluation experiment need to be identified. These participants may belong to the company's established customer base but can also be recruited from pre-identified milieus or chosen completely randomly to obtain either specific or cross-sectional data.

7.6.1.3 Part III: Processing

With the visual representation of the product variations and the definition of the product impression profiles to be investigated, a survey can be prepared and carried out. The survey's structure is shown in Fig. 7.11.

The survey mainly consists of three parts, focusing on the user's attitude (I), his impressions of the product variations (II) and his individual preferences regarding these variations (III). Additional user-related data (e.g. age, profession, etc.) may be collected in part I to gain further insights into the composition structure of the investigation group. Part III also includes a preference query whereby the user is

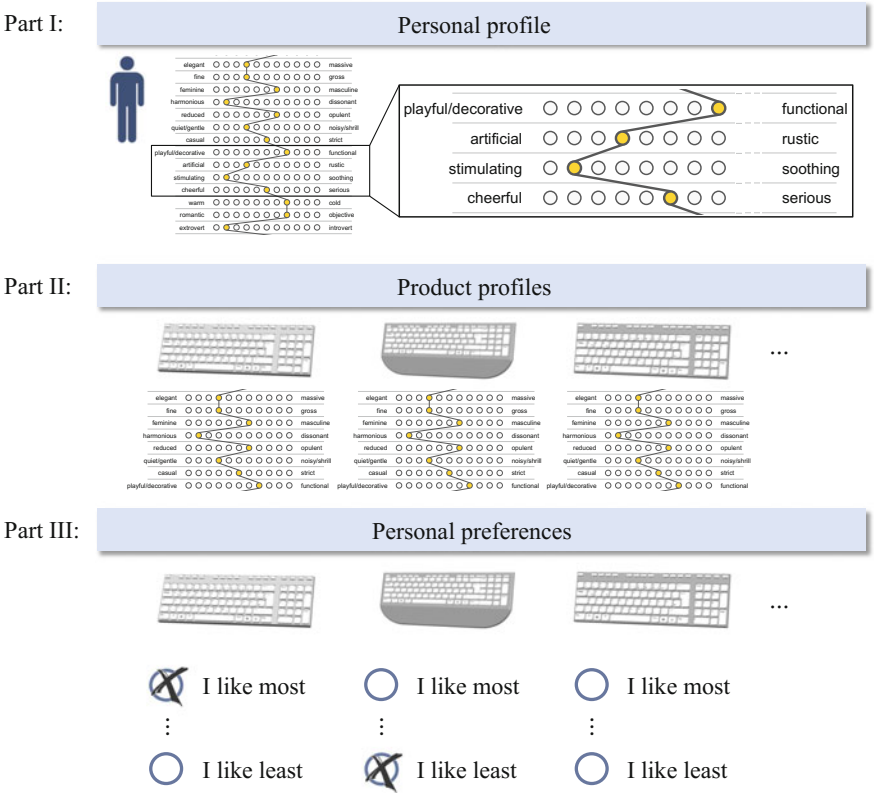


Fig. 7.11 The ACADE survey structure

immediately asked for his overall judgements of the product variations and will become important in the data analysis stage. With this created survey, the chosen participants can now be questioned. It is possible to conduct the survey iteratively and in a paper-based form as well as online. The output of this evaluation experiment is a database consisting of the numerical representation of the users' attitudes, their impression profiles and their general preferences regarding the predefined product variations. These variations have already been described numerically in the preparation stage.

Before analysing the data obtained from the survey, user profiling and clustering are necessary to understand the current user set. For this purpose a mathematical approach was proposed by Kett and Wartzack (2017). This approach segments the target group into respective attitude typologies by similarity observations. The actual users' profiles may be clustered within the current user group as well as in the general attitudes context. This first assessment creates knowledge of the current observation group from a subjective perspective and is very important for subsequent analyses and interpretation. Furthermore, the clustering outcome can be evaluated in the context of the overall strategy, which has been defined in part II of the survey. If there was no predefined specific target group, the company may already understand better the kind of attitude that their current or prospective users have. In the following section, the subsequent data analysis of the ACADE will be explained by presenting an excerpt from the ACADE architecture.

7.6.2 The ACADE Process Chain

In the subsequent data analysis, there are several fields and relations to be investigated. Therefore, an excerpt from the general architecture and interdependencies of the ACADE is illustrated in Fig. 7.12 and will be explained step by step.

The key interface of the procedure is the integrated analysis of both product-defining (Fig. 7.12, left) and user-affecting domains (Fig. 7.12, right). In

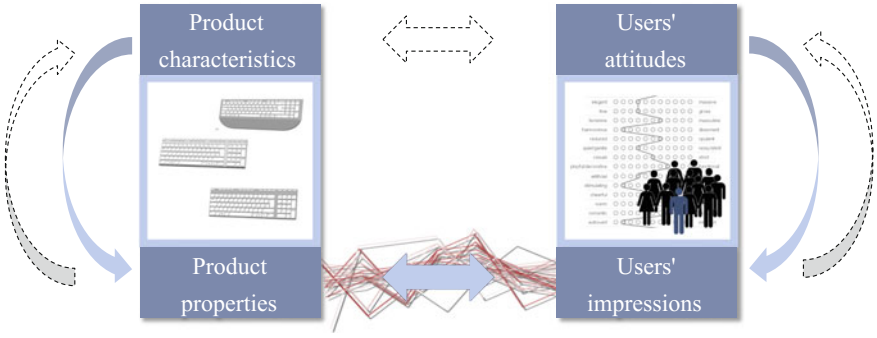


Fig. 7.12 Excerpt from the ACADE architecture based on Kett and Wartzack (2016)

general there are four different parts that may be differentiated: on the left side, the product characteristics and the product properties to describe the product variation mechanisms; on the right side, the users' impressions related to these respective product variations and the users' subjective evaluation system represented by their attitude profiles.

To apply numerical data analysis, the different parts of this architecture need to be represented mathematically. By knowing the interdependencies between product properties and characteristics, the matrix *MP* representing the product set for a number of *m* product variations *P* can be set up as follows:

$$MP_m = \begin{pmatrix} P_1 \\ P_2 \\ \cdots \\ P_m \end{pmatrix} = \begin{pmatrix} f\left(properties_{product1}\right) \\ f\left(properties_{product2}\right) \\ \vdots \\ f\left(properties_{productm}\right) \end{pmatrix} \tag{7.1}$$

A product property consists of a number of *c* characteristics. The relations between a product property and its respective weighted characteristics can be described as:

$$property_{productp} = \begin{pmatrix} char_{productp,1} \\ char_{productp,2} \\ \vdots \\ char_{productp,c} \end{pmatrix} \tag{7.2}$$

The user-affecting domain on the right side can also be described formally. If a number of *r* participants are considered in the study, the users' attitudinal set consisting of all the participants' profiles is introduced. As each profile consists of 30 attributes (a), it can be represented through the matrix *MA*:

$$MA_r = \begin{pmatrix} P_1 \\ P_2 \\ \cdots \\ P_r \end{pmatrix} = \begin{pmatrix} a_{1,1} & \cdots & a_{r,1} \\ a_{1,2} & & a_{r,2} \\ \vdots & \ddots & \vdots \\ a_{1,30} & \cdots & a_{r,30} \end{pmatrix} \tag{7.3}$$

Finally, the impression profiles for product variation *p* consisting of *k* attributes each can be constructed by the matrix *MI*:

$$MI_p = \begin{pmatrix} I_{p1} \\ I_{p2} \\ \cdots \\ I_{p,r} \end{pmatrix} = \begin{pmatrix} i_{k,1,1} & \cdots & i_{k,1,r} \\ i_{k,2,1} & & i_{k,2,r} \\ \vdots & \ddots & \vdots \\ i_{k,p,1} & \cdots & i_{k,p,r} \end{pmatrix} \quad with\ r \in [1;m] \tag{7.4}$$

As a basis for the data analysis, the correlation matrix $MC_{p'}$ for a product variation p' can be defined. This matrix represents the relations between the product variation impression profile $MI_{p'}$ and the product variation properties $P_{p'}$:

$$MC_{p'} = f\left(MI_{p'}, P_1\right) \tag{7.5}$$

Aggregating the correlation matrices for all m product variations used in the study, the overall correlation matrix MC_g can be represented as follows:

$$MC_m = \begin{pmatrix} MC_1 \\ MC_2 \\ \cdots \\ MC_m \end{pmatrix} = \begin{pmatrix} f(MI_1, P_1) \\ f(MI_2, P_2) \\ \vdots \\ f(MI_m, P_m) \end{pmatrix} \tag{7.6}$$

Lastly, there is the preference matrix based on the users' preferences regarding the different product variations. This matrix describes the preference structure of the r participants, evaluating the m different product properties from "*I like best*" = 1 to "*I like least*" = m in an ascending manner:

$$MPref_r = \begin{pmatrix} Pref_1 \\ Pref_2 \\ \cdots \\ Pref_r \end{pmatrix} = \begin{pmatrix} Pref_{1,1} & \cdots & Pref_{1,m} \\ Pref_{2,1} & & Pref_{2,m} \\ \vdots & \ddots & \vdots \\ Pref_{r,m} & \cdots & Pref_{r,m} \end{pmatrix} \tag{7.7}$$

With this mathematical basis, the data analysis can be carried out. Similar to Kansei engineering approaches, there is a variety of possibilities regarding which kind of mathematical analysis to apply. Besides multivariate statistical analysis, fuzzy set theory and artificial neural networks lead to satisfying results. A possible outcome will be presented in the following section using an application example. In this case multivariate analysis is applied to illustrate the general workflow.

7.6.3 Application Example

The application example used in this context is a small sample consisting of $m = 7$ product variations and $r = 25$ participants. The r participants were asked to give feedback on $k = 8$ attributes in the product variation impression profiles. The participants were all chosen from the same background, so it was expected that the user or target group would be homogeneous. They all have an engineering background, work in the department of engineering design as Ph.D. students, are the same age and have the same income. Standard keyboards were chosen as the product domain to ensure the familiarity and simplicity of this investigative study. Part I of the ACADE workflow was carried out showing 19 characteristics, 9 of which were varied to create product variations with different properties.

7.6.3.1 First Assessments

After the conducting of the survey, the first step (the user profiling) unveiled the first important insights into the apparently homogeneous target group. Two main different clusters could be identified based on attitudinal characterization (Fig. 7.13). Apart from a dominant cluster, represented by about two-thirds ($n_1 = 16$) of the group (cluster #1), there was another cluster represented by one-fifth ($n_2 = 5$) of the group (cluster #2). Only a few ($n_{rest} = 4$) were randomly spread. This already highlights the importance of a distinguished understanding of user groups in this particular topic of subjective quality perception.

As the second step, the impression profiles of each product over the target group were investigated (see Fig. 7.14). It turned out that the values of each impression amongst the user group for one product variation were mostly normally distributed (1). Depending on the user's individual character, he tends to evaluate impressions preferring extreme or rather median values, so the data variation is acceptable. If there is an unexpectedly high variation in these impression profiles throughout the whole product variation set, it might be an indicator of indifference of this particular impression so that this impression is not actively perceived by the user or clearly communicated by the product variations (2).

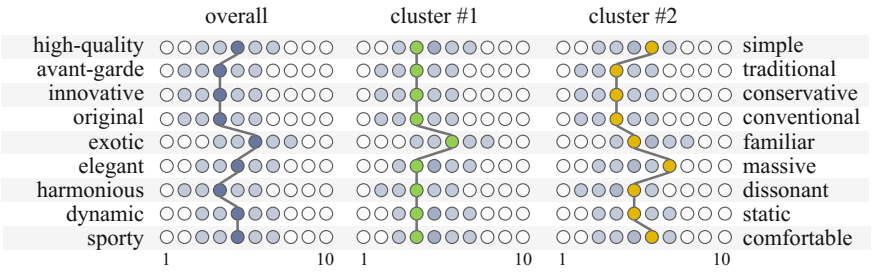


Fig. 7.13 Cluster variations in the application example

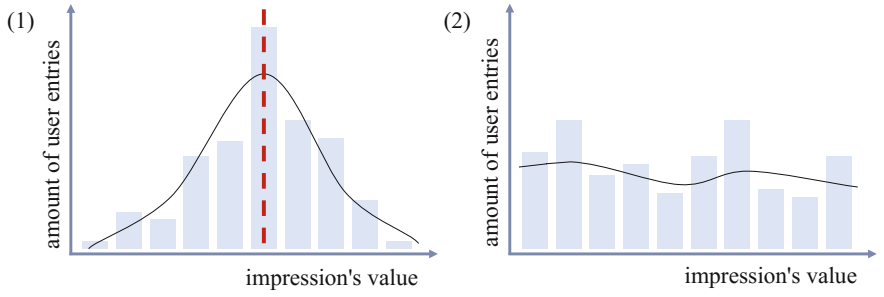


Fig. 7.14 Distribution of users' evaluation of a product variation in one impression

After ensuring the suitability of the impressions for the use case, the investigation of the relations between product properties and impression profiles can be conducted. There are characteristics that have a great impact on the user perception, but in general the investigation of product properties as functions of several characteristics is more effective. These properties aggregate the significance of each single characteristic used in its respective definitions and relations. Thus, the sensitivities of several characteristics showing equal sensibilities on design changes are subsumed. This does not exclude investigations on the individual characteristics' level. Therefore, the impression values of each product variation are reduced to their mean values, preserving the respective standard deviations for later use (see Fig. 7.14, *1*, red line).

Due to the characteristics–properties description of the product variations, certain ascending sequences can be determined for each property. In the application example, the product property "roundness" as a normalized function of different radii and angles was defined, as illustrated in Fig. 7.15. Thereafter, the product variations set can be assorted by the grade of roundness that the different variations have from 0% (angular) to 100% (round). Another property, called "space consumption", represents the amount of space used for buttons and functions. The characteristics used for this property are for example boundaries, button sizes and the space between the buttons.

Depending on these sequences of product property variations and with the information about the overall value of each impression for every single product variation, the dependencies of product properties and user impressions can be investigated. Typical relations between properties and impressions are shown in Fig. 7.16, keeping the exemplary properties "roundness" and "space consumption" regarding the impressions "dynamic–static" and "sporty–comfortable".

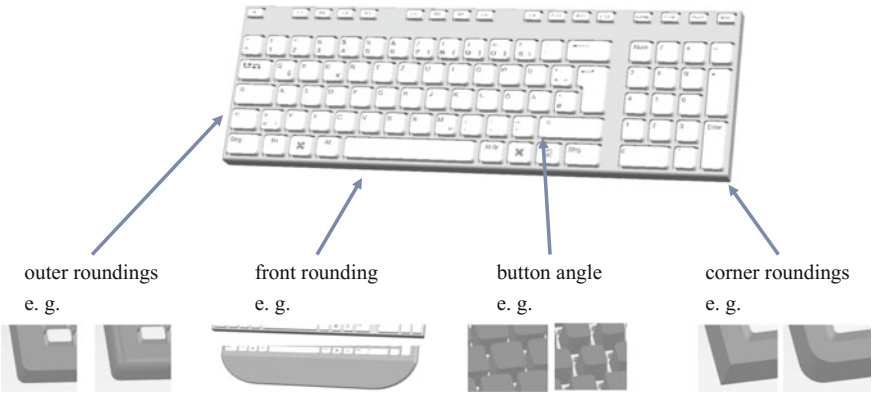


Fig. 7.15 Characteristic elements of the property "roundness"

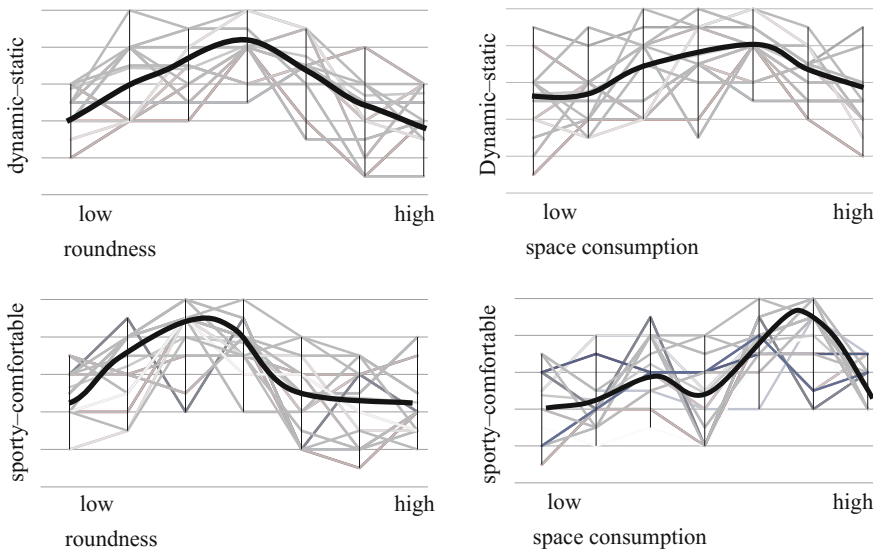


Fig. 7.16 Derivation of functional dependencies between product properties and user impressions

As an example, the rising roundness sequence against the impression "dynamic–static" reveals that there is a parabolic dependency in this case, whereas the dependency between roundness variation and "dynamic–static" is not as pronounced. Due to the functional approximation of these curves, consistent mathematical descriptions can be derived and kept for the design optimization, which will be explained later.

7.6.3.2 Cross-sectional Investigations

Based on these functional descriptions of impressions' and characteristics' interdependencies, the different product variations can be investigated regarding their different impression profiles. Figure 7.17 shows that the product variation profiles differ strongly in certain aspects whereas in others they seem to be more similar to each other. As an example, keyboard #7 shows great similarity to keyboard #6, whereas keyboard #3 progressively differs in trust (dynamic–static) and superiority aspects (sporty–comfortable). This information will be used to relate impressions to each other regarding their implicit dependencies via product properties. Highly similar impression profiles may further indicate product variations of equalities in subjective aspects and offer the potential to compare their product characteristic structure with this similarity. Thus, the relations between different combinations of product characteristics can be derived.

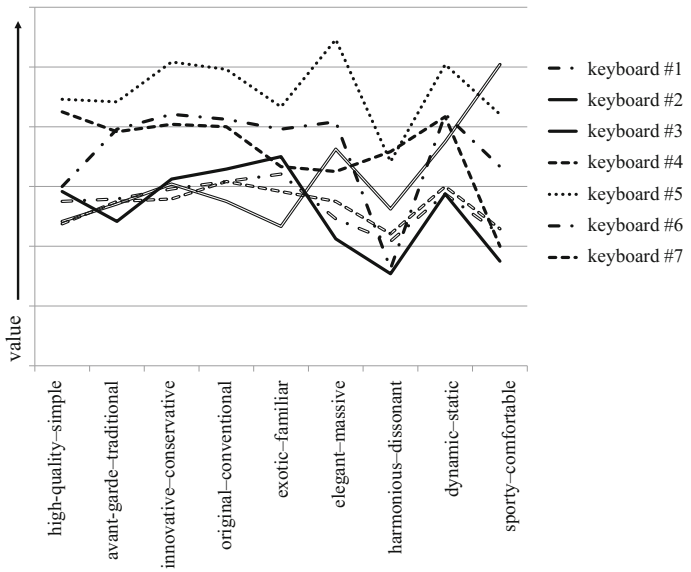


Fig. 7.17 Product variations' impression profiles

7.6.3.3 Participants' Preferences

With all the information gained based on the product variation properties, product impression profiles and participants' attitude profiles and their respective relations amongst each other, one last question needs to be answered. There is only an insight into the inner structure of product characteristics and their consequences for the emotional impression of the participants. However, there is still information that has not yet been used and that can help to answer one important question: How do we know, based on the prior knowledge, how to optimize future products for user groups that we are not able to ask directly? Therefore, the relationships between the participants' attitude profiles in the different clusters and the impression profiles of the product variations need to be investigated again. This time, the participants' direct overall preferences are also taken into account. These were asked earlier in combination with the survey. In the application example, two main clusters were identified: one dominant one (accounting for around two-thirds) and one minor one (containing one-fifth). Looking at the direct feedback of their product variation preferences, we can see that the differences in their attitudes can also be found in their preference choice (see Fig. 7.18).

Against this background we now have to identify the relations between a user's overall preference choices of product variations and his attitudinal profile. Therefore, the impression profiles of the product variations are compared directly with the attitude profiles of the user clusters. As shown in Fig. 7.19, the overall profile of all the users differs slightly from those of cluster 1, as it is slightly

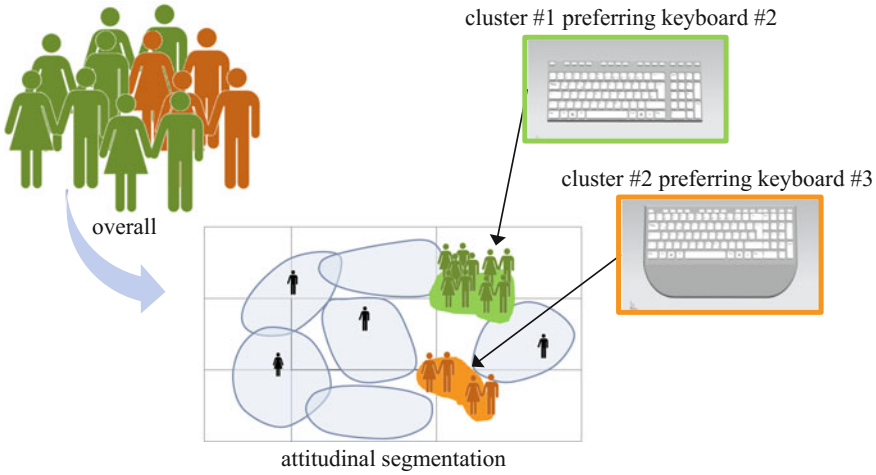


Fig. 7.18 User preferences in attitudinally heterogeneous groups

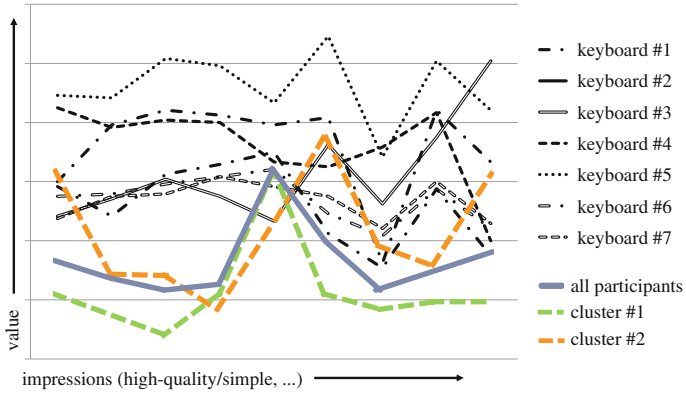
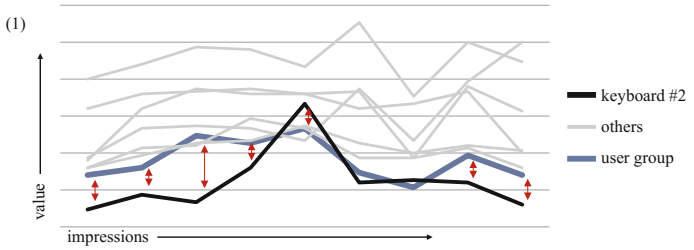


Fig. 7.19 Product variation impression profiles in comparison with users' attitude profiles

influenced by cluster 2. Moreover, the distances between the user clusters' attitude profiles and the impression profiles of the product variations can be assessed directly, as they are based on the same evaluation system.

Based on the knowledge of impression or attitude distributions, the respective product variation preferences in the different user segments can now be investigated (see Fig. 7.20). The directly gathered product variation preferences of the different clusters show that keyboard #2 (used in this application example) is the favourite one. Carrying out similarity analysis using blocking distances, it appears that this product variation, regarding its impression profile, shows the greatest similarity to the users' attitude profile (Fig. 7.20, *1*). Moreover, the comparison of the users'



(2)

	similarity index*	similarity ranking	users' overall preferences
keyboard #1	17,2083333	5	5
keyboard #2	8,5	1	1
keyboard #3	14,75	4	4
keyboard #4	17,25	6	7
keyboard #5	26,0833333	7	6
keyboard #6	9,125	2	2
keyboard #7	9,45833333	3	3

*based on blocking distances regarding users' attitude profile

Fig. 7.20 Similarity investigations in users' attitudes and product variations' impression profiles (*1*) and their correlation with users' overall preferences (*2*) (Kett and Wartzack 2017)

overall preferences and the similarity of the respective product variations' impression profile reveals that the two rankings show highly similar behaviour (Fig. 7.20, *2*).

It was observed that any user groups showing highly similar attitudinal profiles had almost the same preference choices. Moreover, the curve progressions of the participants' attitude profiles against the product variation impression profiles were investigated. Similarity investigations between the users' direct feedback on product preferences against their attitude profile and the product variations' impression profiles show that there are high correlations between these two data sets in any case.

Thus, it can be stated that the participants always prefer the product variation with the impression profile that is most similar to their own attitude profile.

7.6.4 The ACADE Mathematical Optimization Theory

Regarding these insights and with the knowledge of the strong relations between the profile similarity of users' attitudes and the product variations' impression profiles against the users' overall preferences, it is now possible to formulate a new optimization strategy using the mathematical description from Sect. 7.6.1.3 describing the targeted product variation with the property P_{target} for a specific target group:

$$P_{target} = \begin{pmatrix} char_{target1} \\ char_{target2} \\ \dots \\ char_{targetc} \end{pmatrix} = \left\{ f(MC_t) | I_t \rightarrow A_{target} \right\}$$
$$with\ A_{target} = \begin{pmatrix} a_{1,target} \\ a_{2,target} \\ \dots \\ a_{k,target} \end{pmatrix} \tag{7.8}$$

Formula 7.8 describes the circumstance that a property set P_{target} of a product variation, which consists of c characteristics, $char_{target}$, has to be optimized in such a way that its product variation's impression profile I_t is aligned with the targeted users' attitude profile A_{target}. This is necessary to ensure that the most similar product variation's impression profile is targeted to the users' attitude profile.

This connection between the product impressions towards the targeted user group and the attitudes of the users themselves finally allows reliable and successful product adaptation to subjective values of the users without personalization biases. Although the product developer might not share or understand the subjective evaluation system of the target group that he wants to design a product for, he now has a system to describe and process design optimization formally to address the users' implicit values.

7.7 The Macro Level of the ACADE: User Segmentation, Forecasting and Effective Portfolio Management

The consideration of user segments based on subjective, attitudinal differences shows the high degree of importance of user-centred design strategies. The case of the application example reveals that assuming user groups are subjectively homogeneous if they are objectively homogeneous is a misleading approach. The overall perception and thereafter the users' choice to use or not to use a product are highly dependent on subjective perception. The application example illustrates that the dominant segment in the investigated user group has superimposed the subjective needs of other segments. In the case of Kansei engineering, this phenomenon would have not been noticed. However, based on the ACADE, further strategies can be derived. As in the example, a third alternative of the product variations showed high acceptance in both cluster #1 and cluster #2. Its impression profile appeared to be a compromise between both attitude profiles of the users' clusters, although both of them would have preferred different product configurations separately. Concluding, this product variation alternative showed adequate

acceptance in both clusters but would not have been noticed without the ACADE, treating the investigated user group as a whole.

So far several studies have been conducted using the ACADE, which show similar behaviour to that in the former application example. In a cross study using computer accessories as an overall product area, we further investigated the potential of knowledge transfer to other user groups and product variations. The following findings should be highlighted:

- User groups can be segmented and classified equally so that similar user analyses are feasible and cross-comparable.
- The product variations' property sequences show equal curve progressions, as in former studies.
- Applying the knowledge gained from previous studies, product variations in new studies have been introduced that were expected to have the most similar impression profile to specific target user segments. These were rated most preferred by the participants in these targeted user segments.

The former approaches in user-centred design mainly focused on current or past products that already existed in the market and that were already well known by the users. By using the ACADE, not only can past or current products be examined but also scenario forecasting is possible. Moreover, the ACADE excludes influencing factors like branding or surroundings by providing platforms to rebuild product variations in CAD environments. With this approach it is also possible to address effectively the users' long-term subjective needs in new product development processes with fruitful forecasts.

Regarding successful user segmentation not only for the respective use case but for a broader product range, the ACADE offers good potential for a more generic point of view. Considering the interdisciplinary background of the ACADE and especially the link to marketing activities in user segmentation, we can integrate another approach based on subjective value perception. The socio-cultural segmentation approach also characterizes users by their lifestyle, depending on two dimensions: the social situation and the basic orientation (Sinus SocioVision GmbH 2015). It effectively groups users into a few meaningful clusters so that the subjective value perception may be better targeted. This clustering method is mainly based on insights into buying behaviour and psychological mapping over time. As the social situation and the basic orientation are closely related to user attitudes, this model represents potential for technical product development purposes.

Now the attitude profiles used in the ACADE process can further be used to link this generic approach of socio-cultural user segmentation to the respective applications. Therefore, different user typologies, based on the specific socio-cultural milieus, have been derived (Frey 1993).

Figure 7.21 shows how these user typologies can now be applied to process efficient subjective needs management. These typologies cannot only be used to build socio-cultural clusters and not only to segment users in the specific use cases but also concerning their implications for segment-specific design preferences.

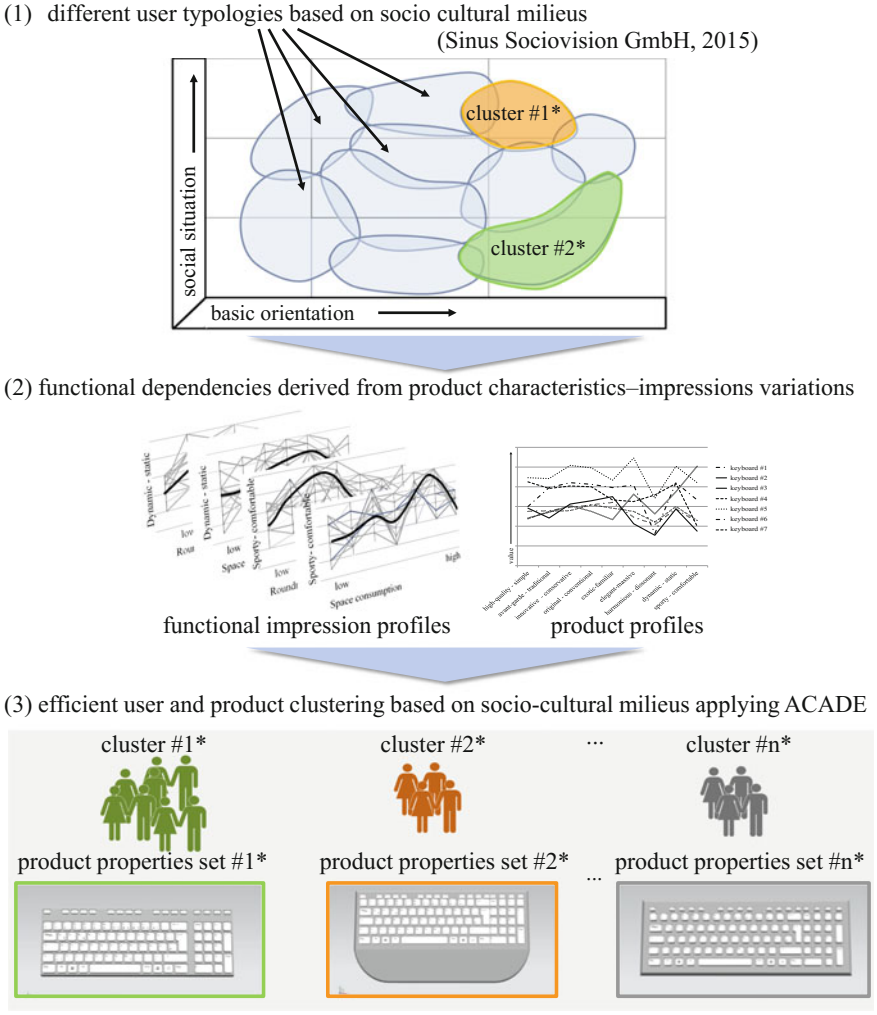


Fig. 7.21 Socio-cultural segmentation for users and products

Effective product portfolio management based on subjective quality factors could be conducted (Fig. 7.21, *1*). Furthermore, different product properties and characteristics can be linked directly to different user typologies. Knowing the functional dependencies of product characteristics and user impressions due to data analysis, product segments based on socio-cultural typologies can be derived (Fig. 7.21, *2*). Instead of randomly varying products to ensure sufficient design variation, only a few effective product variations are now necessary to address and satisfy the users' subjective needs successfully (Fig. 7.21, *3*).

7.8 Conclusion: Attitudes in the Age of Subjective Engineering

The ACADE is a methodology that integrates interdisciplinary knowledge to derive a better user understanding in product development processes and to address the users' subjective needs. The priority of these needs is increasing in times when international competition in widely saturated technical markets is pushing manufacturers to differentiate in quality instead of financial aspects. Users' perceived quality does not only consist of objective criteria but is highly affected by subjective impressions.

Although the ACADE offers good potential to work on, there are some aspects that need to be mentioned finally. Although only visual sensory perception has been considered so far, the presented workflow can also be adapted to other sensory systems, like hearing or touch. This might become important regarding special product domains or users. The ACADE also excludes environmental influences that may affect users' evaluation in some cases. Nevertheless, these are also integrated into the model as they influence attitudes indirectly, because the usage scenario of technical products is often iterative (see 7.7). As an ex ante approach, the ACADE considers psychological needs from a theoretical perspective, which is fairly unique. It does not only investigate the relations between product characteristics and user impressions but also answers the question of what these impressions should be like to address truly the users' specific subjective preferences.

Attitudes are the backbone of our feelings. They do not immediately appear in instant product evaluation so that we might be aware of them, but they form our long-term value system on which we base our preferences. Keeping this in mind as a product developer, we will not just succeed in offering a broad variety of products to choose from, but we will also be able to address users' subjective needs better from a long-term perspective. In technical product markets, a lasting and forward-looking focus on user satisfaction is essential.

All in all, the nature of designing products for users will change increasingly from the question of objective quality to the creation of a subjective product experience. In other words, this will open up the age of subjective engineering (Fukuda 2015).

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Chapter 8
Design for Additive Manufacturing: Supporting Intrinsic-Motivated Creativity

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Abstract Emotional aspects and designers' motivations in Design For Additive Manufacturing are rarely studied. Still, as they can influence creative behaviors, it is worth of interest to draw some bases for a relation between designers' motivations and the field of Additive Manufacturing. This paper aims at identifying the motivations that push designers to deal with AM in their practice. We have highlighted that they experience some extrinsic motivations: technical improvements, economics and social environments pressures. We also noticed that creative designers, apart from AM, usually experience some intrinsic motivations and, moreover, that it exists an ideal state to generate creative concepts: the *Flow*. To support creative designers in DFAM in reaching the *Flow*, we then identified 4 key levers through the potential of AM: the newness of AM processes, the needed skill of 3D modelling, the investigation of new shape grammars and finally the opportunity of embodying concepts into physical objects. To benefit from this potential, we assume that designers' intrinsic motivations should be supported: we identified three required conditions. The first one is the use of a proper vocabulary i.e. the expression *Additive Manufacturing* instead of *3D Printing*. The second one is the development of a design process which integrates a creative approach. The third condition is the use of AM objects as experience triggers during creative sessions to arise positive emotions.

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8.1 Introduction

At first motivated by the expansion of Additive Manufacturing (AM) through various industries and its impacts on designers' activities, we focused our research on Design For Additive Manufacturing (DFAM) methods. In a previous state-of the-art of existing methods (Rias et al. 2017) we noticed that they are limited regarding supporting designers' creativity. In order to enhance creativity in DFAM, this paper aims at identifying the motivations that push creative designers to integrate AM in their practice. We first highlight that creative designers are experiencing some extrinsic motivations: technical improvements, economic and social environments are all reasons which push designers to deal with AM.

Secondly, as literature is rich about creative behaviors analysis, we also notice that creative designers usually experience some intrinsic motivations and, moreover, that it exists an ideal state to generate creative concepts: the *Flow*. To support creative designers in DFAM in reaching the *Flow*, we then propose to identify the potential of AM regarding intrinsic motivations.

To benefit from this potential, we assume that designers' intrinsic motivations should be supported to reach the best conditions to generate creative concepts. We identified three required conditions. The first one is the use of a proper vocabulary i.e. the expression *Additive Manufacturing* instead of *3D Printing*. The second one is the development of a design process which integrates a creative approach. We present our creative-DFAM process for that purpose. The third condition is the use of AM objects as experience triggers during creative sessions to arise positive emotions such as surprise and playfulness.

8.2 The Additive Manufacturing Expansion

In our study, personal 3D printers and educational uses are not considered, we focus on industrial applications of AM.

8.2.1 Historical and Current Extrinsic Motivations

Grouping twenty different manufacturing processes, Additive Manufacturing is rooted in a thirty-year-old technical background (AFNOR NF E 67-001 2011; Rias 2016). Along with the technical improvements of the different processes and materials, AM has gradually penetrated through several industrial sectors such as Aeronautics and Space, Motor sports, Military, Medical, Jewelry and Consumer products and electronics (Wohlers Associates 2013). AM integration in industries is

even more progressing since some processes allow to produce with metallic alloys (since 2000s). Indeed, beyond rapid prototyping, processes such as Laser Beam Melting or Electron Beam Melting build products which are not prototypes but fully functional and ready to use.

This technology-pushed paradigm is currently nourished, in various industries, by economic, marketing and social motivations. Economic motivations are various, we highlight here some of the most significant. Using AM, molds and specific tooling are not necessary any more. In other words, this technology allows industries to save some money usually dedicated to project development and production. As a 3D file is the only necessary input data, AM is often applied to projects subjected to strong time pressures. For example, the Motor sports industry particularly benefits from this advantage: mechanical parts are produced and delivered according to the needs of racing teams during the few months of a racing season. AM is also enhancing the development of an industrial spare parts market. When it is possible, reusing and repairing parts instead of replacing them is a strong economic motivation for several industries. For example, the Laser Metal Deposition process has this specific advantage: it allows to repair damaged parts, often turbine blades for Aeronautics.

Customer satisfaction is an important marketing motivation which also contributes to explain additive manufacturing's expansion. Based on a digital workflow only, AM allows to produce unique parts for patient specific needs and anatomy such as implants, prosthetics and surgical guides. Indeed, the Medical industry often uses this advantage of custom-made solutions. Custom-made solutions are also popular in other industrial fields with specific requirements such as Space and Military.

Social motivations are less studied but they are worth to be mentioned as a contribution to the expansion of AM. In our competitive world, industrial companies have divisions dedicated to the exploration of new processes. For them, being at the cutting edge can make the difference. In many industries, AM is still considered as a new technology which has to be learnt, experimented and integrated. An obvious example of this trend is the flourishment of a range of theoretical and practical courses, offered by different private and public organizations. In France, more than 10 different training offers are currently available (Leandri 2016).

The cited motivations are rooted in technical, marketing, economics and social environments. In this sense, they are extrinsic motivations which push designers to integrate Additive Manufacturing. Indeed, their activities are directly impacted by AM: new opportunities and constraints in terms of geometries, new development times, new materials, new knowledge to integrate and other consequences. Design Research is currently supporting this paradigm with the development of design methods. These methods, grouped under the name Design For Additive Manufacturing (DFAM), are summarized in the following section.

8.2.2 Impacts on Design Methods: The Development of DFAM

As the specific orientation of Design For X (DFX) for the AM paradigm, DFAM groups methods that are intended to manage the required knowledge about product, process and material as soon as the beginning of the product lifecycle i.e. the so-called *early stages* of the design process (Segonds et al. 2016). *Opportunistic* DFAM methods guide designers to take into account AM specificities, such as the geometrical and material distribution freedoms, from the beginning and during the design process. These methods lead them to the creation of IRs (Hague et al. 2003; Doubrovski et al. 2011). Other methods, called *Restrictive* consider AM limits and define criteria, such as manufacturability and cost, to evaluate the IR regarding AM specificities (Alimardani et al. 2007; Rafi et al. 2013). They guide designers to progress from an ideal IR to realistic ones by embodying variations due to the manufacturing constraints. The 3rd category *Dual DFAM* groups methods combining the two previous approaches (Laverne et al. 2015). *Dual DFAM* is more suitable for product innovation since it guides designers to exploit AM potential in a realistic way. Indeed, by conducting, as soon as early stages, both IR creation and IR evaluation, these methods help avoiding late design changes which cause extra cost and longer development time. However according to the cited authors, *Dual DFAM* methods currently represents less than 30% of existing DFAM methods.

Conducting a state of the art of existing DFAM methods, it appeared that they are limited regarding the integration of a creative approach. We identified that *Dual DFAM* methods have different approaches to process from input data to the creation of an initial IR. We proposed to categorize them in 3 levels as we noticed, through the qualities of the generated initial IR, 3 levels of changes: Level 1—Formal newness, Level 2—Functional reconfiguration and Level 3—Form & Function implementation (Rias et al. 2017). *Dual DFAM* methods follow 3 strategies which already integrate some creative approaches and creativity tools, and thus generate some creative outputs. We compared the 3 strategies and the qualities of the generated concepts in a summary table (see Table 8.1). The main result of this comparison is that the existing *Dual DFAM* methods guide designers to generate only partially creative concepts while fully creative concepts are suitable for a more radical innovation than incremental innovation (Garcia and Calantone 2002). We deduced that the development of a creative approach to be integrated in DFAM methods could enhance the generation of fully creative concepts.

As creative approaches are still poorly studied and integrated in existing DFAM methods, the focus is also rarely centered on additive manufacturing and creative designers' motivations. Without mentioning the specific paradigm of DFAM, it has been recognized that creative designers have different types of motivations (see the following section). Focusing on DFAM, it might be interesting to question creative designers' motivations and their roots.

Table 8.1 Summary table comparing the DFAM strategies and their generated concepts qualities of the 3 identified levels (X = No newness, O = Newness)

Generated concepts qualities		Level 1: formal newness	Level 2: functional reconfiguration	Level 3: AM F and F implementation
DFAM methods authors		Rosen (2007), Maheshwaraa et al. (2007), Chu et al. (2008), Vayre et al. (2012), Ponche et al. (2012), Tang et al. (2014)	Munguia et al. (2007), Rodrigue and Rivette (2010), Boyard et al. (2013)	Burton (2005), Maidin et al. (2011)
New what	Functions (25%)	X	X	O
	Forms (25%)	O	O	O
New to	AM industry (25%)	O	X	X
	Conventional industry (25%)	O	X	O
Level of newness allowed by the methods (max. 100%)		75%	25%	75%
Realistic to AM capabilities		O	X	O

8.3 Creative Designers' Intrinsic Motivations

8.3.1 General Definitions

According to Ryan and Deci (2000), the notion of Motivation is composed of *intrinsic* motivation and *extrinsic* motivation. Human beings in general experience *extrinsic* motivation when the action is initiated by one or a combination of external circumstances such as the expectation of a reward, the feeling of a social pressure, a punishment or others. In opposition, *intrinsic* motivation means that individuals are conducted to an act only by the interest and the pleasure that they find or think they will find in doing it. It is then distinct from the other cited circumstances. *Intrinsic* motivation is related to the field of emotional engineering in the way it influences the emotional processes which occur during design activities. Even if current research in emotional engineering is more focused on the end-users, it may also concern the designers themselves. Indeed, in design sciences, emotional aspects have been measured especially when researchers want to enrich designers' experience through new design methods and tools and when they want to assess designers' activities (Rieuf 2013).

In design activities, intrinsic motivation modifies designers' experience in a decisive way. Indeed, it is related to inherent satisfaction and pleasure felt during some activities such as: playing, creating, and generating ideas. This type of

activities is very familiar to creative designers both in research and professional contexts. In other words, intrinsic motivation concerns, not only but certainly creative designers. To complement the definition of intrinsic motivation, it may be noticed that it is more specifically related to inspiration, energization and activation, through the experience of positive emotions. Furthermore, intrinsic motivation is a crucial mechanism for an open and agile cognitive development since it is the driver of spontaneous exploration and curiosity (Oudeyer et al. 2007). Consequently, it impacts the learning processes, therefore the knowledge management processes and finally the idea generation processes. Moreover, on this point, intrinsic-motivated behaviors have been recognized as being more creative, having a greater persistence in the face of adversity and a better focusing.

Considering this definition, we assume that designers' intrinsic motivation and especially their curiosity, may be ignited by adequate stimuli which can be, as presented later in this paper, intermediate objects made with additive manufacturing. In this case, these objects must be open enough to enable tasks such as divergent thinking and new concepts generation, but close enough to cope with additive manufacturing requirements. This issue represents a challenge at the moment and for the future, in the way that it can contribute to draw innovative ways of exploiting additive manufacturing.

8.3.2 The Ideal State of Flow*: Definition*

Emotional engineering approaches consider emotions *in engineering design activities* (Bouchard et al. 2014). Even if these approaches mainly focus on evaluating the end-users experience, some studies addressed the emotional state of the designers themselves. From these studies appeared the notion of *Flow*. *Flow* is linked to the designers' emotional states and so to his/her intrinsic motivations. (Csikszentmihalyi and Robinson 1991; Ocnarescu 2013).

Csikszentmihalyi identified 4 main conditions which can lead to the state of *Flow*. The first condition is the perceptual response, the second one is the emotional response, the third is intellectual response and the fourth is the communicative response. Extended definitions of these four conditions are beyond the scope of this paper, we focus here on their relations with intermediate objects and representations. The perceptual response is directly related to the objects or representations that designers build and share along to the design processes (Pei et al. 2008). It depends on the nature, the shapes and the information embodied in the intermediate objects or representations. We retain that the level of novelty they convey strongly impacts the perceptual response of designers. Secondly, the emotional response, which is activated during design tasks, and the emotional intensity over the emotional states is also partly driven by the interaction with intermediate objects and representations. Thirdly, the intellectual response includes the understanding of the phenomena presented to designers through intermediate objects and representations and the experience of imagining, interpreting, and rebounding with them. Finally,

the communicative response is more related to the social aspects related both to group of participants in the context of a creative session and to the work to be done. All the cited conditions are part of intrinsic motivations. Intrinsic-motivated designers can then experience some specific emotions such as curiosity, excitation and surprise. In a more recent study, Ocnarescu summarized the *Flow* as a specific state characterized by a high intrinsic motivation and the experience of positive emotions with a high intellectual pleasure (Ocnarescu 2013).

According to these definitions, the *Flow* seems to represent, for creative designers, the ideal state to be reached. We contextualize our assumption in a collective creative design context. In this context, we assume that the nature and the qualities of intermediate objects and representations, if they are presented in a playful way, can lead to responses of mixed cognitive constructs. We then assume that these mixed responses can enhance the generation of a bigger number and more creative concepts. As a second effect, we assume that it may also improve the social cohesion between engineers and industrial designers by making the technical knowledge more explicit and easy to share.

In the context of a group creative session, we understand that the intermediate objects and representations have a strong influence on the ability to reach the ideal state of *Flow*. Indeed, by supporting intrinsic motivation and driving to the experience of positive emotions they represent some of the required conditions to reach the *Flow*. Focusing on DFAM, we identify, in the following section, the potential of AM to support the quest of the *Flow*.

8.3.3 *The Potential of Additive Manufacturing Regarding the* Flow

The previous Sect. 8.2.1 *Historical and current motivations* mentions the technical, economics marketing and social environments of additive manufacturing as extrinsic motivations for designers. Section 8.3 highlights that, apart from AM, creative designers also usually experience intrinsic motivations and that the state of *Flow* represents the ideal state to be reached for the generation of creative concepts. We then assume that creative designers in DFAM can also experience some intrinsic motivations, positive emotions and intellectual pleasures which are specific to additive manufacturing characteristics.

As intrinsic motivations are more individual experiences than a standard phenomenon, it would require an extended experimental study on designers' activities supported by emotional engineering research. However, we here suggest 4 key levers we found embodied in additive manufacturing itself.

The first lever is the relative newness of additive manufacturing. Regarding industrial processes history, AM is still quite new. It has, in total, a 30 years-old background while milling or foundry have been mastered for several decades. We assume that this newness tickles designers' curiosity and that they feel the need

to satisfy that curiosity by, at least, being interested in the theory of AM if not trying to investigate it in practice. We assume that satisfying his/her curiosity contributes to the experience of positive emotions and that it is a motivation to be spontaneously interested by AM.

The second lever is related to one specific characteristic of AM: it is entirely based on a digital workflow. To be more specific, using AM requires skills of a high level in 3D modelling. In other words, designers have to exercise their skills for virtual representations. We assume that achieving complex virtual representations contributes to the experience of a high intellectual pleasure.

The third lever directly follows the first and second levers: being an expert in 3D modelling allow designers to investigate new shape grammars (Oxman 2006). We assume that investigating new shape grammars contributes to the experience of both positive emotions regarding newness and a high intellectual pleasure regarding the achievement of complex activities. In this sense, designers could be motivated to investigate AM because they want to satisfy their curiosity and find pleasure in achieving complex tasks. We assume that this lever enhances a high intrinsic motivation.

The fourth lever is also related to a specific characteristic of AM: based only on a 3D file, this technology allows to rapidly obtain a physical embodiment of a virtual concept, an object. As 3D models exist only virtually, they can be rapidly expanded or modified. Consequently, while investigating AM, designers keep a constant relation between physical objects and virtual representations. We assume that this characteristic contributes to satisfy designers' need of feeling their concept *in real* by experiencing textures, weights, dimensions, colors and kinematics. We assume that experiencing *in real*, by the manipulation of objects, is a playful activity which contributes to the experience of positive emotions.

Considering the cited 4 key levers, we can assume that AM has itself great potential to guide designers to reach the ideal state of *Flow*. Indeed, its specific characteristics could contribute to the experience of a high intellectual pleasure, positive emotions and a high level of intrinsic motivations.

However, as the question of how to reach the *Flow* is not yet an approach integrated in DFAM methods, we assume that intrinsic-motivated creativity for DFAM would require some conditions. Through the cited potential of AM, we identified 3 conditions: designers should be guided to use the proper vocabulary regarding technologies (Sect. 8.4), their activities should be supported by a design process oriented to the generation of creative concepts (Sect. 8.5) and enhanced by using objects as experience triggers (Sect. 8.6).

8.4 First Condition: *3D Printing* or *Additive Manufacturing*, Using the Proper Vocabulary

The vocabulary may be considered something trivial. We assume that the choice between *3D Printing* or *Additive Manufacturing* is not. It may indicate the level of expertise regarding these technologies but more importantly the motivation, for designers, to integrate these techniques in their practice.

8.4.1 The Role of Semantics

Firstly, it should be noticed that the expression *3D Printing* has been patented by an American private company. It is frequently used to describe projects made by the Material extrusion process, with plastic filaments on the small printers we can now have on a desk. It is also used to describe projects made either with Stereolithography or Selective laser sintering. However, the strict definition of *3D Printing*, as patented, describes precisely the Binder jetting process. This technology is based on jetting, through cartridges, a glue and colored inks on a white sheet. The resemblance to the familiar 2D printing on paper sheets might have promoted the use of *3D Printing* by a wide range of people.

From a semantic point of view, choosing *3D Printing* instead of *Additive Manufacturing* means ignoring the European and American studies which produced the standards NF E 67-001 and ISO/ASTM 52900-15. Previous literature presented, along to the technical improvements, various categorizations according to the materials, the energy sources or the applied transformations (Kruth et al. 1998). In order to standardize vocabulary and definitions, it is now defined that Additive Manufacturing groups all the processes which allow to produce, layer by layer, by the addition of material, a physical object from a digital file (AFNOR NF E 67-001 2011). The standards categorized 7 type of processes. Regarding how to title each process, definitions are still under discussion. For example, the title Selective Laser Melting is often used but, as it is propriety of a private company, standards switched to Laser Beam Melting. From a designer point of view, it is necessary to investigate these techniques, in theory and in practice, to avoid getting lost through all the available definitions.

8.4.2 Confronting the Technologies

At the time when *3D Printing* was not yet a familiar expression, communications for a wide audience were organized along to the technical improvements, especially visible in the USA. For example, Stereolithography were presented in 1989 by 3D Systems in the famous American TV show *Good morning America* (Systems 3D

1989). In this sense, it is not certain that simplifying *Additive Manufacturing* into *3D Printing* is a benefit for the integration of the different technologies into designers' practices.

Using *3D Printing* also means disregarding the historical roots of these technologies that draw upon Topography and Photosculpture from the 19th century. More than 20 patents, focused on the processes themselves, have been registered (Bourell et al. 2009) as well as dozens of patents about 30 years of industrial applications of additive processes.

Using *3D Printing* also means focusing on a portion reduced to 20% of the wide range of different additive processes, which counts in total 20 processes, developed until 2010. From a creative designer point of view, focusing only on some processes makes invisible some new opportunities as, for example, designing to produce products (not prototypes but finished parts) out of metal with the Laser Beam Melting process. Sticking to *3D Printing* is also a disadvantage in taking into account the latest technical developments (reliability, costs, fastness, range of material…) that scale additive technologies to an industrial productivity level.

Finally, using *3D Printing* stifles one of the intrinsic motivation for creative designers while *Additive Manufacturing* favors the adoption of these technologies.

8.5 Second Condition: A Creative Approach for Early Stages of DFAM

To guide designers to reach the *Flow*, we assume that their activities should be supported by a creative approach to be integrated in the early stages of DFAM methods.

8.5.1 Purpose of the Creative Approach

Creative designers use sources of inspiration as input data to stimulate ideas production. They gather visual and textual information to get inspiration about features that could be, by analogical or case-based reasoning, implemented in the product to be designed (Ansburg and Hill 2003; Goldschmidt and Smolkov 2006). In the same way, they also use precedents. By being examples of existing solutions, artifacts, graphical and textual information embody design knowledge which activates the designer's personal knowledge. Recently activated knowledge is used to generate ideas (Pasman 2003). According to Bonnardel (Bonnardel and Marmèche 2005), inspirational examples can be found within the product domain (i.e. *intra-domain*), in this case within AM processes and AM products background. They also can be found far from these domains (i.e. *far-domain* examples). Some existing DFAM methods showed that inspiration from intra-domain leads to partially creative

concepts while some others, inspired by far-domain examples also guide to partially creative concepts. Therefore, we assume that our approach must rely on associations between intra-domain examples and far-domain examples. Thus, our method intends to foster designers' creativity by crossing AM examples with other domains examples. The goal of this forced association is to extend the design space to new possible concepts. Based on this approach, we propose a method called Creative-DFAM.

8.5.2 *Framework of the Proposed Creative-DFAM Method*

This 5 stages Creative-DFAM method is rooted in Maidin's (Maidin et al. 2011) approach but with the integration of other domains examples inspiration. The forced and systematic association of 2 different domains examples is inspired by the work of Yoon (Yoon and Park 2005) on morphology analysis to forecast R&D opportunities. The method can be used by both engineers and industrial designers who already have some knowledge about AM processes. It is intended to impulse R&D collaborations between designers and industrial stakeholders interested in emphasizing the use of AM in the industrial sector they work for. We specify that this method is dedicated to AM design projects only, not to projects where the choice between AM or conventional processes is not yet done. The method starts when general design specifications are available, it is represented in Fig. 8.1. To illustrate our method, we propose an example: the generation of a creative AM concept of a turbine blade (Fig. 8.2).

1/Features Discovery (Fig. 8.1 stage 1)—The first task for R&D designers is to gather examples of AM products (i.e. features already realized in AM) and other domains examples (i.e. features not yet realized in AM). The examples can be represented by pictures, words or artifacts. The purpose of this stage is to have a great view of what has been done and what can still be created. The survey has to be regularly enriched to update the two taxonomies. Then, designers name the examples' features with keywords and 3D model these features in a simplified and editable manner. In the showed illustration (Fig. 8.2 stage 1) a turbine blade is

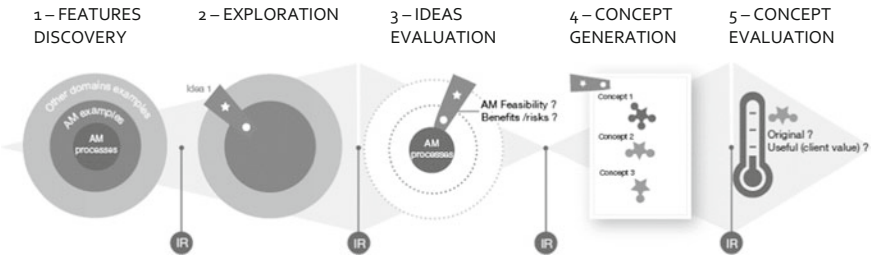

Fig. 8.1 The proposed Creative-DFAM method

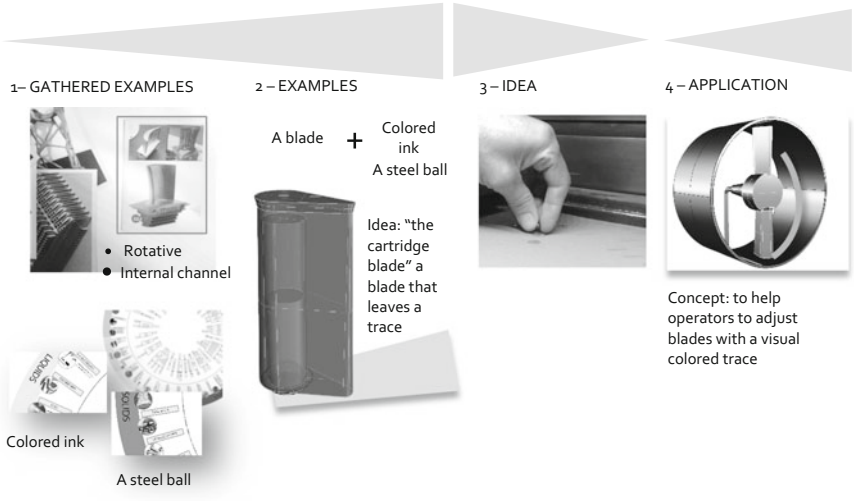

Fig. 8.2 Example of a generation of a creative AM concept following the Creative-DFAM steps

identified among others as a product already realized in AM. It is described by two keywords: ROTATIVE and INTERNAL CHANNEL. Two others domains examples COLORED INK and A STEEL BALL have been identified, among others, as not yet linked to AM. Their features are named LEAVE A TRACE and ROLL. As an output, designers form an extended portfolio of examples.

2/Exploration (Fig. 8.1 stage 2)—This stage consists in randomly and systematically associating an example of one wheel to an example of the other wheel. In other terms, designers conduct forced associations of AM examples with OD examples in order to generate ideas. At least one idea should be formulated for each association. For example (Fig. 8.2 stage 2), blade's features are associated to colored ink and steel ball features to generate the idea of a blade that integrates a colored ink in its internal channel and a steel ball at the end of it in order to leave a trace when it's rolling. As being similar to a cartridge, the idea is called "the cartridge blade". The idea is represented by modifying the input simple 3D model. The output of this stage is a case-base of various and numerous ideas that present potential opportunities for collaborative R&D.

3/Ideas evaluation (Fig. 8.1 stage 3)—A first idea evaluation is conducted by AM experts. The generated ideas are faced to AM processes in order to scale the ideas at a mature level i.e. they are feasible with current AM processes or an emergent level i.e. potentially feasible if AM processes improve. Some associations could be evaluated as impossible due to major technical limit or technical risk. The association would be then eliminated. The proof of the ideas feasibility is established by actually additively manufacture them as shown in Fig. 8.2 stage 3. This stage leads to a reduced portfolio of ideas embodied in artifacts.

Table 8.2 Evaluation of criteria Originality for the concept example "Cartridge blade"

New what	Functions (25%)	O
	Forms (25%)	O
New to	AM industry (25%)	O
	Conventional industry (25%)	O
Level of newness of the concept		100%

4/Concept generation (Fig. 8.1 stage 4)—The artifacts and their manipulation stimulates analogical reasoning to translate the previous ideas into concepts which show application scenarios. As shown in our example (Fig. 8.2 stage 4), the scenario of a "cartridge blade" used to help operators in adjusting rotative blades has been formulated. The blades should leave a constant and uniform trace on the support if they are well aligned. This stage is conducted by designers in a co-design approach with industrial stakeholders to enhance the formulation of concepts with a high client value. This stage output is a base of concepts sheets describing potential products to be developed for industrial sectors.

5/Concept evaluation (Fig. 8.1 stage 5)—The purpose is to identify the concepts to be further detailed and optimized in downstream DFAM stages. The required profiles for the evaluation are experts of AM who have a good understanding of industrial sectors where AM is integrated, such as innovation managers, senior designers and trade engineers for example. They are asked to say how much the generated concepts are: 1/Original (in the sense of new) regarding traditional products of the involved industrial sector and regarding AM industry, 2/Useful regarding the involved industrial sector (client value), 3/Realistic regarding AM capacities. Following our example, the "cartridge blade" is considered new since it integrates new functions and forms, and since the associated features have not been already realized in AM industry (see Table 8.2).

8.6 Third Condition: Using Objects as Experience Triggers

Intermediate objects and representations are created all along the design processes. We assume that using intermediate objects as experience triggers contributes to the experience of positive emotions such as playfulness.

8.6.1 Background Regarding Intermediate Representations in DFAM

In a previous experimentation we have noticed that there is a gap between designers' intentions and the information embodied in the created intermediate

representations (Rias et al. 2016). It is especially true when designers want to represent complex features and when it is about representing kinematics. We noticed that participants have expressed the limits of keywords to describe evolving features while these ones are the most typical of AM and the limits of static representations while these ones showed a great potential for innovation. The lack of interaction between designers and representations appeared. They also expressed the limits of 3D modelling while they wanted to experiment kinematics and to share their ideas within the groups. This gap raises the need for a new kind of intermediate representations in early stages of creative design for additive manufacturing.

Research work of Cruz and Gaudron (2010) specified the role of intermediate objects in early stages of creative design with the notion of *Open-ended objects* in opposition to *Closed objects*. Indeed, physical objects such as mock-ups and prototypes are often used by designer teams to validate some design solutions. These objects are not intended to be modified, they are then *closed* (Cruz and Gaudron 2010). On the contrary, *Open-ended objects* are made to be indefinitely modified because they are not meant to embody design solutions. They have four main purposes. *Open-ended objects* create a shared experience in the beginning of creative design processes that will infuse in designers' minds during creative sessions. Secondly, they are not exactly *objects* since they should be quite abstract, minimalist and simple. Thirdly, they should be functional so designers can observe, try and feel, in other words, experience. Finally, they are a tangible translation of the brainstorming brief. In other words, they are a medium to explore the questions through experience rather than through language. They are then meant to be useful in multidisciplinary design teams.

We assume that using experience triggers during group sessions is a way to support intrinsic motivated designers. According to the specific characteristics of AM (see Sect. 8.3.3), producing objects with AM could allow designers to experience their concepts through tangible characteristics by manipulating the objects. Based on the cited definitions, we initiate in the following section a conceptual definition of this objects that could play a role of experience triggers to enhance the experience of playfulness and more generally positive emotions. This approach, as well as the objects themselves are called AMIO for Additive Manufacturing of Intermediate Objects.

8.6.2 *Objects as Experience Triggers in Additive Manufacturing*

We propose a conceptual definition of AMIO in a creative DFAM approach. AMIO are meant to be at the crossing point between *closed* and *open-ended objects*. Figure 8.3 shows that AMIO are part of the Intermediate Representation (IR) sequence illustrated by an example of the generation of a new function for turbine blades. We assume that AMIO could foster the generation of AM creative concepts

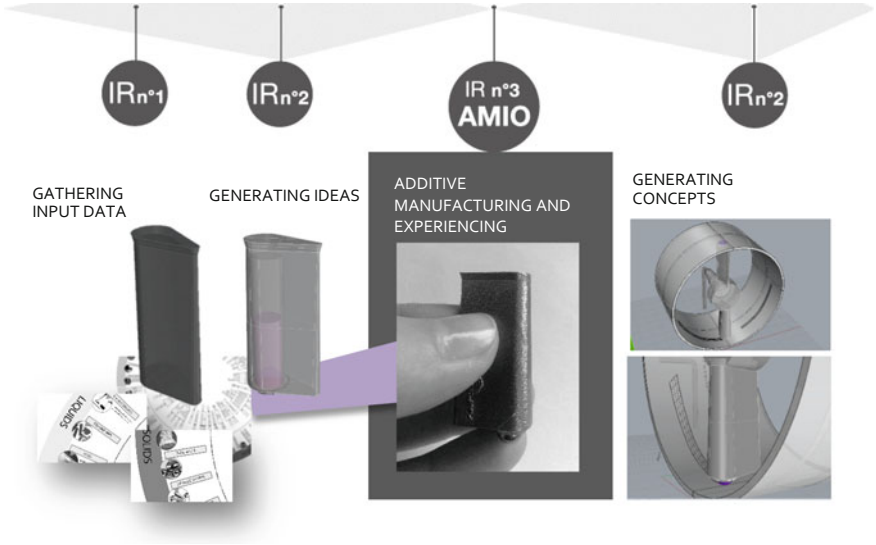

Fig. 8.3 Intermediate representation sequence integrating AMIO

as it can play the role of a mediation to ease the collaboration between AM designers and industrial experts from several industrial sectors.

As the digital workflow of DFAM needs 3D virtual models as input data, the objects can be easily manufactured from the IR n°2. AMIO thus create a link between a virtual experience of an idea and a tangible experience of it: they are easily manually actionable (see IR n°3 on Fig. 8.3). Through sensory manipulation, AMIO are to be used to introduce creative concepts generation sessions. For example, on Fig. 8.3 (IR n°4, the last one), designers generated a concept of rotating blades filled in with a viscous liquid used to check the alignment of the blades. They phrased that this function "could be integrated in test bench turbine blades".

According to Cruz recommendations, AMIO are abstracted enough to not be understood as product mock-ups or prototypes. The different design stakeholders can interpret and diverge upon the objects to generate different concepts. In this sense, AMIO are open-ended objects. However, by being actually additively manufactured with the same processes and materials that could be used for the final product production, AMIO also play the role of an early technical validation of the generated idea. If the idea is not realistic enough regarding AM specificities, it won't be manufacturable. Being tangible objects actually made with AM, AMIO could also contribute to give the idea more credibility to the eyes of industrial experts. In this sense, AMIO are also *closed* objects.

8.7 Conclusion

Emotional aspects and designers' motivations in Design For Additive Manufacturing are rarely studied. Still, as they can influence creative behaviors, it has been interesting to draw some bases for a relation between designers' intrinsic motivations and the specific field of Additive Manufacturing.

This paper aimed first at identifying the motivations that push designers to deal with AM in their practice. We have highlighted that creative designers are experiencing some extrinsic motivations: technical improvements, economic and social environments are all reasons which push designers to investigate AM.

Secondly, we also noticed that creative designers, apart from AM, usually experience some intrinsic motivations and, moreover, that it exists an ideal state to generate creative concepts: the *Flow*. To support creative designers in DFAM in reaching the *Flow*, we then identified 4 key levers through the potential of AM: the newness of AM processes, the needed skill of 3D modelling, the investigation of new shape grammars and finally the opportunity of embodying concepts into physical objects.

To benefit from this potential, we assumed that designers' intrinsic motivations should be supported to reach the best conditions to generate creative concepts. We identified three required conditions. The first one is the use of a proper vocabulary i.e. the expression *Additive Manufacturing* instead of *3D Printing*. The second one is the development of a design process which integrates a creative approach. The third condition is the use of AM objects as experience triggers during creative sessions to arise positive emotions.

It is worth to be mentioned, this paper is part of our current doctoral study. The questions and assumptions raised in this paper will be experimented in an industrial context during collective creative sessions, through Poly-Shape company and its industrial partners.

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Chapter 9
A Semiotics Inspired Framework Supporting Branding in Automotive Integrated Product Development

Mark Cini and Philip Farrugia

Abstract In an increasingly saturated automotive market, product design may be the only distinguishing feature in a myriad of similar cars that are technically almost identical. Customers choose a particular brand because they connect with the car emotionally. The role of branding in the product's success is vital. This chapter presents a framework aimed at supporting designers to integrate branding in automotive design. The framework is inspired by semiotics and includes the three pillars of integrated product development, namely, business, design and production. A number of real case studies are presented to substantiate how principles of the framework are applied in the automotive industry. The framework is an extension of our previous work, the version in this chapter includes a business screening frame. The framework has been evaluated qualitatively by a sample of academics and renowned designers working in the automotive field.

9.1 Background

The increase in quality level, technology diffusion and platform sharing lead to most cars being comparatively the same mechanically within their market segment (Verhoef et al. 2012). Consequently, the only way to be able to justify a higher price is to stand out and be distinctive is through the design and the brand of the

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company (Kotler and Rath 1984; Bloch 1995). A survey amongst product designers from five countries in Europe and North America showed that 75% of the respondents rated aesthetics as the key aspect of design, further highlighting its increase in importance (Page and Herr 2002). Thus, to be successful a company has to be more than just good at producing quality cars; it has to produce good looking cars, with a meaning (Cini 2014). Several studies have shown that the product design is the main reason on a firm positive performance. These studies have established that aesthetic products capture customer attention (Bloch 1995; Berkowitz 1987) cause positive emotional reaction (Bloch 1995; Holbrook and Zirlin 1985) and also have a positive effect on quality perception (Page and Herr 2002). Car designers use aesthetics as one way to gain customer attention, as evidenced by the introduction of the New Beetle in 1997. In the highly saturated car market it is difficult to break through without having a standout car. *Volkswagen* unveiled the Concept 1, a retro-themed concept car designed by J Mays and Freeman Thomas, in the 1994 Detroit Motor Show. *Volkswagen* was initially reluctant to resurrect the Beetle but a strong public reaction convinced the company that it should develop a production version based on the *Golf* platform (VW Club 2003). The New Beetle, with its round fenders and oversized oval headlights which, according to some resemble "*a happy face in a sea of snub-nose competitors*" (Vlasic 1998) helped *Volkswagen* to achieve an overall sales increase of 54% over the previous year. This revolutionary new design of the New Beetle was such a success that it sparked a retro-futuristic design craze in the automotive industry, as similar retro designs started to show on the market like the new *Fiat 500*. The product's touch points are an important means of communicating the message the brand is trying to convey to its customers (Hestad 2013). This is very common in the automotive industry where several designers are inspired by biomimicry (Pinter 2013).

Thus, product aesthetics, integrated with branding, is a major tool that can be used to gain competitive advantage (Bloch 1995; Kotler and Rath 1984). For example, *Audi* says that the product design determines up to 60% of a consumer's decision to buy a particular car (Kreuzbauer and Malter 2005). Furthermore, a product design can be used to represent the brand, commonly referred to as design language in the automotive industry, making branding essential for the success of the product (Cini 2014). Branding is no longer viewed as a separate activity to product design, but the product in itself represents the brand (Cini 2014). Arguably, the product is the most important brand representative as during the interaction with the product, the user creates perceptions of the brand (Hestad 2013). Similarly, the importance of adopting an integrated product development (IPD) approach (Andreasen and Hein 2000) is fundamental since a company must concurrently consider business, product design and production.

Branding appeals towards the emotional side of the brain; humans are inherently intuitive beings and the desire to buy something can override the rational part of the brain. Branding and product design have been typically seen as separate entities, with branding and marketing viewed as an add-on to the product (Hestad 2013).

In recent times there has been a change in mentality, with designers incorporating brand awareness in the development process, not just in the development of the product itself but also of the surrounding activities between the brand and customer.

Customers looking to buy a sports car are more interested in its acceleration rather than the leg room, whereas leg room and comfort is one of the main factors in family cars. Luxury is another factor which must be continually differentiated, recreating a distance between itself and its peers (Kapferer and Bastien 2009). Yet, it is very common that carmakers make an error of judgement regarding the latter when it comes to branding. It is also worth noting that branding has now become a regional process, and it is why carmakers have designs offices all around the world to keep in touch with their local markets. It is also why carmakers offer different products for different regions as brands are perceived differently throughout. For example, whilst in USA, *Lexus* is viewed as luxurious, in Japan, *Lexus* is perceived as an extension of *Toyota*, and therefore without the essential intangible attribute of luxury (Cini 2014).

Product aesthetic features are an important means to communicating the message the brand is trying to convey. Therefore, the product can be perceived as a sign. There are several messages that can be told about a product, and one of the common ways to group all messages is through semiotics. Semiotics is the study of signs, where a sign is something that can be interpreted to stand for something (Chandler 2002). As will be explained in Sect. 9.2, the three pillars of semiotics can be directly linked to the three parts of the brain; the instinctive layer called the visceral level; the behavioral level which contains the processes that control everyday behaviour and the contemplative part of the brain; the reflective level. Such levels can be perceived respectively as product characteristics—appearance and other sensory characteristics, effectiveness of use and pleasure derived from using it and representation of self, personal satisfaction.

Despite the ample evidence on the importance of branding in integrated product development and the parallelism between semiotics and product design, the critical literature review presented in Cini (2014) indicates that there is a research gap in the development of a semiotic-based IPD framework which adequately integrates branding with automotive design. In view of the scenario described above, the research presented in this chapter revolves around the development of a semiotics inspired framework supporting branding in an IPD context.

Based upon this introduction, the rest of this chapter is organised as follows. Given that a product should suitably communicate the intended message to customers to make it successful, Sect. 9.2 deals with the customers' psychological responses to a product. Section 9.3 describes the framework developed and provides real examples where the framework's principles apply in the automotive industry. A qualitative evaluation of the framework was carried out with a sample consisting of renowned automotive designers and academics. Section 9.4 discloses and discusses the main findings. Section 9.5 draws key conclusions, with focus made on the contribution of this chapter.

9.2 Customers' Psychological Responses to a Product

In the introductory section the importance of branding and aesthetic design in the automotive industry, together with their significance to the car's success in the market, were highlighted. In this section, the psychological aspect that underlines the relationship of a customer with a product is the main focus. Fully understanding this relationship is vital, since only with a thorough understanding of this interaction between product and customer one can build a model that is able to make full benefit of this relationship.

The product form elicits a variety of psychological responses from customers. Cognitive science indeed indicates that emotion is a necessary part of life affecting how we feel, behave and think. User's requirements from a product have been often compared to Maslow's (1987) hierarchy of needs (Lewalski 1988; Yalch and Brunel 1996; Rutter and Ange 1998). This indicates that once the product satisfies the basic user requirements of utility, safety and comfort, the focus of the user turns towards the decorative, emotional and symbolic attributes of design (Moultrie et al. 2004). This infers that provided that all functional aspects are equal, the more aesthetically pleasing product will be, the more desired. Surprisingly, there is also evidence that aesthetically pleasing objects enables the user to work better (Norman 2004). This train of thought summed up best by Esslinger stating that "*consumers don't just buy a product; they buy value in the form of entertainment, experience and identity*" (Esslinger 1999).

These studies confirm that products are used to communicate a message through its aesthetics. The consumer is left to form his/her own interpretation of the design, which is based predominantly on their interaction with the design (Norman 1998). Various factors influence how a user interprets the product, like his/her sociological background, previous experience with a similar product or a product from the same brand. The company may have a message in mind that it is trying to convey through the product, but it is only when the consumer interprets the product that this meaning will be communicated. This means that the product will not become a meaningful brand representation, unless the consumer understands the product the way it was intended for (Hestad 2013).

Herein lays the challenge to designers and brand messengers; to make sure that the product represents the message that the company is trying to deliver and to make sure that this message gets through to their customers. Despite their best efforts, inevitably there will be distortion in the process of defining the meaning and translating it into a designed object, as well as in how the consumer understands the designed object (Karjalainen 2006). The design team sometimes fails to project the design brief into a tangible object, and that leads to the first distortion; when the intended message is not portrayed in the design. The second distortion that may occur is in the interpretation phase, where the product does not communicate the intended message. It may not be solely down to the product design, but also a result of the context in which the product is operated. This continues to illustrate that a product has more to it than just its design, it is also a result of the context it is used,

the situational factors and the character of the consumer amongst other things. It is therefore imperative to understand all the aspects that make up a product; deconstructing it to its basics through semiotics, the science of signs. An example of such a failure is the *Volkswagen Phaeton*. *Volkswagen* intended to use the Phaeton as its premium class vehicle, similar to offerings from the likes of *BMW*, *Mercedes* and *Lexus*. However, sales were far less than the forecast. There were myriad of explanations why the *Phaeton* failed, but it is ultimately down to the brand image of *Volkswagen*, in comparison to its competition (Car Buzz 2012). The Marketing department did not fully understand the value of a brand, leading to a poor marketing and pricing plan, showing that in the automotive industry a good product will not sell itself.

Research has also shown that product form and brand strength have a major influence on the perceived quality of the product. Products from a weak brand that are not aesthetically pleasing suffer from a significant competitive disadvantage with regard to quality perception as they do not have the brand strength to protect or limit damage (Page and Herr 2002). Subsequently, product design is more important for weaker brands than for strong brands as it is the only way that they can compete with products from a stronger brand. This is the road that *KIA* motors undertook when they poached ex-Audi designer Peter Schreyer. With increasingly more aesthetically pleasing offerings, and increased quality too, *KIA* experienced an average year-to-year sales growth of fifteen percent through a period of four years (Kia 2013). For strong brands, the impact of a poor design is initially much less consequential as it does not suffer from strong initial negative reaction as the brand limits the damaging effects in the near term (Page and Herr 2002).

When people look at an object, every single one of them forms a different option. Despite the image they receive is physically the same, the interpretation varies depending on the observer's personality and situation. Even the same person can have several different points of view on the same object depending on the setting. Nowadays, the importance of the product's image is increasing at the expense of the product's actual function. These images formed and enhanced by the situation are difficult to determine and may even appear irrational; "*the product in your head is never the same as the product in your mind*" (Mono 1997). Given the understanding of semiotics, it is clear that all products make a statement through their form, even if the interpretation may not be intentional. The impression formed affects how the customer assesses the products' appearance, functionality and amongst other things. This would infer that designers should not only have a clear vision of the message that they wish to portray through the product and the expected response from the user, but most importantly the interaction between all these aspects and their application. Having a sound knowledge of this interaction allows designers to make judicious decisions in the design process that allows the envisioned message to be visible in all aspects of the product (Mono 1997). Designers with an awareness of the function of a design have the ability to "demystify complex technology, improve interaction between artefacts and their uses and enhance opportunities for self-expression" (Krippendorff and Butter 1984). The product should communicate the intended message, both the reflective message and also the functional one.

The messages communicated by the product to the customer can be classified in one of the three levels of semiotics, which as mentioned in Sect. 9.1 are the visceral, the behavioral and the reflective level.

The design objective for each level varies wildly. The visceral design is targeted for the pre-conscious level. It is about the instant impact of the product; the appearance, touch, and smell. The behavioral design is concerned about the experience using the product; its function, performance and usability. If any one of these aspects is inadequate, the product will be of little value; unless its visual impact is as such that its value can be found as an ornament. Whilst the visceral and behavioral level feelings are an effect of the product, the reflective level is down to the interpretation of the user. This makes it very subjective to change from external factors. Every individual constructs his/her opinions based on the society one lives in, his/her upbringing, experiences and education. The subjectivity and the variation of the interpretation make it the most difficult part of the design to get right; and yet this level of thought has the power to override all others.

A product needs to communicate the message to the customer well in all levels to be successful. However it becomes instantly clear the difficulty designers face to ensure a successful product. How does one trade off the requirements of one level against the other? This means that no single product will ever satisfy everyone, which is why there is a big variety of cars aimed for different market segments. At the visceral level, the aspects that dominate are those that control the senses—look, feel, sound. It is relatively simpler in making a product that appeal at the visceral level if one follows the norms of design of a certain product, even if the result may be somewhat simple or bland, because the principles underlying visceral designs are consistent across people and cultures (Norman 1998). Such a design however risks in being overshadowed by others that are less conventional and break the norm. When something is observed to be ‘pretty’, that process comes from the visceral level. Observations such as pretty, cute or fun are something that is frowned upon within design circles, as it is a shallow description to a product. Designers want their design to connect on a deeper level than just the visceral.

Whilst visceral design is all about the immediate emotional impact, the behavioral design is about the use and performance, and appearance and rationale do not matter. Behavioral design can be split into four main components: function, understandability, usability and physical feel (Norman 2004). The first behavioral aspect that a product must accomplish is whether or not it fulfils it needs; if a car is not able to take a person from one place to another it is useless. Although at face value it may seem that the functional aspect is the easiest to get right it is not easy as it seems. This may be because people’s needs are not as obvious as they might seem or they may have been misunderstood.

The last layer is the reflective design. Reflective design is about the meaning of things and the feelings evoked by the product. Attractiveness is a product of the visceral level, but when it is influenced with knowledge, experience and the culture it can become beautiful. This means that unattractive objects can still give pleasure. Other aspects that come into play at the reflective level are exclusiveness, prestige and rarity; all aimed at creating a perceived superiority for its customers.

Here, the product goes into the background when compared to the reflective level. That is not to say that it lacks at the visceral and behavioral level, in fact they have to a certain extent sustain the reflective message, but it is this reflective message that will sustain the expensive price tag (Kapferer and Bastien 2009). Sometimes adverts aim to sell a product not at the visceral level, but at the reflective level. This is often seen in adverts of cars, comparing them either to sexy girls or powerful animals. This seduction aspect has always been part of design, where it can be described as a promise and a connection to the user's goal and emotions (Shedroff and Khaslavshy 1999).

9.3 The Framework

The aim of the framework is to serve as a roadmap incorporating all the aspects related to branding, IPD and customers' responses to a product described in the previous sections. Key requirements of the framework include usability, clarity, yet generic enough to be used in multiple companies (Cini 2014). The framework is characterized by the main product design factors which cover branding and integrated product development aspects (see Fig. 9.1). Such factors have to be considered in the automotive environment which is characterized by external influences and constraints. The framework incorporates a list of checkpoints aimed to act as a reference in order to evaluate the car design from a branding point of view. In addition, this reference list is aimed at prompting automotive product designers to assess the emotional connectivity of the car with customers, as a consequence of their decisions taken. With respect to the framework that we presented in Cini and Farrugia (2016), the framework depicted in Fig. 9.1 has the third frame dealing with business screening. This part of the framework was added following qualitative feedback received from a number of stakeholders, who evaluated the initial framework configuration. Following are the details of the framework.

9.3.1 Branding Aspects

As described in Sect. 9.2, semiotics takes into account all the psychological reactions that a consumer experiences through. The proposed framework presents the different branding aspects, classified according to the three levels of semiotics.

9.3.1.1 Visceral Level

- Brand Design Attributes: Brands usually possess certain key identity attributes through which the brand is recognized and defined. Recognition of the core

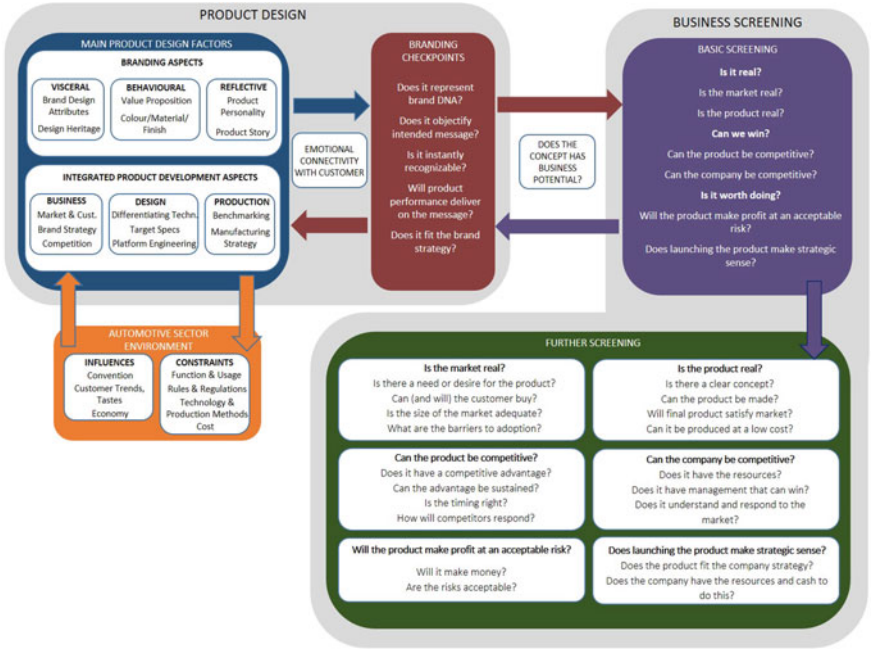

Fig. 9.1 Framework developed

brand values can be built through both explicit and implicit visual references (Karjalainen 2003). Explicit references are those design features that are immediately perceived and recognized by customer. Implicit references are features that are not easily distinguished but aim to become inherently perceived and recognized without customers being consciously aware of what the features are. In car design there are several features that can be classified as explicit references. These include the face of the car, the grille and the rear. Using *BMW* as an example, the face of a *BMW* is easily distinguishable with its two kidney-shaped air intakes with the *BMW* emblem above and two double-round headlights have been distinguishing every *BMW* for more than forty years (see evolution of grills in Fig. 9.2a). Continuing using *BMW* as an example for implicit references, the proportions of a *BMW* are such to convey dynamism with its elongated bonnet and long wheelbase. These traditional proportions also portray a certain timeless elegance but with a certain sportiness as well. Another BMW implicit reference is the crease line and more specifically for *BMW*, the kink in the rear window in the C-pillar (see Fig. 9.2b). It is commonly referred to as the *Hofmeister kink*, after the former director of design at BMW that created it. Visible on all *BMW* saloon cars since the 1960s, the *Hofmeister kink* creates the impression that the back of the car sits precisely on the

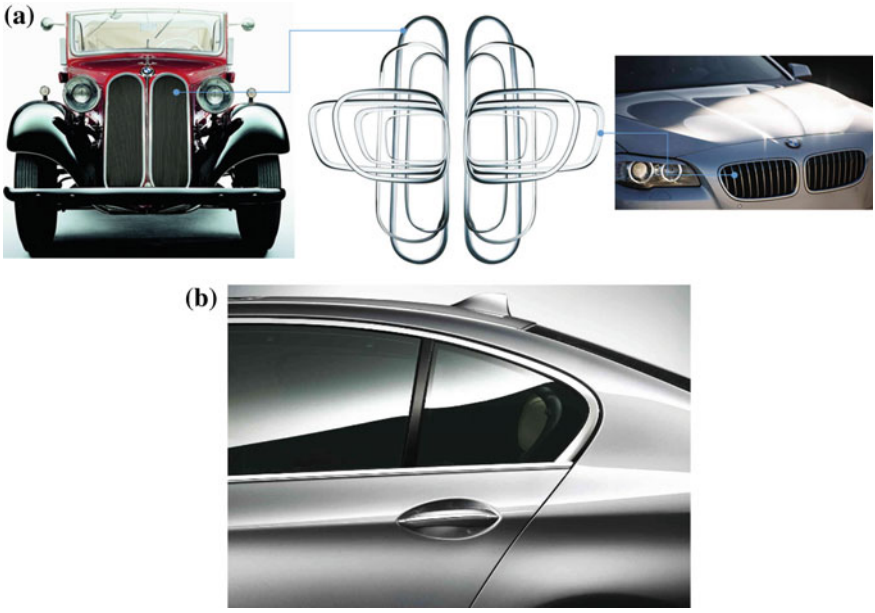

Fig. 9.2 *BMW* **a** explicit references (two-kidney shaped air intakes), adapted from BMWon (2016) **b** implicit references (the kink in the C-pillar), *source* Inquirer.net (2016)

rear-wheel axis, referring to the rear-wheel drive typical of a *BMW*. Even after detection, most people may still not be aware of how important these implicit references like the kink are for their perception of the product, in this case a powerful, rear-wheel drive car.

- Design Heritage: Design features become distinguishable characteristics by being repeatedly used in one form or another over several models, only then these become part of the brand's identity. By visually referring to this heritage, designers seek to make the product recognizable as being worthy of, or enhancing the brand (Moultrie et al. 2004). One of the top car makers which is closely connected to its design heritage is *Porsche*. Today it is considered the quintessential sports car, the benchmark for all others. More than 800,000 *Porsche 911* cars have been built, and has now become a design icon. In the words of Michael Mayer, Porsche Design Manager "*One of the reasons for that the design has been very cautiously and consistently refined over many years*" (Porsche 2011). Even the implicit references of a *Porsche* like its silhouette have become distinctive characteristic of a *Porsche 911*. This model has become so synonymous with *Porsche*, that it has become the design reference point to all other brand extensions. From the *Cayenne* to the *Panamera*, every *Porsche* carries a feature of the 911 design philosophy, shown in Fig. 9.3.

Fig. 9.3 All seven generations of the *Porshe 911*—showing the consistent design philosophy, *source* Leffingwell (2013)

9.3.1.2 Behavioral Level

- Value Proposition: The value proposition will be the main selling point of the car. This is achieved by turning one or a few of the customer needs into specific targets. The way the congested market is means that different companies take a different approach, depending on the market segment, brand and target customers. It can also apply to the whole organization or it can be different for each product. Examples of value propositions are plentiful. An interesting case is the value proposition of the *Tata Nano*. The value proposition was twofold; the first proposition was the target price at Rs. 1,000,000 (approximately €2000), which would make it the world's cheapest car and second proposition was for a safe, affordable and attractive car for Indian families that often commuted on a scooter. This generated special attention by media worldwide, thus gaining a foothold in the customers' mind and in the market before the product was even launched. The economic value as proposition is usually that used by entry segment level brands. Other automotive companies, especially those in the value segment, choose to use the technological capabilities of the car as the main value proposition. This is seen by many brands, and the trend nowadays is to focus on the environment by being green. This is generally done by promising a certain mileage per gallon as shown by *Volkswagen XL1*. The value proposition of the *XL1* is that the one-liter engine car is able to travel a hundred kilometers on one liter of diesel. *Volkswagen* markets the car as the most aerodynamically efficient and most fuel efficient production car ever (Hutton 2011). Even other value propositions that may seem intangible like emotional value and symbolic value

can be turned into a measurable target by companies. An example of this is set by *Porsche*. Whilst marketing its *Porsche 918* hyper car as being the fastest production car can be enough on its own, it set the target that it can lap the world-famous Nurburgring circuit in less than seven minutes (Porsche 2013).

- Color/Material/Finish (CMF) has been increasingly gaining in popularity in the product design industry, so much so that CMF has become a specialized field in itself. CMF covers all the aspects of color and new materials, the study of trends and the definition of new color systems that are able to influence customers. CMF is experiencing a continuous development in transportation where consumers' attitudes are becoming more characterized with a stronger emotional identity and this is achieved by richer, highly customizable and way more sophisticated color palettes and finishes. Color, especially from a marketing perspective, helps in defining the product character that the brand wants to portray. Colors such as red and yellow indicate extroversion and a certain boldness which are associated with feelings and emotions (Spriggs 2013). These colors are typically used to promote sports cars to promote the same personality trends. On the other hand, brands that aim to depict a certain maturity and sophistication tend to choose more traditional colors such as black, grey and navy blue. According to Frank Stephenson, *McLaren*'s design director, color has the ability to invoke emotions and communicate with viewers and has a big part to play in the design process (Car Design News 2013). "*The first thing color does influence is the brand—it gives the customer an identifiable element to what we're talking about. McLaren, for example, can be identified by orange*", *he explains.* "*It's one of the colors that is most prominent in our history, but of course when we originally used it in the past it was a papaya-type orange*". Materials also have an important role in how the product is perceived. The fabric and finish of the interior define the character of the car. An interior that is mainly plastic indicates that this is a no frills value car. On the other hand, sports cars tend to make use of a lot of carbon fiber material and alcantara (a type of leather) to emphasize the sportiness. Luxury cars tend to use leather and wood a lot more, getting inspirations from various other luxury objects like yachts and aristocratic houses. An example of how important the selection of material is highlighted by Gilles Vidal, *Peugeot* design director, stating that future Peugeots will be defined by their use of materials in a bid to shift the brand upmarket (Car Design News 2014). Raw, unprocessed materials, he says, will not only prove to be more ecologically sound, but also more engaging. CMF can be a good exercise to promote the origins of the product. Italian cars emphasize on their 'Made in Italy' leather, with the luscious leather and intricate stitching, whilst German cars have similar connotations with no frills and high technology and engineering. British marquee brands like *Aston Martin*, *Bentley* and *Rolls Royce* promote their British bespoke craftsmanship characterized by classic designs, elegant presence and Old World interior (Hampson 2013).

9.3.1.3 Reflective Level

- Product Personality: Refers to a set of characteristics based on the human character that people used to describe a specific product. These human-like characteristics serve as an analogy for the product behavior and capabilities (Janlert and Stolterman 1997; Aggarwal and McGill 2007). Product personality is important because it can help the user anticipate how to interact with the product (Govers et al. 2009). For example, a *Volkswagen Beetle* has a cheerful and friendly personality whilst a *Volkswagen Tuareg* is dominant and tough. Even though these products are from the same brand they have different personalities, and these have to be reflected as well in the design of the car itself because the appearance of the product is a major determinant in the perception of the product's personality (Govers et al. 2009; Jordan 2000). In fact, a study proposed by Brunel and Kumar shows evidence that visual aesthetics such as simplicity, dynamicity, timelessness and novelty are linked to perfection of product personality (Brunel and Kumar 2007). When a product is given human characteristics, it is called anthropomorphizing, which is something marketing personnel encourage as brands are filled with images and distinct personalities (Biel 2000). Studies have shown that anthropomorphizing a product may lead to more positive evaluations when the characteristics evoked are of a positive nature (Aggarwal and McGill 2007). An example of how anthropomorphizing influences product design is the latest *Citroen C1*, shown in Fig. 9.4, where designers focused on giving the car a strong character and a 'cheerful' design with sensible design of the two-part headlights and round inserts to create a smiling front end (AutoNews 2014). To further enhance the cheerful image and playful character that it wants to portray, *Citroen* makes use of two-tone and bright colors for both the interior and exterior. As it is noticeable, decisions taken at other semiotic levels like CMF and brand characteristics together have a

Fig. 9.4 New *Citroen C1*, *source* AutoNews (2014)

big influence on the reflective level, further highlighting the bond between all three levels of semiotics. Whilst the product appearance is the main contributor for a product personality, it has to be backed up by other aspects of the product, especially those from an engineering and production perspective such as performance, sound, finish and trim. A car that is tough in appearance has to have the same personality matching both in the interior of the car and its performance, otherwise the product story will not be credible. Person-product interactions can also have an influence on the product personality (Desmet 2003).

- Product Story: is a cautious act. Luxury level brands use one storyline to encompass all cars with the same message. An obvious example is *BMW* with its "*Ultimate Driving Machine*" slogan and Audi with "*Vorsprung durch Technik*" slogan, with both companies creating cars in that image. This obviously suits these companies very well; their car reviews and ultimately their sales reflect the success that they are achieving with this strategy. It is worth nothing that it is the brand strength which is allowing them to be able to design and manufacture cars with that image in mind, even though the products may not always reflect the image portrayed in the story. It is not possible for other companies with reduced brand strength to copy the same approach of a product story. Although the brand inherently carries a certain image, they try to tailor the product story for each vehicle. This allows them to target specific segments of the market individually. An example of this can be seen in *Fiat's* approach to different models. For instance, whilst *Fiat* still focuses on the brand image; aspects such as "*Italian style*" and "*fun*" are referred to constantly, however in case of the *Panda* the focus is mostly on functional side of the car highlighting aspects such as "*bigger, roomier, safer and more fuel efficient that its predecessors*" (Fiat Group 2012).

9.3.2 Integrated Product Development Aspects

In order to succeed in the automotive sector, it is vital that all three pillars of IPD, i.e. business, design and manufacturing are taken into account as from the outset every project. These factors have been selected and developed based on literature of different IPD models as well as design practice in the automotive industry.

9.3.2.1 Business Level

- Target market and customers: Market segmentation also allows for an analysis of consumer needs within that segment as well as comparing the strength of the company's existing or prospective product with respect to others in the same sector (Cini 2014). By mapping competitors' products along with its own products in segments, a company can assess which products will provide the best opportunities either to address weaknesses in its own product line or to

exploit unattended customer needs (Cini 2014). There are a number of different ways for segmentation, depending on the amount of variables chosen. Perceptual maps are one of the common segmentation techniques used due to their simplicity as they do not require a detailed study to create. Generally perceptual maps contain two dimensions as variables and they are commonly used by the marketing team to position its brand or product relative to its competition. An example of such a map is shown in Fig. 9.5.

- Competition: Rival companies are at the same time doing the market analysis as well and this will inevitably lead to movements by competitors to move into more profitable segments (Cini 2014). This increased competition will inevitably lead to a loss of market share and profit share within that segment if it is not addressed. In recent times, brands from the premium segment started widening their product portfolio by adding entry level cars and gaining a significant market share in that segment. Brands such as *BMW* and *Mercedes*, with the *Series 1* and *A-Class* respectively view this market expansion as a means to reach different customers. "*We aim to reach new target groups with the CLA—including those who never wanted to drive a Mercedes*", stated Dr. Joachim Schmidt, executive vice president *Mercedes-Benz* cars, sales and marketing, in a statement (Weiss 2013). What these premium segment brands hope by expanding their range with an entry level car, is to attract buyers and build brand loyalty, which in turn would hopefully lead to the same customers moving on to other models with higher profit margins. This means that brands in the same segment have to innovate with their approach to keep the same market share;

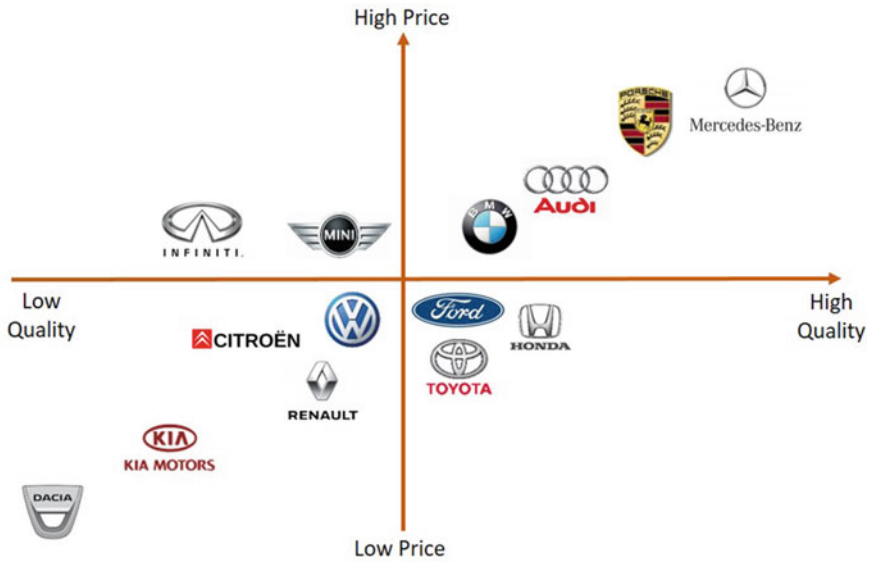

Fig. 9.5 Reproduced from positioning graph, *source* Adi (2016)

either by differentiating through technology or by clever marketing and sales programmes that entice customers.

- Branding strategy: There are companies that focus on technology leadership by developing new technologies and bringing them first on the market. These tend to be the premium segment brands such as *Mercedes* and *BMW*. Other companies' strategy nowadays is to focus on cost by providing the most efficient return for the money. A brand that is having big success in the cheap, entry-level segment is *Dacia*. Its success lies in providing customers with no-frills models that significantly undercut the competition by selling them at used-car prices (Ciferri 2013). Another strategy is to be imitative by following the market closely and analyze trends, then challenge the competition by rapidly providing a product that can fulfil that market's needs.

9.3.2.2 Design Level

- Differentiating technologies: It is important to keep in mind that the car is still fundamentally a functional object, and thus its functional aspect needs to remain in focus. The other possibility of the source of inspiration can be the technology push. Unlike the market pull there is minimal or no customer demand, so the technology push is driven by engineers. Together with the marketing and sales team they try to forecast which future technologies will be desired by the customers, or which they think will revolutionize the industry. The technology push is becoming ever more important in the automotive industry; for instance in 2011, *Toyota* and *General Motors* spent around 4.2 and 5.4% respectively of their sales on research and development activities (The Economist 2012). As highlighted earlier, in a highly saturated market, having a distinctive technological feature or advantage is imperative in breaking away from the market.
- Target Specifications: Customer needs are usually expressed in the "language of the customer" (Eppinger and Ulrich 2012), such as "comfortable ride" or "exciting". These are generally vague and subjective and whilst useful, they provide little guidance how to design or engineer the product, thus they need to be established as a measurable target of how the product should perform. The targets set here can be various depending on the market segment since different market segments have different requirements and customer expectations. The main specifications that are defined in general at the initial concept stage include cost, speed, acceleration, weight, fuel economy and sales volume. Other specifications are dependent by sector. For example in the luxury section where people are usually chauffeured in their cars, target specifications can also be rear headroom, leg room and shoulder room.
- Platform Engineering: Complex products such as cars consist of several subsystems interacting together for the car to be able to perform. Each individual subsystem requires its own specialization and design and in an industry where developing each subsystem such as engine and transmission require extensive

budget. Given as well the increasingly stringent regulations with respect to environment and safety and the increasing market segments, automakers look at sharing components between several models. Platform planning is a cross-functional activity involving all stakeholders of the company and where the integration of all departments is essential. A platform is a shared set of common components between multiple cars. Platform sharing is a popular product development method where different products and the brand attached to them share the same components, technologies and service procedures (Olson 2008). It has many benefits, but the main aim of platform sharing is to reduce the cost and have a more efficient product development process (Ulrich and Robertson 1998). The cost to engineer and tool up a mass-produced vehicle can run into billions of dollars. By spreading the cost over several product lines, a brand can offer an attractive price or have higher profit margins due to the economies of scale involved (Muffatto 1999). Other benefits include the increase in quality achieved by reducing the varying parts and increased global standardization between cars (Brylawski 1999). A platform consists of the under body, type of suspension, steering mechanism, powertrain components, placement of engine and passengers. The selected platform will influence many decisions. It will influence the overall dimensions of the car, as it will impose packaging restrictions on the designers as well as shape the overall concept of the car. The manufacturing department can start working on the initial estimation of costs, production planning and feasibility. Concurrently the marketing team will start defining the product unique marketing strategy. On the other side of the coin, there are downsides of platform sharing, in particular the reduced flexibility to make changes to the platform and a higher risk concentration which means a higher recall possibility in the automotive industry.

9.3.2.3 Manufacturing Level

- Benchmarking: at this initial phase serves several purposes. First it allows the design team to analyze market trends and customer tastes, since most customer driven demands come from having seen them in other cars. Secondly, they serve as an analysis of how the proposed car would compete against these benchmarked cares, based on the initial specifications. These then could be altered slightly to promote features that are lacking in these competing products. From a manufacturing point of view, benchmarking indicates the level of performance, quality and finish that the new car will, as a minimum, has to be equal to. At a further level of design, benchmarking takes a more technical turn where new technologies by competitors are analyzed to learn the technology in an inexpensive way by disassembling cars and their systems. However, at this stage no such detail is required. Benchmarking here will compromise of a guidance of current trends and analysis of how the chosen car's performance indices compare to the competition.

- Manufacturing strategy: This is becoming ever more important in the automotive industry, with companies nowadays looking to make the most of their manufacturing and labor resources by becoming ever more efficient (Cini 2014). Nowadays, one of the first decisions to be taken once a car is kicked-off for production is where it will be built (Autonews 2010), so it is important that even at the early stages of the product design the manufacturing strategy is taken into consideration, even if its importance at such an early stage is minimal.

9.3.3 Branding Checkpoints

As remarked in Cini and Farrugia (2016), these product branding checkpoints were based on evaluation criteria proposed by Hestad (2013). The qualitative feedback on the framework yielded two other branding checkpoints to Hestad's list, namely "*Is it instantly recognizable?*" and "*Does it fit the brand strategy?*" Both of these additional checkpoints provide a more robust approach to branding, ensuring that the product firstly is instantly recognizable (Cini 2014). Secondly, it is important that the product represents the brand strategy, both now as well as the future image the company wants to portray (Cini 2014). Together, these checkpoints cover all aspects of branding, both the product and the meta-product. Following are further details on the rest of the branding checkpoints (Cini 2014):

- "*Does product represent brand DNA?*" The aim here is to ensure that the product that is being developed is ultimately an associate of the brand; there has to be a perceived fit between the brand and product in the eyes of the customer. A customer will look at a car, especially those in the premium segment where the only justification of the price is in the brand image, and think "*Does this car look like a Porsche?*" Here what counts are not the marketing programs set to sell the car, or the badge of the car; what counts is the looks of the car carrying the characteristics that define the brand. Figure 9.6 shows a car with all explicit references to the brand removed; however it is still clearly identifiable what car

Fig. 9.6 Brand DNA ensures that the car is easily identified even though the image is modified, *source* Porsche (2016)

it is. This is because during the design stage, *Porsche* designers ensured that the soul of the brand is translated in the design.

- "*Does product objectify intended message?*" The product story and emotions need to be reflected in the design. Taking *Land Rover* as an example, a *Land Rover* is idealized as being a tough off-road vehicle that can be used for adventures. This brand message has to be taken on board and make sure that the looks reflect the intended message. This would mean that a *Land Rover* has to have an imposing silhouette and stance that as the marketing team defines it "*demands respect on every street corner*" (Land Rover 2014). Having a smiley or a cheerful appearance does not represent the intended message of the brand, even if the design on its own is aesthetically very appealing.
- "*Will product performance deliver on the message?*" This checkpoint relates the marketing with engineering design. It is essential that the performance specifications reflect the intended product story of the car. If a car promises the most comfortable ride, this has to be the main concern of the engineering team. For example, the *Fiat Panda* is aimed to be a people's car where functionality supersedes looks. This does not mean that they have to be necessarily lacking, but that the main concern with the design are functional aspects, and the design has to work around them. Given this premise, the *Fiat Panda* delivered on the product story, offering fourteen different storage spaces. Teaming this with a roomy interior, designers had a challenge to package this all, but they did so very well.

9.3.4 Influences and Constraints in the Automotive Industry

The key sources of influences and constraints which characterize the automotive environment are highlighted in this section. As mentioned in Cini and Farrugia (2016) we used the work described in Bloch (1995) and Moultrie et al. (2004) as a basis.

9.3.4.1 Influences

- Convention: Despite the desire of designers to break the mold and design something completely revolutionary, they have to deal with convention (Cini and Farrugia (2016)). Humans are a creature of habit, which is why it is very rare that new designs are not similar to something that customers are already familiar with. The same happened to car design (Cini and Farrugia (2016)). The first cars are almost identical to coach carriages without the horses. Since then, car designs followed the same evolution pattern with the engine in front of the passenger. This example shows how difficult it is for designers to move away and do something new which will be either loved or hated by the public.

- Customer tastes and trends: Trends are invariably one of the main outside influences on design, be it a conscious decision or not. Trends are the ultimate cultural and social influence on product design, where the influence is not just on a single product, but instead it becomes a style or a trend. A main generic example is the trend towards a minimalistic, sleek design most prominently used by *Apple*. *Apple*'s minimalistic design, which in itself was not a new thing, was appreciated so much by customer that it revived the whole minimalistic trend which influenced not just electronics but design in general (Mokhov 2012). The issue with trends is that they can easily become a yesterday's thing and seem dated, however looking at some of the current industry trends that are emerging, is the move towards elegance and simplicity. The trend in the interior car design follows the current general design trend of minimalism. The amount of physical buttons is being drastically reduced, and has been replaced by display screens similar to tablets, like in the *Tesla Model X* shown in Fig. 9.7. Not only has this made the interior more aesthetically appealing but also reduced the cabin of clutter and possible distractions, giving the impression of more space. Despite the trend towards stripped-back interiors, the complexity and decoration levels of interiors have reached new levels with automakers increasing the level of detailing with complex shapes and interesting new materials (Gallina 2013). The importance of this intricate detailing, material combinations and finishing is becoming essential as this has become a way to increase the perceived quality and craftsmanship (Gallina 2013).
- Cultural and Social Forces: Preferences for products and product form are also shaped by cultural and social forces (McCracken 1986) and part of the designers' job is to interpret these forces and channel them in their designs. An example of this is that lately customers are becoming ever more environmentally conscious and new designs are reflecting this. Materials used are not only green, but advertising brochures explicitly point this out. This is an extract from the

Fig. 9.7 *2016 Tesla Model X* uncluttered interior, *source* Carspecs (2016)

BMW i3 promotional material: "*The interior of the BMW i3 features a visible use of natural resources such as KENAF fibers in the door panels. This member of the cotton family is particularly sustainable. Its characteristic fiber structure, which remains visible after processing, underscores the premium claim of BMW i. In addition, the designers developed a completely naturally tanned leather with the customary outstanding BMW quality and feel. In addition to the use of natural materials, 25% of the weight of the plastic used in the interior comes from recycled material or renewable resources. The textiles used on the seats consist of up to 100% recycled fibers. This utilizes another potential for reducing CO_2 emissions*" (BMW Group 2013). This is but just one example of how cultural and social forces influence design. Designers as well as engineers have to understand and be ahead of these social forces. A car represents the owner, and buyers are especially careful with the image they want to project of themselves hence these need to be understood and interpreted in the design.

- Economy: It goes without saying that the state of the economy affects car makers and their approach to new cars. The economy affects in a multitude of ways. It affects the target markets and the approach to product design. In hard times, customers start moving towards the cheapest or most valuable options of the market and brands need to ensure that they not only are present in these market segments, but also be competitive both in price and in product. In addition, the economy affects what characteristics customers find more important. In times where fuel prices were low, the importance of miles per gallon was low and looks and size took precedence. These trends lead to the proliferation of gas-guzzling SUVs. Nowadays, customers look more towards efficiency and viewing the car more for its functional value rather than for its image value, which explains why brands such as *Dacia* are being successful (Ciferri 2013). By focusing more on being completive on pricing and offering a package that represents value, *Dacia* was able to experience growth in difficult times for the automotive industry. The state of the economy will invariably change over time, but its importance and influence on both the product and its design will always remain an underlying factor in car design.

9.3.4.2 Constraints

- Function and usage: The function, or main scope of the car, defines how a car will look. This ties in with the product story and the target market and customer, because a family car that has to fit five passengers comfortably will look invariably different from a sports car whose aim is an enjoyable ride, sometimes at the expense of comfort. However, apart from the main function of the car, the aim is to target the basic functions of a car that may sometimes be neglected and taken for granted. These practicalities of what the product does need to be understood from a user perspective and that includes aspects that go unnoticed like ingress and egress.

- Brand values and heritage: Since the product has been shown to be one of the main channels of communication it is vital that it represents the brand in the desired way. Consequently, designers are tasked with developing a product that will strengthen the brand identity, tying in with the semiotic aspects of design. Brand references are the signals that identify the brand and can act as both a motivation to designers to come up with a different and still liked interpretation of a brand reference as well as a constraint in limiting designers' creative freedom. An example of this is the aforementioned famous *BMW* kidney grille, which evolved throughout the years; designers might have seen the grille as a constraint but instead throughout the years it was interpreted differently depending on the times to always be relevant and one of the most interesting features of the car. A study reported in Burnap et al. (2016) aimed at investigating the relationship between design freedom and brand styling, revealed that two from four different car makers (*BMW*, *Audi*, *Lexus* and *Cadillac*), had a negative relationship between these two parameters. This means that in such cases designers would struggle more to change the car styling as it would impinge on the brand recognition.
- Rules and regulations: During the design of the car, apart from the challenge of having to package all the components and their functional requirements and making sure that the brand is well represented, car designers have to comply with a range of legal and regulatory guidelines that will invariably influence how a car looks like. Looking at exterior lighting requirements for example, the headlights shall consist of a high and low beam, to illuminate the environment in front of vehicle. To complicate matters further, different regions have different requirements (Cini 2014). One of the main differences between the American standard and the European standard is the glare to other drivers on the low beam setting. Whilst the American standard permits a relatively high amount of glare and a gradual transition of the beam from bright to dark, the European standard is stricter; requiring a sharp change between the dark glare-control zone and is the bright seeing-light zone (Grueninger 2016). Differences do not end there. American regulations require that all headlights have the same angle to the floor irrespective of the vehicle height, which makes that the visibility of a sports car is drastically reduced to that of a truck, the European standard angle depends on the mounting height so that all drivers have roughly the same visibility distance and all cars produce roughly the same glare (NHTSA 2016). This example of just one area of the car shows how regulations affect greatly how cars look, and how much attention designers give to these legislations, especially when trying to produce global cars in order to produce cost-savings.
- Technology and production methods: In markets that are technologically driven such as the automotive industry, products compete based on their technological competence. Product form influences the product perception (Page and Herr 2002), therefore cars designers aim to accentuate the technology competence using the product form. They especially try to use the latest technology available to further emphasize the point. Given that the automotive industry cannot respond quickly to trends like other products since the product life cycle can be

up to six years it is especially important that when cars are designed they use the latest technology possible to them. Production methods also influence greatly the look of the product and designers must take into account the available production methods capabilities and limitation (Moultrie et al. 2009). The current trend is the increased use of carbon fiber, not just for body panels but as well as the chassis. Carbon fiber has a high strength to weight ratio; around 50% lighter than steel and around 30% lighter than aluminium which makes is desirable to use, however it is expensive and time consuming to produce in high volumes until now. Although this technology has been limited to racing car, its use is becoming ever more frequent in the automotive industry. Apart from sports car manufacturers like *Ferrari*, *Porsche* and *McLaren*, carbon fiber use is expanding further with companies such as *Alfa Romeo* and *BMW* making use of it. Carbon fiber gives the flexibility to design complex shapes, and *BMW* designs took full advantage of this creating a very futuristic looking cars as carbon fiber allows designers to achieve complex shapes and radiuses that steel pressing does not permit (e.g. *BMW i8*).

- Cost: It is not just the technicalities that influence the product form but as well the cost of producing the product depending on these technologies and production methods. The marketing experts set the price range depending on various factors such as market positioning and competitors. The company will have a target return of investment on the project and these pretty much dictates everything from the new technologies used to the type of materials. Apart from the product cost, senior management has a set budget for research and development of new technologies to keep in check during its expenditure. Whilst innovative companies such as *Ferrari* may invest as much as 17% of their annual turnover in product development and another €250 million in research and development into reduction of emissions (Ferrari SpA 2013), other companies are not as affluent as *Ferrari* and their contemporaries and has to keep the product development costs as low as possible. One such possibility is to share costs of development, such as using product platforms between its products or sharing them with other companies. The challenging economic situation is leading OEMs to take drastic decisions to keep up with the market demands whilst keeping the financial realities in check. Currently there are two trends that are prominent in the automotive industry; one is mergers and acquisitions, and the other is strategic alliances. The benefits of mergers and acquisitions are mainly down to the economies of scales achieved by joining two or more companies together. Other benefits include technological ones where a company can tap into the other's resources to develop its own products. Also, research and development costs can be spread out onto multiple brands and cars, leading to an overall cheaper car that is able to compete better in the market. A merger can also provide a company with a platform to another regional market that it currently does not have a foothold in. All these instances were seen in the acquisition of *Chrysler* by *FIAT*. Merging both companies made sense for both. *FIAT* now has become a global industry player and will be better positioned to challenge *GM* and the *Volkswagen* group. *FIAT* also gained access to *Chrysler*

profits, helping it shore its European market losses. The merger will also help tightening the bond between all of its brands, with *FIAT* and *Dodge* sharing the same platform as well as *Maserati* and *Alfa Romeo* using the same platform as the *Jeep Grand Cherokee*. On the other hand, other OEMs look at other solutions to still benefit from economies of scale and keeping their company autonomous. Strategic partnerships or alliances are becoming ever more common in the automotive industry with OEMs seeking partners when to develop expensive technologies. This has led to the likes of *BMW* and *Toyota* to partner together to build a sports car on the same platform, as well as seeking cooperation on other technologies such as lithium-ion batteries and lightweight technologies (Reuters 2013).

9.3.5 Business Screening

This part of the framework is not intended to be used for the initial stage of concept generation where ideas are important and restrictions on creativity should be few or none. Rather, the business screening frame shall be employed further on in the project cycle where initial concept starts developing into a more serious business proposition. The potential behind this part of the framework is that, apart from offering a summary of the important factors, it assists during the decision making throughout the several design iteration stages.

A useful tool at this stage to help weed out several concepts is the *Real-Win-Worth-it* (RWW) method by Day (2007). This screening process is another simple but powerful tool that presents a series of questions that cover all aspects, ranging from the product, market and the company's capabilities and competition. It works well with the framework as it helps the users consider the main factors; now the screening will help in making decisions based on these factors. The *RWW* method does not consist of an algorithm for making go/no-go decisions, however it is rather a systematic process that can be employed at multiple stages of product development to help the users come to a rationalized decision. The screen will help with identifying problems, given that new projects are inherently a non-linear process, especially when it comes to styling. The *RWW* method is based on the following three main questions:

- "*Is the opportunity real?*" The first steps of the screening are the basis of the screening, where the team figures out if there is a market for the product and whether a product can be made to satisfy that market. This evaluation is done based on factors mentioned in the main framework like market size, market growth, technology available and the likelihood of customers buying the product.
- "*Can you win with this opportunity?*" After determining that the product and market are real, the team must assess if it is able to gain and hold the market share. This is done by analyzing the competition, whether the product will have

a competitive advantage through differentiating technology and if the company has the resources to succeed. At this stage, the screening has moved from analyzing if the product has the qualities to succeed in order to understand whether the company is able to make the product succeed.

- "*Is the opportunity worth doing financially?*" Arguably the most important screening for the management, the team now has to provide a rigorous analysis whether or not this project is worth pursuing from a financial and strategic perspective. Even at the early stage of product development, unless a concept is being done just for illustration of either technology or aesthetic design, a product has to prove itself financially if it is to be given the green light. Initial assessments of resources and risk analysis are to be conducted to understand the risks and devise ways how to mitigate them even at early stages.

The initial screening process focuses mainly on the viability of concepts; however the screening can be continued to be developed further for different development stages with increasing detailed screening questions, moving from vague answers to ever more accurate answers. To this end, as shown in Fig. 9.1, the initial questions proposed, at the basic screening stage, are decomposed into a set of six main questions as the design process becomes more intensive and moves towards production.

9.4 Evaluation and Discussion

As reported in Cini (2014), a qualitative evaluation activity was carried out intended primarily at assessing the suitability of the framework. A presentation on the framework was first delivered. Semi-structured one-to-one interviews were then conducted in which participants were asked questions a number of questions to scale from 1 to 5, where 1 is the lowest scale of the ranking. Participants were encouraged to comment on the rating given so that more insights on the framework could be gathered from qualitative data.

As reflected in Table 9.1, the sample consisted of academics and product development stakeholders, which as remarked in Cini and Farrugia (2016), included high profile designers, programme directors and engineers with experience at renowned car makers including *Porsche Automobil*, *McLaren Automotive*, *GM* and automotive design firms, e.g. *Qoros*. The aim of having a sample of participants with such a diverse background is to assess the framework from broad perspectives; in fact several interesting points emerged.

Key results reported in Cini and Farrugia (2016) and other findings are summarized below:

- Predictably, all interviewees agreed on the importance of branding, with almost all interviewees giving it the highest ranking possible ($M = 4.7$, $\sigma = 0.47$). As one participant stated "*There is an acknowledgement within upper management*

Table 9.1 Background of participants who volunteered in the evaluation

Background	No. of participants	Average experience (years)	Typical posts held
Academic—IPD	5	15	Programme Director for the M.Sc. Integrated Product Design (IPD), Design Consultant
Academic—Design	5	8	Senior tutor in vehicle design course
Industry—Management	5	12	Project Manager, General Manager of Motorsports Strategy, Styling Director, Exterior Design Manager
Industry—Design	5	19	Car interior and exterior design, product development of dashboard car switches

that design and brand play an enormous role; management are seeing the positive impact that design can have if it's done right. Design becomes especially important when you move into international markets where you might not have been very present until now".

- Irrespective of their background, participants agreed that semiotics is relevant to represent branding in product development (average rating $M = 4.60$, $\sigma = 0.60$). As a participant stated, he has three main criteria to judge cars; "*Emotion, how much does it turn you on? Intellect, does it fit with the brand and how new is it? And execution, how well is the handiwork done?*" The three aspects mentioned by the participant relate to the three facets of semiotics. This further confirms that semiotics is the right choice to represent branding in product design, especially in the automotive industry (Cini 2014).
- A positive attitude was also expressed on the extent to which the selected factors in the framework really represent design, branding and engineering at early design ($M = 4.45$, $\sigma = 0.60$). Participants confirm that the factors which characterize the framework are the main factors that should be determined during the initial concept stage. Other factors may have been included, however it was agreed that doing so would have made the framework more cumbersome, and that the factors are an umbrella for several sub-factors, that could then be developed on in more detail further down the line in the product life cycle. This aspect of the framework, the balancing of factors and presentation was praised by participants, as one succinctly put it "*The framework shows in a very clear, condensed way the starting phase of a new car. Experienced car manufacturers have this knowledge immanent by their people. For new companies (e.g. Tesla) this is very helpful. For established companies it could help to accelerate the discussions on new cars*".
- On average, most participants agree with the inclusion of constraints and influences in the framework ($M = 3.95$, $\sigma = 1.10$). Contrasting views were provided on this aspect. As one participant highlighted, "*Constraints are very important in order to develop a successful product. Ignoring influences and*

constraints till later on in the product development cycle can result in cost implications and a product which doesn't satisfy all constraints". On the other hand, some participants were not favorable on the inclusion of constraints and influences, arguing that whilst the constraints are unavoidable nowadays, car companies should ignore the external influences as it would mean that these brands would be following not leading, always behind the curve. As one participant puts it; "*'Leading and not following' are crucial for any company, reacting to trends ensures that a company will always be two or three years behind*". The prevailing conclusion here is that the use of influences and constraints is circumstantial depending on brand positioning. For supercars and marquee brands, both constraints and influences are marginal and possibly negligible. On the other hand, constraints and influences could result crucial for economic brands to survive.

- A very positive opinion was exhibited regarding the framework's usefulness in practice ($M = 4.00$, $\sigma = 0.79$). It was explicitly mentioned by one participant that the framework serves as a systematic discussion tool in initial project meetings "*I think that this rationalized approach needs to be used as a basis for group discussions between company designers, strategists, engineers, sales and marketing people and the board, so that future directions are supported by all team members. This is much better than having apparently arbitrary decisions made for one*". This statement sums up the usefulness of the framework, in which all the intended objectives were met. As is the nature of IPD, product development should be integrated with other development activities and decisions should be taken collectively as a group with all stakeholders represented (Andreasen and Hein 2000). The framework aids in these discussions by providing a platform on which the main factors are presented and discussed, helping giving a clear picture of the company, the competitive market and constraints and influences that can affect the project. Furthermore, it can be argued that the framework is generic, applicable for several companies. For instance, the business screening process is a generic one and is used by multiple companies across different industries with positive results. In itself, this is another strength of the framework. The branding checkpoints are another strong point. Given the importance of branding, it was important that the framework fully translated that and represented branding correctly. Comments from participants were equally positive on this and as one participant highlighted "*a designer's job is to understand and interpret the culture of a company and then turn that understanding into a three dimensional object; that is what designers do, and that is what I still see myself doing. The framework helps in doing so*".

On the other hand, as reported in Cini (2014), one of the main weaknesses mentioned by the survey participants from an academic perspective is that it is not an active framework, i.e. the framework does not offer feedback or is in process form to aid the design process. This weakness was highlighted especially from academics used to frameworks being process based or activity related. These types of frameworks usually follow a chronological order of tasks and activities, whereby

depending on the result achieved the next step is determined. Such design activity framework, as the one of Ullman (2010) is normally desired because of its ease of use and sense of clarity. This rigid approach however was found that it was not the way to go to create a useful tool for the automotive industry given the non-linear approach to design and the difference in design processes of different companies (Baxter 1995; Lewin and Borroff 2010).

Another weakness of the framework is that, as one participant highlighted, the framework is just the 'tip of the iceberg'. Without arguing about its usability, it can be said that the framework can be more effective if somehow it can be modified for different solutions/guidelines at different stage of the design process. A judicious compromise is needed to balance this with the fact that a complicated framework would be an 'ivory tower', something that is theoretically robust but would however be discarded by the industry. The previous results show that the right balance between usability and complexity was achieved with the framework, however there still remains scope of improvements. Any improvements to the framework can be established through a 'hands-on' evaluation exercise by applying it in early development stages of a new car model. This shall shed light on the validity of the evaluation results achieved so far, considering the small sample of participants. Another future direction is to use the framework as a backbone for a proof-of-concept computer-based supporting tool (e.g. an app) to guide novice automotive designers to take a holistic approach to integrate branding in product design.

9.5 Conclusions

This chapter contributes a framework which integrates branding in automotive product design. Although it was initially intended for the automotive sector, it can be applied across a number of other fields. The distinguishing features which collectively make the framework novel consist of semiotics, IPD principles, branding and business checkpoints. The initial results are promising, in particular, because a pool of experts, including renowned automotive designers, expressed their positive views on the proposed framework. However, future work is required to validate its usefulness in practice by applying it in real industrial projects, not necessarily in the automotive field.

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Chapter 10
The Brand Gap: A Framework for Brand Experience Analysis

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Abstract Companies need to focus their innovation activities on the generation of unique and memorable brand experiences to gain sustainable and significant competitive advantages. Existing brands already have certain products and services that generate a particular experience in customers' minds. Every time customers interact with any of the brand's contact points, they form an idea about this brand. This is how a brand experience is built. However, distortions exist between what the brands want to communicate and what the customer perceives. This is called a brand gap. Understanding the brand gap and its origins might help companies to open up new innovation opportunities to strengthen the brand experience. This article presents a theoretical framework to better comprehend the brand gap.

10.1 Introduction

Companies in growth markets set a strong focus on technology-driven innovation. However, technology starts losing its potential for differentiation as the market transforms from a growth to a mature market. Moreover, the oversupply of information and product variants has overstretched customer decision-making capabilities. Digitalisation has increased the amount of information available on brands and products. Nowadays, customers are better informed and can more easily realise the technical similarity of products. Accordingly, customers are becoming more demanding in their choices. Thus, innovation becomes valuable when it meets

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customers' expectations (Fukuda 2013). These facts, along with an increasingly globalised society, have transformed the process of value creation.

Since innovation can be considered more emotional than technical (Fukuda 2013), companies can no longer solely rely on operational efficiency or technological superiority to create a sustainable competitive advantage. Today, companies must also find ways to increase customers' empathy and loyalty with a brand. Experience offers brands great potential to create differentiation from competitors and to obtain customer engagement. In essence, it can help companies generate a sustainable and significant competitive advantage.

Pine and Gilmore (1999), through the theory of the Experience Economy, present evidences and case studies on the importance of experiences in the development of value proposition. This theory suggests that corporate activities, such as innovation, should introduce an experiential variable and focus on the generation of experiences that reinforce the bonds between brands and customers. To do so, ensuring that brand values are consistent in the customer experience is among the challenges for brands in the future (Newbery and Farnham 2013).

In the Experience Economy (see Fig. 10.1), the brand is no longer a mere label or logo that identifies the manufacturer or owner. It has, in fact, become a strategic asset capable of generating sustainable competition (Aaker and Jacobson 2001). So, brands like IKEA, Apple and BMW are focussed on building experiences related to the brand that highlights the sensory, cognitive, emotional, social and behavioural characteristics of customers (Brakus et al. 2009).

A brand experience happens whenever you come into contact with an organisation or its brand. Brands, especially strong ones, embody a relatively small set of

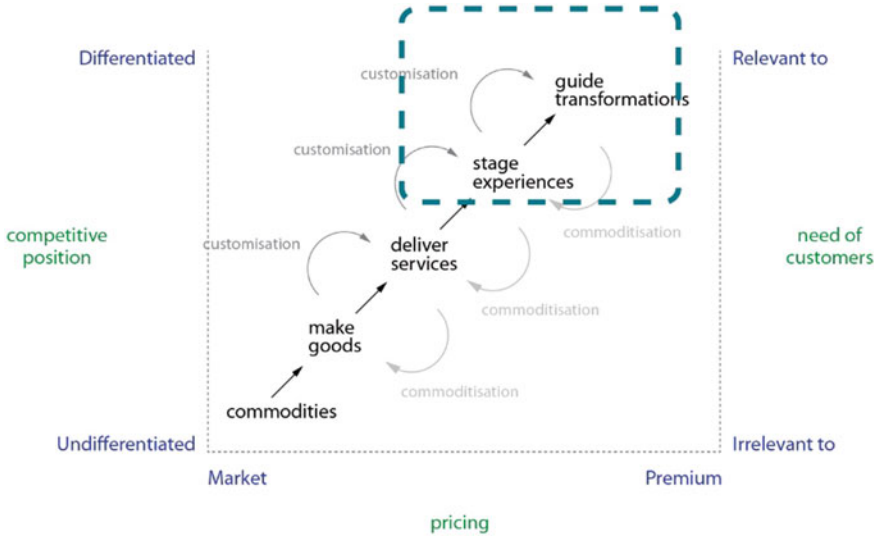

Fig. 10.1 Economic value in the experience economy (Pine and Gilmore 1999)

attributes that are specific and distinct to that brand. These values gain significance when customers interact with any of the brand's contact points (products or artefacts), also called touchpoints. Each touchpoint carries specific brand values. So, brand values need to be materialised at each touchpoint and engineered to deliver brand values in an optimum way (Roscam 2010).

For example, Nespresso has a simple brand idea: 'the quest for excellence'. This idea carries certain core values linked to excellence, timeless elegance and exclusivity. These values can be perceived every time we interact with any Nespresso touchpoint, for instance, one of its stores. The Nespresso store has been designed according to a boutique concept (see Fig. 10.2a); when customers enter the store, they perceive, feel and experience the exclusivity and elegance of the brand. However, this is not sufficient for a forward-looking, consistent brand experience. The Nespresso coffee capsules have a diamond-like structure and exotic-sounding flavours (see Fig. 10.2b); the angles of the capsules, together with their shiny texture, lend a sense of elegance and luxury to the product. In addition, the coffee machine itself is unusual (see Fig. 10.2b); Nespresso combined traditional coffee machines and art deco patterns to create a unique design. Further, the company's web page reaffirms the Nespresso brand experience through its design, usability and services offered. For example, the web page shows a variety of coffee menus that have certain similarities with haute cuisine. In conclusion, every element that

Fig. 10.2 Examples of Nespresso touchpoints: (**a**) store, (**b**) capsules, (**c**) coffee machine and (**d**) web page menu service

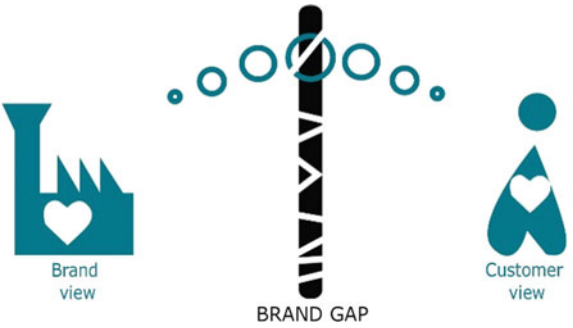

Fig. 10.3 The concept of a brand gap

surrounds Nespresso is designed taking into account the brand values. This is how Nespresso manages to evoke a consistent brand experience.

When designing touchpoints, several authors highlight the importance of aligning brand values and customer experiences (Newbery and Farnham 2013; Karjalainen 2004; Clatworthy 2012; da Motta Filho 2012). However, brand values are not always properly embedded in touchpoints, leading to inconsistent brand experiences, often due to distortions in the touchpoint design process (Karjalainen 2004). Inconsistencies result in gaps between what the brand wants to communicate and what the customer perceives, which is how a brand gap arises (Neumeier 2003; Hestad 2013) (see Fig. 10.3).

If we are able to figure out the origin of the brand gap, we might be able to take innovative action to reduce it. To do so, we must evaluate how the brand values have been embedded into touchpoints and how the customer perceives them. As a result, the brand gap can become a new source of innovation.

For instance, when an outdoor power product company wants to show a robust image, all its products and services should evoke and look robust. Imagine if the company designed a light coloured, slim, lightweight chainsaw that start up with a delicate gesture. From the customer's point of view, such shapes and interaction create a sense of something that is delicate rather than rugged. Thus, customers might feel like the product is not sturdy enough for use in harsh environments and that it will break easily. So, if we figure out why customers do not perceive the product as robust, we can take innovative action to improve the product.

As discussed earlier, improving customer experience and satisfaction is a top priority for brands. Therefore, focussing on the brand gap can enable companies to respond more effectively to customer requirements, build customer loyalty and create stronger value perception. Additionally, understanding the brand gap can generate innovation opportunities, which in turn generate sustainable, competitive differentiation. This leads to improved prospects for long-term profitability.

This chapter presents the concept of the brand gap and suggests a theoretical framework to comprehend and analyse its origin as a new source of innovation. First, the chapter defines what an experience is and explores how brand experiences are built. Next, a detailed and thorough look at the brand gap concept is presented.

Finally, a theoretical framework is discussed to further define and understand brand gap. The novelty of this chapter is that brand gap is yet an unexplored source of innovation.

10.2 Experience and Experience Design

In the last decade, the design community has identified a new idea that might become a competitive differentiator for business: experience. Major corporations (e.g. IKEA, Philips, Nike) have adopted an experience design strategy for their product development. In fact, the design community is engaged in an increasing amount of research and publications (Green and Jordan 2002; McDonagh et al. 2003).

The term 'experience' has a multiple meanings.

1. A particular instance of personally encountering or undergoing something.
2. The process or fact of personally observing, encountering or undergoing something.
3. The observing, encountering or undergoing of things generally as they occur in the course of time.
4. Knowledge or practical wisdom gained from what one has observed, encountered or undergone.
5. Philosophy, or the totality of all the cognitions obtained through perception; all that is perceived, understood and remembered.

All these definitions can be split in two categories (Schmitt 2011). Some refer to the past (referring to knowledge and accumulated experiences over time) while others refer to ongoing perceptions, feelings and direct observation. In the English language, as in many Romanic languages (French, Spanish and Italian), there is only one term to refer to both. Other languages use two separate lexicalised items; for example, *erfahrung* and *erlebnis* (in German). Both concepts have been pointed out in multiple fields like philosophy, psychology, marketing and engineering design. All of them have made important contributions to understanding the nature of experience, its impact on consumption habits and on product and service design processes.

A literature review on experience shows that it is no longer sufficient for a product to function properly, to be usable and efficient. It needs to heat the hearth of the consumer in order to compete (Desmet et al. 2004). In fact, studies show that experiential purchases (e.g. the acquisition of a ticket to an event, such as a concert, dinner, journey) make people more happy than material purchases (e.g. the acquisition of tangible objects, such as clothing, jewellery, stereo equipment) of the same value (Van Boven and Gilovich 2003; Carter and Gilovich 2010).

Thereby, experience design refers to the approach of creating emotional relationships with users through meticulous planning of both tangible and intangible aspects (Pullman and Gross 2004). Moores (2004) argues that experience design is

a process of engineering every aspect of the customer interaction with the brand. Diller et al. (2006) highlight the role of touchpoints as the intermediate element between the customer and the brand, whereas Newvery and Farnham (2013) point out the importance of the entire lifetime of the customer relationship with a brand.

There is still very much confusion around the subject of experience, and there are several existing approaches to this topic. For the purpose of this chapter, experience design is understood as the conceptualisation, development and orchestration of all interactions between a customer and a brand over time, which are meant to maximise the value generated for the customer and the brand (BrodtT 2007).

10.3 User Experience, Customer Experience and Brand Experience

The popularity of the concept of experience is increasing across practitioners and academics. This is why, in the last years, many terms and acronyms that seem similar have appeared. Many even have multiple interpretations by industry practitioners, which adds to the confusion. This fact, moves us to analyse the differences and similarities of the following concepts: User experience (UX), customer experience (CX) and brand experience (BX).

The concept of UX has a high level of abstraction and complexity. Academics and researchers are not yet in consensus regarding its definition (Law et al. 2008). However, the most accepted definition of UX is the one presented in the international standard on ergonomics of human system interaction, ISO 9241-210: UX is defined as a person's perceptions and responses that result from the use or anticipated use of a product, system or service. According to the ISO definition, user experience covers all the users' emotions, beliefs, preferences, perceptions, physical and psychological responses, behaviours and accomplishments that occur before, during and after use. UX is about transcending the material and creating an experience through an artefact (Hassenzahl 2011). It encompasses all the interactions of users with a company's products and services, not just interactions in the digital realm (Shedroff et al. 2013).

On the other hand, CX is defined as the internal and subjective response customers have to any interaction with a company (Lemke et al. 2011; Meyer and Schwager 2007; Zomerdijk and Voss 2010). This definition seems to resemble the broader definition of UX, which considers all the customer interactions with the company. So, UX is a part of the broader CX, but CX contains some aspects outside of a product that UX does not. Although CX is influenced by the quality of the experience at each point, it is especially interested in the entire life cycle.

Finally, BX is conceptualised as sensations, feelings, cognitions and behavioural responses evoked by brand-related stimuli. Such stimuli appear as part of a brand's design and identity, packaging, communications and environments

(Brakus et al. 2009). This means that BX, encompasses each interaction between a customer and a tangible or intangible artefact, which awakens subjective customer responses. So, BX is the sum of customers' perceptions at each touchpoint (Chattopadhyay and Laborie 2005; Alloza 2008). In this context, BX is created when customers use the brand, talk to others about the brand, and seek out brand information, promotions, events and so on (Ambler et al. 2002).

Although there is great confusion about the distinction between CX and BX, most authors agree that the differences between these two concepts are minimal. Some authors believe that CX is a subset of BX, while others think that both concepts are essentially similar and that the difference lies in the company's approach to these concepts.

This chapter focusses on BX. BX takes into consideration the relationship between the customer and the brand through all channels. Moreover, it places a special focus on the brand and its values as a differentiating and recognisable element of this relationship.

The next section provides an in-depth analysis of brand experience and its design through an example.

10.4 Brand Experience Design: The Nespresso Case

As discussed earlier, experience is becoming a top priority for many brands. Brand experience-based companies manage to differentiate their offerings in competitive marketplaces while staying relevant to their customers. However, experience design is getting vaguer, as the number of concepts and models around this theory are increasing. Consequently, the process of developing strategies to reach the desired brand experience is also getting more complex.

To clarify our approach on brand experience design, fictitious scenarios are described as an example. These scenarios show how the Nespresso brand and Anne, the protagonist of the story, interact in a brand experience context.

Every Saturday morning, Anne starts the day with a cup of Nespresso coffee. When she opens the cupboard to reach for the coffee pot, she realises that there are only a few flavours left. So, after having her coffee, she decides to go to the Nespresso store to buy new ones. There is a beautiful Nespresso boutique two blocks from her home, where you can not only buy coffee but also enjoy it there along with the sweet treats served with it. Anne arrives at the store at around 11.00 o'clock and is served by Alberto. He informs Anne about the new limited editions that Nespresso has recently launched: Cafezinho do Brasil and Africa Passion. Anne decides to buy the Africa Passion limited edition in addition her usual flavours. Happy with her new acquisitions, she arrives home and fills the pot with all the colourful coffee capsules. Of course, Anne ends the morning by tasting her new Africa Passion limited edition coffee.

However, this is not the whole story. Next time, Anne decides to buy the coffee capsules online. First, she visits Nespresso's website and she checks the existing

flavours. Once that she selects what she wants, a promotional video describing the new limited edition pops ups. Afterwards, the online service gives Anne the option to also buy them and she accepts it. Finally, she clicks the order tab and she receives a message thanking for the purchase. Two days later a telephone message informs Anne that the capsules are about to arrives. Anne selects the option "bring it here" and 3 h later the delivery person appears with a nice Nespresso give box.

So, how will these two experiences impact the Nespresso brand's experience building?

In the first situation, also called a lived experience (see Fig. 10.4a), Anne takes certain actions through which she obtains certain inputs. The quality of these inputs generates an opinion in her mind. This means that Anne attributes values to the brand based on her experiences with it. In the second situation, a similar thing happens. She again gets certain inputs and, consequently, generates specific attributes. The sum of the attributes generated in each of these experiences creates a memory related to the brand, which is called the remembered experience (see Fig. 10.4b). Although the environment and touchpoints change in both scenarios, the perceived values should be similar in order to construct a consistent brand experience. Only then will the customer experience strengthen the brand.

In the first instance, each experience is built by a sequence of events: when she wakes up and sees the empty pot, the moment when she enters the store (see Fig. 10.4c) and buys the products, and finally when she arrives home and enjoys the coffee. The sum of all these sequences in time is called the customer journey. Now, imagine a situation where Anne buys the new flavour, arrives home, and when she

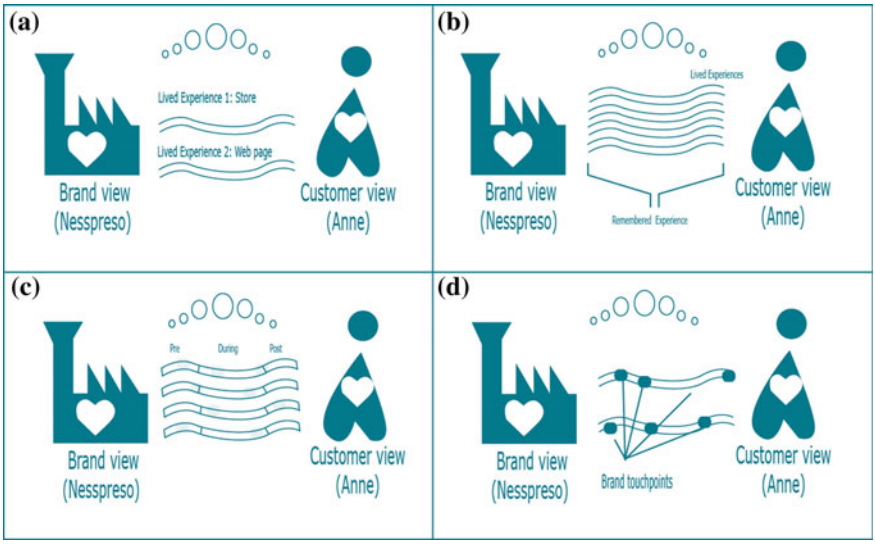

Fig. 10.4 Influencing factors in the brand experience: (**a**) lived experience, (**b**) remembered experience, (**c**) customer journey and (**d**) brand touchpoints

starts preparing the new Africa Passion flavour, the coffee capsule does not fit into the coffee shaft. Or when she decides to buy the coffee capsules through Nespresso's website, it takes her more than 30 min to figure out how to make the purchase. It is pointless to have a positive first sequence if the rest of the sequences are not given any thought.

During the customer journey, the customer interacts with different artefacts and elements called brand touchpoints. In the example, this would be the empty coffee pot, the store, the behaviour of the assistant, the new coffee capsules, and the coffee itself (see Fig. 10.4d). The quality and type of interaction and the way in which all these elements are orchestrated will affect the final experience. Therefore, the quality of the customer's memories will be affected by how these artefacts are designed and orchestrated.

In summary, to construct a consistent brand experience, brand values must be coded into the design and orchestration of each touchpoint, as these are subsequently decoded by customers as they interact with the touchpoints.

10.5 Theoretical Brand Experience Design

In this section, we will theoretically approach the factors highlighted in the previous section.

10.5.1 Lived Experience Versus Remembered Experiences

Regarding experience, there are two concepts worth analysing: the lived experience and the remembered experience (Forlizzi and Ford 2000). The former is defined as an experience with a beginning and an end, an action that could lead to changes (Dewey 2005). In practical terms, the lived experience can be understood as each individual's experiences with a brand and the same customer might have multiple and diverse experiences with the brand.

The remembered experience is defined as the knowledge and memories accumulated through life lessons and events. This concept is directly related to a customer's purchase decision making of a particular brand. Since human beings spend most of their time thinking about events from the past or anticipating future events, the quality of their memories impacts their decisions (Hassenzahl 2010).

Thus, the remembered experience is built through all the lived experiences of a customer with a brand (Carlson 1997). Although remembered experience is most likely to influence the choice of any of the brand options, several authors have pointed out the duality of experience (Hassenzahl 2010; Boswijk et al. 2005; Wright and McCarthy 2010); they state that both momentary and accumulated experience must be taken into consideration. Therefore, companies should focus on

their offer of present and future lived experiences if they want to change the remembered experience of the customer.

10.5.2 Brand Touchpoints

Brands do not interact with customers through a single element; rather, they do so through various interactions. These interactions, called brand touchpoints, are points through which a customer comes into contact with a brand. Therefore, each brand touchpoint needs to be designed to evoke the brand values in a consistent and optimal manner. This would help to strengthen the brand at every point of the customer's experience (Roscam 2010).

Brand values are manifested through different product characteristics and features. Depending on how they are designed (colours, forms, materials), the customer's product interpretation might be altered. When building touchpoints, designers need to take into account to communicate, describe, identify, exhort or express ideas (Warell 2001).

Some authors argue that the most important brand touchpoints are the products. In brand building, the product is portrayed as the key physical representation of the brand. Products are the core physical element that companies use to manifest their values and ideas and connect with the customer. Therefore, products enable intangible concepts, such as a brand, to become real for the customer (Aaker and Joachimsthaler 2012). However, in the Experience Economy theory, the product is seen as one of the many touchpoints that can allow the customer to engage with the brand. Companies have a wide range of touchpoints, each playing its part in building the brand experience (Hestad 2013).

An individual product or touchpoint is only a building block in the total brand experience. In addition to the importance of designing each individual brand touchpoint, it is also relevant to consider its role in the entire brand experience. Roscam (2010) uses a musical metaphor to express this idea. The brand experience is like a symphony. All brand touchpoints together form an orchestra playing the symphony; the task of each brand touchpoint is to contribute to the symphony by playing its specific part in harmony with the other brand touchpoints.

In summary, it is necessary to design and orchestrate brand touchpoints in consonance with brand values. Thus, an in-depth understanding of brand experience can only be obtained through a holistic view of all the touchpoints of a brand.

10.5.3 Customer Experience Journey

Customer experience develops through all the sequence of events in the service or product delivery process (Frow and Payne 2007). The sum of all these events is called the customer journey, and the customer's journey to achieve a certain task

(e.g. search for information, purchase a product) is formed by a series of touchpoints.

In the customer journey, time is a key factor. When analysing a customer journey, three key timing sequences are highlighted: pre, during and post (Davis and Dunn 2002). In the case of Nespresso, the 'pre' sequence might be when Anna realises that she is out of Nespresso coffee capsules. The 'during' sequence might be the period that she spends at the Nespresso store. The 'post' sequence might be the moment where she goes back home and tries the new flavour she has just bought.

Depending on the context, the customer's emotional situation, among other factors, may alter the abovementioned interactions over time. Therefore, it is important to understand that the brand experience is not only a one-time experience, but the sum of several experiences (Roscam 2010).

10.6 Models for Brand Experience Design

Brands are created by organisations, however they also have to reach the hearts and minds of people. Thus, some kind of transfer of meaning must take place between the brand creator/designer and the customer/user, and vice versa. So, understanding how a brand affects experience building is vital, according to the Experience Economy theory.

Traditionally, the transfer of meaning is understood from a communication point of view framed by Shannon (2001) (see Fig. 10.5). This communication model shows the existence of a message sender, the recipient of the message and the medium (Karjalainen 2004; Shannon 2001). This model explains value transmission from the point of view of a sender. However, this model does not take into account the recipient/user perspective in the communication process.

As for the user perspective, the literature has several models that aim to exhaustively illustrate the dimensions of UX. One of the clearest models on user experience was proposed by Forlizzi and Ford (2000); it is a basic scheme that describes the interaction between the users influenced by his/her values, emotions

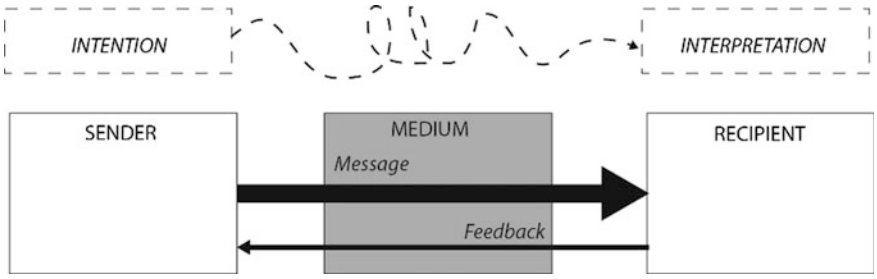

Fig. 10.5 Shannon's (2001) communication model

and prior experiences and a product characterised by its form, language, features, aesthetic qualities and usefulness. In 2004, Crilly et al. (2004) provided a useful model to describe customer response to visual stimuli in product design, based on three types of user responses: cognition (aesthetic impression, semantic interpretation and symbolic association), affect and behaviour. Finally, Desmet and Hekkert (2007) described product experience as being composed of three main components: aesthetic experience, emotional experience and the experience of meaning.

In 2003, Hassenzahl (2003) described the key elements of UX from the designer's perspective on the one hand, and from the user perspective on the other. So, this model takes into consideration both the sender and the recipient.

All these models demonstrate the strong efforts made by the research community to obtain a good understanding of experience. However, according to Karjalainen (2004), there is an apparent need for descriptive and explorative studies involving in-depth discussions on how brand-specific meanings may be constructed in design to create a strong brand experience (Karjalainen 2004).

The semantic transformation model (Karjalainen 2004) is the first model that introduces the brand as the sender, the customer as a receptor, and the design of the touchpoints as a medium. Figure 10.6 depicts this process.

The model presents design as a central axis between brand intention and consumer perception. As a brand is abstract and intangible by nature, design is used as a means of transforming abstract ideas into explicit forms (Roscam 2010). In other words, design explores and defines how brand values need to be transformed to shape each touchpoint and orchestrate them coherently.

In Karjalainen's model, brands use brand values to define the message to be communicated. Brand values, being intangible by nature, are translated into design characteristics, such as colour, form, material and technology. Later, these characteristics are embedded into touchpoints, which are ultimately the points of contact between the brand and the customer.

When interacting with the different touchpoints of the entire experience, customers assign values and meanings based on what they are seeing, listening or touching (Roscam 2010). For example, a product that is black might have different connotations, such as elegance, exclusivity, loneliness or sadness.

Fig. 10.6 Process of the semantic transformation model (Karjalainen 2004)

Karjalainen's model highlights two distortions along the process. The first distortion, called semantic transformation, occurs when brand values are embedded in the touchpoints. It is a result of the designer's failure to encode the proper values into the features of the product. The second distortion, called semantic attribution, is due to differences between the customer's interpretation of the touchpoint and the expected reaction. This happens due to the user's failure to decode the proper meaning of the design. Distortions occur in two phases of the model: (1) between the brand and design semantic transformation; and (2) between the design and the customer perception (semantic attribution).

10.7 Brand Gap

In ideal situations, products function as the manifestation of brand identity, evoking certain associations that are aligned to strategically defined brand messages (Karjalainen 2004). However, brand values embedded in touchpoints leave room for ambiguous interpretations. This ambiguity leads to a gap between the brand and the customer, and it happens when brand intention and customer perception do not match properly. Neumeier (2003) uses the brand gap concept to describe the inconsistencies between the brand intention and customer perception.

The brand gap describes the differences between what the brand wants to achieve and what the customer experiences (Neumeier 2003). In other words, the gap between what the brand wants to be, show and communicate, and the actual customer experience.

From a design point of view, analysing the brand gap and understanding the reasons behind its existence is an important part of the process (Press and Cooper 2003). This research, carried out at the start of the design process, might inspire and bring to light new products and services. Consequently, the brand gap shows innovation potential and provides a new perspective for innovation in the Experience Economy.

Karjalainen's model is among several models (Newbery and Farnham 2013; Clatworthy 2012; da Motta Filho 2012) the one that best evidences the brand gap. The model shows that a brand gap encompasses all the distortions occurring between the brand and customer, as illustrated in Fig. 10.7. Ambiguous interpretations of brand values embedded in touchpoints could be caused by two major 'distortions'—either the designer failed to 'encode' proper meaning into the product, or the user did not correctly 'decode' them. Distortions in encoding can arise, for example, from unclear brand values, ill-defined design briefs, or weak knowledge of semantic transformation. Potential distortion in decoding can be a consequence, among other things, of the user's weak experience in that particular product category, inconsistent supporting information or differences in cultural and social contexts.

Karjalainen shows the existence of two distortion points in the product development process. Yet, he does not explore the brand gap as a whole. In addition, the

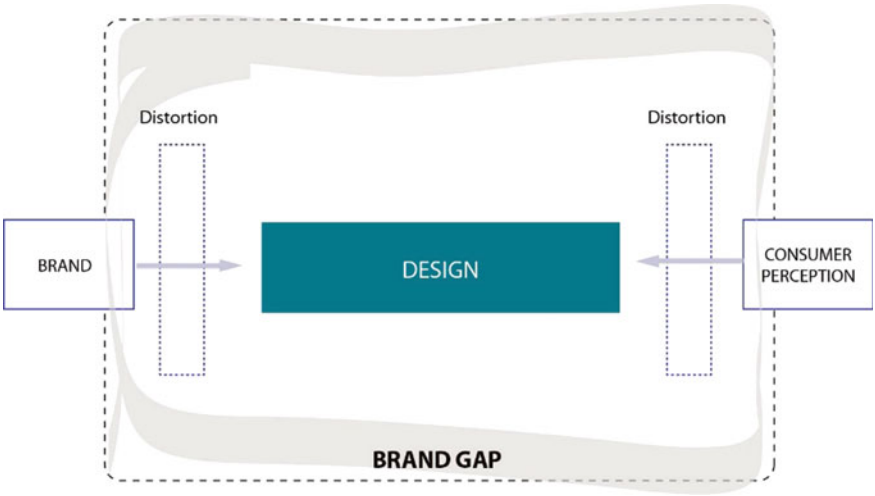

Fig. 10.7 Brand gap interpretation based on Karjalainen's model (Gonzalez et al. 2016a, b)

process does not consider distortion as a source of innovation. That is why there is no methodological support to understand the existing distortion between a brand and its consumer.

Since a brand gap can be the result of two types of distortions, we need to understand the reasons for the existence of each of them. The aim of the next section is to an in-depth look at both distortions. First, the ways to transform values into the physical domain by designing deliberate semantic references to touchpoints (semantic transformation) is explored. Second, the interaction between a customer and a product is analysed to determine how the interaction might impact the customer's perception of the situation (semantic attribution).

10.7.1 Semantic Transformation

Within various categories of consumer goods, it is easy to name a number of brands that are not only known for high-quality products but also for their recognisable design. These brands use specific design features consistently over their product line-ups. Through design consistency, brands can become solid and unmistakable. Volvo, for instance, is characteristically safe, Scandinavian and dynamic, whereas IKEA aims to be perceived as exuding togetherness, enthusiasm, curiosity and creativity. The trick is to transform values into the physical domain by designing deliberate semantic references to products.

The process of semantic transformation explores how qualitative brand or product characteristics get embodied in various physical design features of a product.

This section explores different design views about how brand-specific meanings and values are transformed to shape each touchpoint.

Specific characteristics and attributes, which often manifest as core values, are linked to specific brands and thus constitute the brand's 'character' (Roscam 2010). Traditionally, brands were embedded in the product through the use of a specific logo and colour. Therefore, when we see the logo and some certain combinations, we link them instantly to the brand values.

However, beyond the product 'style', literature shows that to transform values into design attributes, designers need to pay attention to different product layers, in particular, the product's pragmatic and hedonic attributes. The pragmatic layer focusses on the product qualities that fulfil the functional (pragmatic) needs of users; the hedonic layer focusses on other psychological needs, such as stimulation, identification and evocation. According to Hassenzahl (2003), a product's hedonic attributes are emphasised in the Experience Economy.

Among the different product layers, historically, the visual layer has been most explored. The aesthetics of a product plays a critical role in the initial customer perception and evaluation of product properties, as well as in the eventual product choice (Veryzer and Hutchinson 1998; Karjalainen 2007). By managing selected design features strategically and consistently, companies can substantially impact the visual recognition of their brands (Warell 2001; Pugliese and Cagan 2002; McCormack et al. 2004). Visual features catch our attention and direct our interpretation by linking specific associations to the product and the brand. Companies can select features, such as shapes, forms, colours, surfaces, textures and logos, on the basis of their attractiveness, and use them repeatedly to create recognition. However, Ravasi and Lojacono (2005) state that the brand's design philosophy, including its visual design features, should embrace the company's competitive scope and strategic intent. If the link between design references and brand core values is missing, design cues may be perceived as 'artificial'.

Nevertheless, transforming brand values into touchpoints goes beyond providing a specific aesthetic related to the brand (Norman 2013). For instance, within the context of smart environments, interaction layers are becoming increasingly more important. In this layer, artefacts can no longer be considered in isolation, as they are part of a larger ecosystem of technologies that users interact with. Therefore, designers need to provide users with handles and clues to make them understand and enable them to be effective, to understand what is happening and to allow them to be and feel in control.

Moreover, symbolic associations and, in general, the meanings generated by design features are also becoming central points of interest among designers (Karjalainen 2007). There are a variety of semantic or related approaches to product analysis intended to help designers understand how meanings are embodied in products (Krippendorff 1989, 2005).

Despite the importance of the product 'style', the new era is transforming the way products are conceived. Beyond the aesthetic (colours, forms and logos), other layers, such as interaction and meaning, are arising. Thus, different authors propose that different layers be considered when transforming values into design features.

Vihma (1995) described four interrelated dimensions of how a product can be conceived: syntactic, material, pragmatic and semantic. The syntactic dimension includes an analysis of the product's technical construction and various visual elements. The material dimension deals with the material of the product. The pragmatic dimension analyses the product's usefulness, and finally, the semantic dimension covers what the product represents.

Creusen and Schoormans (2005) identified six different roles of product appearance for customers: communication of aesthetic, symbolic, functional and ergonomic, information, attention drawing and categorisation. A product's appearance can have aesthetic and symbolic value for customers, communicate functional characteristics, give a quality impression (functional value) and communicate ease of use (ergonomic value). In addition, it can draw attention and influence the ease of categorisation of the product.

Roscam (2010) defined five layers to capture the ways in which an organisation translates its brand vision into design: sensory, behavioural, functional, physical and mental. The sensory layer (aesthetic) refers to image aspects. The behavioural layer (interaction) explores the type of interaction that customers have with the touchpoints. The functional layer (performance) meets the functional attributes and benefits provided by each touchpoint to customers. The physical layer (construction) describes the technologies, materials and processes used. The mental layer (meaning) defines the meaning and emotions evoked by each touchpoint.

Among the various layers, it may seem like the aesthetic or 'look' layer is the most important one. However, interaction and symbolism are playing an increasingly important role in the product design. Although the hedonic attributes are the ones that most impact in the Experience Economy, we should not forget the pragmatic ones like function, material or technology.

10.7.2 Semantic Attribution

The process of interpreting the design features and assigning values and meanings is called semantic attribution. Products are interpreted and valued in relation to a certain social context in terms of acceptance or rejection. Products can, through their semantic content and expression, either strengthen or weaken the customer experience by creating positive or negative perceptions, emotions, values and associations (Wikström 1996). Nevertheless, the way that the human brain processes such information is not necessarily similar to that of the actual physical world. In some cases, the physical characteristics are perceived differently from the actual ones (Ramachandran and Blakeslee 1998; Sakurai et al. 2016).

The orthodox view of a customer's response to a product comprises cognition and affect, followed by behaviour. Thereby, customer responses might be divided into three dimensions: cognitive, affective and behavioural (Bloch 1995). Dewey (1925) viewed experience as the intertwining of human beings and their environments. Dewey considered that knowledge (classifying, analysing and reasoning

about things) is only one part of our understanding of the world. In addition to intellectual experiences resulting from knowledge, experiences also include perceiving (through the senses), feeling and doing.

Schmitt (1999) presented five types of responses, referred to as 'strategic experiential modules': sensory experiences (sense), affective experiences (feel), creative cognitive experiences (think), physical experiences, behaviours and lifestyles (act) and social-identity experiences that result from relating to a reference group or culture (relate).

Pine and Gilmore (1999) studied staged experiences in retail environments and events. For these settings, the authors have distinguished aesthetic (including visual, aural, olfactory and tactile aspects), educational, entertaining and escapist experiences. Dubé and Le Bel (2003) have distinguished four similar dimensions: emotional, intellectual, physical, and social pleasures.

Gentile et al. (2007) specified the following six experiential components: sensorial (sight, hearing, touch, taste and smell experiences, and how they arouse aesthetic pleasure, excitement, satisfaction and a sense of beauty); emotional (moods, feelings and emotional experiences that create an affective relation with the company, its brands and products); cognitive (experiences related to thinking and conscious mental processes to get customers to use their creativity or problem-solving skills so that they revise assumptions about a product); pragmatic (experiences resulting from the practical act of doing something, and usability); lifestyle (experiences resulting from the affirmation of value and personal beliefs); and relational (experiences, emerging from social contexts and relationships, that occur during common consumption as part of a real or imagined community).

Based on the empirical research, Brakus et al. (2009) defined five dimensions: sensory, affective, intellectual and behavioural. The sensory dimension is related to the aesthetic and sensory perception of the customer. The affective dimension is associated with the customer's feelings and emotions about a brand; therefore, this dimension relates to emotions evoked by the brand, such as joy, fun, pride, nostalgia or even frustration. The intellectual dimension refers to experiences that encourage customers to think, arousing their curiosity and creativity. The behavioural dimension deals with customer behaviour patterns in the long term.

Thus, there has been considerable agreement in the categorisation of experiences among philosophers, cognitive scientists and management thinkers. When customers interact with a brand touchpoint, sight is the one that first senses that gets influenced, although, depending of the product type, other senses might also have the same importance. Later, based on what the customer has seen, touched or smelt, customers will feel certain emotions towards the brand. These emotions will then influence their behaviour with regard to the brand. The experience will also cause the customer to have an opinion about the brand. So, when analysing how touchpoints impact the customer, we agree with Brakus' approach to explore the four dimensions: sensory, affective, behavioural and intellectual.

10.8 Discussion

Existing brands already have certain touchpoints in the market that generate a particular experience in the mind of the customers (da Motta Filho 2012). However, distortions exist between what the brand wants to communicate and the perceived customer experience (Karjalainen 2004). From a design point of view, analysing the brand gap and understanding the reasons behind its existence is an important part of the process (Cooper and Press 2003). Brand gap shows innovation potential and provides a new perspective for innovation in the Experience Economy.

This research is focussed on understanding the brand gap in existing brand experiences. The identification and analysis of the differences between senders (brands) and receptors (customers), together with understanding the context in which these differences occur, provide an interesting approach for innovation opportunity identification that has not been previously addressed.

The framework shown in Fig. 10.8 is proposed as a base to understand the brand gap. It balances the experience from the brand perspective with the customer perspective with the help of design. The brand perspective (brand view) is first

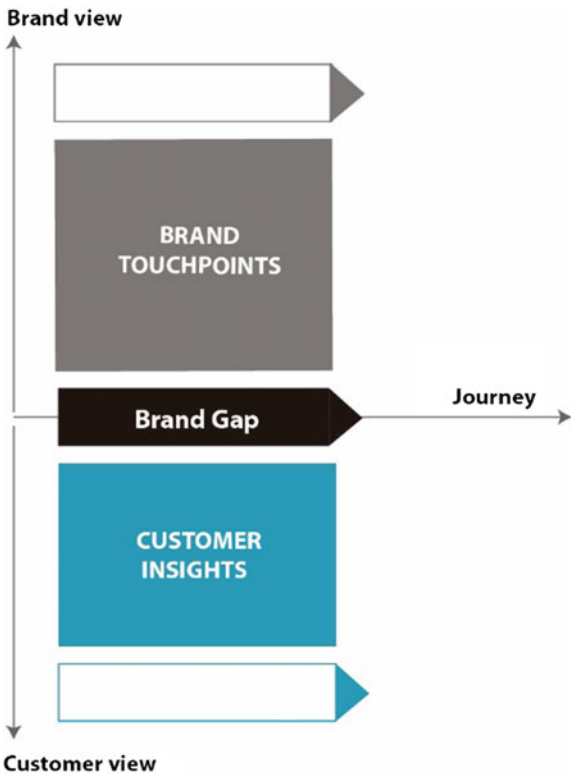

Fig. 10.8 Framework to understand the Brand gap (Gonzalez et al. 2016a, b)

explored, followed by the customer perspective (customer view) view along the customer journey.

The brand view explores how brand values are transformed into brand touchpoints. This transformation goes beyond providing a specific aesthetic related to the brand logo. Each touchpoint needs to be designed so as to deliver the brand values in an optimal way. The brand view involves deconstructing the touchpoints into design layers in order to provide information about the design criteria used to communicate brand values, such as aesthetics, interaction, performance, construction and meaning (Roscam 2010).

The customer view analyses customer–touchpoint interactions to gain insights into customer perception. So, the customer view acts on sensations, feelings and cognitions evoked by the given brand stimuli. Each brand touchpoint creates a response in the way of sensory, affective, behavioural and intellectual responses (Brakus et al. 2009). The customer view involves observing and identifying what the customer thinks, feels, sees and how he/she acts during the journey and while interacting with different touchpoints.

The framework takes into consideration both views along the customer journey, which represents the brand gap. First, it entails understanding how the brand values have been made tangible along the journey. Second, it requires interpreting how customers perceive, feel and act. These two views allow us to work on the construction and deconstruction of the brand path.

The proposed framework brings together two domains of brand experience (Roscam 2010; Karjalainen 2004, 2007), which have been addressed separately with regard to the design of brand experiences (Neumeier 2003): (1) how the brand was embedded in touchpoints (deconstruction); and (2) how the customer interpreted and perceived them (construction).

Therefore, by understanding brand values and how these values are embedded in each brand touchpoint, companies can identify the reasons behind the emotions and feelings expressed by the customer. This enables companies to define and consider the brand gap over the customer journey and opens up opportunities for them to use their comprehension of the brand gap to drive design and innovation actions to improve the overall brand experience.

10.9 Further Research

Since the framework presented in this study is theoretical, there is a need to test it through practical case studies that involve the staff of a company, designers and customers. Such case studies will enable testing of not only the framework's comprehensibility and usability, but also the benefits the results could have for the company.

The framework provides guidelines to activate innovation in the context of the design of brand experience. While the theoretical framework must be demonstrated empirically by means of case studies, there is also a need for explorative analyses

involving in-depth debate on how brand gap identification might help to strengthen brand experience.

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Chapter 11
Food for Thought: Using the RECIPE Initiative to Increase Students' Motivation in Vehicle Design Group Work

Aysar Ghassan and Elaine Mackie

Abstract Group-work projects help prepare students for professional design practice. Research suggests that student group-working is an emotionally charged activity. This chapter discusses group-working in vehicle design education. We identify the following issues: (1) the need for clear allocation of group members' roles; (2) the requirement for a holistic approach to complex vehicle design projects. We observe that decreased motivation amongst students exacerbates these issues. Through employing the acronym ***RECIPE*** (standing for ***R****esearch,* ***E****xterior*, ***C****omponents*, ***I****nterior*, ***P****ackaging*, *(user)****E****xperience*), we describe a mnemonic framework supporting key deliverables within vehicle design practice. The initiative aims to clarify role allocation and engage students in the complexities of vehicle design practice. Qualitative feedback suggests the RECIPE innovation provides a memorable holistic framework for tackling a multifaceted vehicle design project and was partially successful in tackling group-dynamic issues. Feedback indicates the framework succeeded in motivating students to tackle project deliverables. We conclude with recommendations regarding future adaptations.

11.1 Group Working in Vehicle Design Education

Collaborative practice is essential in design activity (Kvan 2000; Stempfle and Badke-Schaub 2002) as it aids practitioners to negotiate issues that are too complex to overcome through solitary working (Stempfle and Badke-Schaub 2002). Collaboration can increase productivity (Schumann and Luczak 1996) and enhance

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organisational effectiveness (Coleman 1996; Brown 2009). In recognising designers' expertise, collaboration can also facilitate practitioners' wellbeing (Schumann and Luczak 1996).

As this chapter concerns vehicle design education, it is necessary to discuss collaborative working in vehicle design practice. Vehicle design is a complex process (Raghavan et al. 2009). Typically, it takes between 3 and 4 years for a vehicle to progress from concept stage to production (Raghavan et al. 2009). It is improbable that any one designer could tackle this level of complexity effectively. Thus, vehicle designers negotiate issues in small groups (Tovey 1997). Cross (2011) cites Gordon Murray's experience in noting the importance of team work in automotive design. Groups may contain the same individuals for a number of years (Tovey 1997). Therefore designers should be able to collaborate effectively for protracted periods.

Design education exists to facilitate graduates' entry to the professional practice community (Tovey 2012a). Group work should feature in design education as it is essential in professional practice (Yang et al. 2005). Davies (2009, p. 564) suggests group-working encourages "deep" learning and promotes experiential learning amongst students. In design education, the latter is particularly important as practitioners acquire knowledge experientially (Demirkan and Demirbas 2008).

From a problem-solving perspective, working in groups develops students' communication and technical abilities (Colbeck et al. 2000). Students benefit from group-working projects if provided with guidance which holds all members accountable for group performance as well as making individual goal achievement dependent upon attainment of group goals (Laal 2013; Colbeck et al. 2000). When student group projects proceed positively, such interdependence introduces a shared identity amongst members (Johnson and Johnson 2009). Additionally, interdependence introduces an element of *risk* in group-working projects as outcomes could be negatively affected by a lack of collaboration (Bohemia and Ghassan 2012). However, Earwaker (1992) argues that for academic and personal growth to occur amongst students, risk should be inherent to the experience of higher education. Challenges associated with group-working include students' reticence to flag up poor group management issues and concerns regarding group members who are perceived as not pulling their weight (Colbeck et al. 2000; Johnson and Johnson 2009). Furthermore, students tend to frame group work negatively when they believe that they are not being provided with specific instructions from tutors concerning members' roles (Colbeck et al. 2000). The issues of group identity, group management, group members' perceived work ethic and role allocation underscore the notion that group projects are emotionally charged settings.

In terms of characterizing emotions in an educational setting, Pekrun and Linnenbrink-Garcia (2014, p. 2) claim that:

> Emotions can be defined as multifaceted phenomena involving sets of coordinated psychological processes, including affective, cognitive, physiological, motivational and expressive components.[1]

[1]Pekrun and Linnenbrink-Garcia (2014, p. 2).

Schultz and Pekrun (2007) argue that emotions of both students and teachers should be considered since both have the potential to influence teaching and learning processes (both positively and negatively).

There is a lack of literature on group-working in vehicle design education. It is important to contribute to this area as group-working features in the curricula of vehicle design programmes worldwide (e.g., Car Body Design 2013; Car Design News 2003; Scuola Politecnica di Design 2015). This chapter aims to contribute to knowledge on facilitating group work in vehicle design education. In so doing, this chapter reflects on the 'RECIPE' initiative, a project designed with the aim of improving student motivation. For the purposes of this research, motivation can be described as an internal state guiding and sustaining one's intention to complete the task(s) at hand (Balaji et al. 2009). Central to this initiative is the use of a mnemonic learning strategy which has been developed to help student groups remember and recall information (Balaji et al. 2009) and to aid with clarifying group members' role allocation. The overarching aim is to facilitate the creation of positive emotions leading to an increase in satisfaction and overall grade improvements.

In keeping with Schultz and Pekrun's (2007) inclusive thoughts on emotions in the classroom, we will reflect on the emotions of both students and tutors in this chapter.

11.2 Background to the RECIPE Initiative

The RECIPE idea was conceived at a time when we collaborated on teaching 2nd year undergraduate students at the host university.

On the programme of study, the academic calendar denotes that a vehicle design group assignment must ensue in term 2 (of 3) of the 2nd year of study. Being "project-orientated", the assignment contains tasks culminating in a single outcome (Lee 2009, p. 554). To contextualize the students' learning journey, there follows a summary of pedagogical activities which take place prior to its commencement.

In the 1st term of their 1st year, students are tutored in manual sketching and 2D CAD visualisation (Ghassan et al. 2014). In the 2nd and 3rd terms, learners individually present proposals for aesthetic alterations to aspects of the exterior of existing vehicles. In professional practice this activity is termed *facelifting* (Maxton and Wormald 2004). In term 1 of their 2nd year, students design the exterior of a vehicle and engage in taught physical modelling and 3D CAD activities. The project which is the focus of this chapter is learners' first assessed group assignment. Teams are required to approach the design of a vehicle in a holistic manner—i.e. learners must conduct appropriate research to tackle both vehicle exterior and the interior design. The project thus reflects some of the complexities of vehicle design practice.

The RECIPE innovation was run during the 2nd academic year in which we collaborated. It was conceived following reflection on issues associated with the group project run in our first year of co-teaching. These issues can be summarised as 'the learning experience of *all* students' and 'complexity in design practice'.

11.2.1 Issues Related to the Learning Experiences of All Students

Students do not necessarily collaborate in an egalitarian manner whilst engaging in group design projects (Colbeck et al. 2000; Bohemia and Ghassan 2012). In our first year of collaboration, we observed that group members who may be described as *more forceful characters* tended to have more influence over the direction the group took than did less forceful students. In addition, students with more advanced design practice skills (e.g. sketching or CAD modelling) contributed more to project work than did learners with less advanced design practice skills. As tutors, we became very concerned about this state of affairs. On reflection it became evident that students who were less forceful and/or less skilled were not motivated to contribute effectively to the project. We felt that this experience may negatively affect weaker students' approach to group working in the future. As such, we believed that the situation did not help these students grow as members of a design team.

11.2.2 Complexity of Vehicle Design Practice

Design practice is characterised as being complex. For example, designers may regularly undertake a range of diverse tasks: from researching social context to creating contextually driven solutions (Yang et al. 2005). Designers may also have to work in a multidisciplinary manner (Yang et al. 2005).

In terms of negotiating complexity, *vehicle designers* may be required to work on a variety of tasks requiring the creation of aspects such as overall exterior form, interior form and many details or components (Kennedy 2005; Tovey 2012a, b). In determining appearance, vehicle designers must represent user requirements and incorporate brand values (Tovey 2012a, b). Vehicle design practice is argued to be iterative, with:

> Interactive loops from each stage to all preceding stages.[2]

In the case of *facelifting*, vehicle designers must be able to develop designs from existing architecture (Tovey and Owen 2000; Maxton and Wormald 2004). Practitioners may work on several programmes simultaneously, for example on the design of new vehicles, vehicle upgrades and mid-life cycle alterations to existing products (Tovey 2012a, b). Given the global nature of their industry, vehicle designers may be required to work in virtual teams (May and Carter 2001). The above evidence underscores the notion that to be successful, practitioners must learn to negotiate complexity (Raghavan et al. 2009).

[2]Tovey (1997, p. 6).

In our first collaboration, mindful of the complex nature of professional practice, we repeatedly advised groups of the importance of a holistic approach to project work (Lockyer et al. 2008). Despite our advice, the majority of groups tended to concentrate on designing the exterior of the vehicle to the detriment of other aspects such as the interior or the creation of a suitable ergonomic and engineering package. Accordingly, students' final proposal did not adequately reflect the complexities of vehicle design practice and did not satisfactorily meet learning outcomes.

This situation worried us because the project did not seem to motivate students at a deeper learning level. As such, we believed the learning experience did not prepare students for the complexities of professional practice. We believed that to tackle both the 'role allocation' issue and the 'complexity' issue, we needed to create a means of tackling the associated motivational issues observed in this project. We introduced the RECIPE initiative with the intention of improving students' experience and helping groups to meet learning outcomes. In attempting to motivate students, we hoped the RECIPE framework helped to provide students with the *will to learn* (Hattie et al. 1996).

11.3 RECIPE: A Mnemonic Strategy to Improve Motivation and Student Experience

As a first step to increasing motivation, we sought to break project tasks down into clearly identifiable areas of focus and develop an easy way for students to recall and cross-check these. We identified the following tasks which are pertinent to vehicle design:

- Design Research: benchmarking (Jorgensen and Lamancusa 1996); brand values (Schroeder 2009); persona creation (Don and Petrick 2003); scenario building (Dong 2008; Suri and Marab 2000).
- Overall Exterior Design: proportion exploration and form giving (Talke et al. 2009)
- Overall Interior Design: proportion exploration and form giving (Jindo and Hirasago 1997; Han et al. 1998).
- Packaging: vehicle measurements; rudimentary engineering requirements; seating arrangements; vision angles; access/egress; accommodation of luggage compartment(s) (Pheasant 2003; Porter and James 1999; Porter and Porter 2000).
- Details: material selection; operational components such as switches; control functions (Tasca 2005).
- User Experience: driver/passenger interactions with vehicle exterior and interior (Benson et al. 2007; Bonapace 2002).

In addition to providing comprehensive guidance on the importance of the above tasks, we wished to employ a *mnemonic* strategy to foreground them in the minds of participating students. Mnemonics make use of imagery or linking items which

are associated with key words (Hattie et al. 1996). This strategy helps place information into automatic and semantic memories (Sprenger 1999) and enables individuals to recollect this information when it is required (Balaji et al. 2009).

11.3.1 Types of Mnemonic Strategies

There are two forms of mnemonic strategies, *peg-word* and *chain-type*. Peg-word mnemonics aid information retention by creating a:

> cognitive cuing structure that is permanently stored in memory and can be used when needed for both associating information to it and later recalling that information by a process of self cuing.[3]

Peg-type, first-letter mnemonics function as acronyms (Sprenger 1999). Acronyms are particularly easy for humans to remember (Manolo 2002).

Our mnemonic aims to communicate the notion that the aforementioned vehicle design tasks (design research; overall exterior design; overall interior design; packaging; product detailing; user experience design) are not only interlinked but are of equal importance in industry. The peg-type, first-letter mnemonic 'RECIPE' aims to form an explicit association with these tasks in students' minds. RECIPE stands for:

- Research
- Exterior
- Components
- Interior
- Packaging
- (User) Experience.

The way design students learn also affected the decision to use this acronym. Design students prefer teaching methods which begin with the big picture and then proceed to explain relevant details (Durling et al. 1996). First and foremost, the acronym RECIPE relates to the bigger picture: "a recipe for great project work" (or words to that effect). We hoped that the acronym would aid students to make a connection between the process of undertaking project work and that of creating a desirable artifact like a cake or a tasty meal. In turn, we hoped, this association would create positive and motivational associations for students. Secondly, the acronym RECIPE allows an opportunity for in-depth inspection of the individual elements. We believed that both the holistic and detailed aspects of the acronym RECIPE would make it useful in facilitating group work.

[3]Bellezza (1981, p. 255).

11.4 Methodology

To evaluate its effectiveness, we incorporated the RECIPE mnemonic into a study with our cohort of 115 second year students. Learners were asked to form groups of 6 members. Odd numbers meant that 3 of the groups incorporated 7 learners.

Earlier, we noted that in our first collaboration more forceful and more skilled students contributed more to group work. To tackle this issue with the current cohort, we asked groups to ensure that each member would be responsible for one design task contained within the RECIPE mnemonic. Therefore, one member should be responsible for creating the user experience; another for designing the interior and so on. As noted, students' learning experiences are negatively affected when groups believe they are not provided with instructions on members' roles (Colbeck et al. 2000). Our 'role allocation' approach intended to address this issue. The process of distributing tasks amongst students aimed to create an environment which would provide all students with an improved learning experience. We refrained from being overly prescriptive in suggesting how groups allocated roles to members. Role allocation implies a sense of interdependence amongst group members. Both *role allocation* and *interdependence* introduced an element of *risk* into this project.

As noted, Earwaker (1992) argues that for academic and personal growth to occur amongst students, risk should be inherent to the experience of higher education. We believed the addition of risk to be integral to facilitating students' growth in project work.

The RECIPE initiative involved a blended-learning approach (Kahiigi et al. 2008). Face-to-face teaching took place in the form of regular group tutorials as well as seminars on aspects such as product detailing and packaging and ergonomics. We uploaded supplementary teaching material to the university online learning portal. Groups were required to prepare an interim presentation at the midway point of the project. The project ran for 7 academic weeks.

In attempting to assess the outcome of the RECIPE initiative, we collected qualitative feedback from participants. To maximize response rates, feedback was administered via a paper sheet in a face-to-face setting (Watt et al. 2002). In asking open-ended questions, the feedback sheets sought to explore students' experiences and perceptions of the group-work activity and the usefulness of the RECIPE mnemonic. Feedback sheets were completed by 30% of students.

11.5 Results and Discussion

Overwhelmingly, students' feedback suggests that the RECIPE innovation enabled learners to understand the importance of a holistic approach to vehicle design. One student said the project helped:

> broaden [her] understanding of the different components of a design project […] to try out something different and experience more of the design world than just sketching.

Another participant commented favourably on the holistic intents of the initiative, which:

> explained clearly the main elements / tasks required to design a car. The ingredients to make a cake (ha ha). I have found that each part is interlinked too, all dependent on each other.

Similarly, another learner stated the initiative "ensures all bases are covered". For this student, risk associated with this project was beneficial:

> it forces you to think of parts you may improve. This prevents people from ignoring parts people often don't like such as interiors or packaging.

Groups' design outcomes reflected students' understanding of the complex and holistic nature of vehicle design practice. All groups tackled all 6 of the design tasks. This illustrates that groups were motivated to complete the tasks specified in the RECIPE initiative. Figure 11.1 illustrates two RECIPE tasks (*Research* and *Components*) as delivered by two separate student groups.

In attempting to counteract negative group-working issues which arose in the previous year, groups were required to distribute the stipulated tasks between members. Many students commented that the RECIPE mnemonic facilitated role allocation. For example, one student noted:

> I do think it helps with dividing roles.

Another participant stated:

> it distributes work nicely.

Students noted that the role allocation aspect helped them work more effectively. One noted:

> categorising works helps to save time as well as optimise work.

On this point another learner stated the initiative:

> gave us a good starting point to what seemed quite a duanting [sic] task […] this was a much easier way to manage ourselves.

The above feedback indicates that the RECIPE initiative seems to have made the complex group-work deliverables more manageable for learners. In terms of motivating students, it helped participating learners tackle more of the deliverables than the students did in the previous academic year.

Feedback also suggests that the RECIPE mnemonic was important in enabling learners to gain an understanding of the notion that group projects work best when members form a cohesive unit. One student stated:

> each of us has his or her own responsibility but just like the [RECIPE] letters - they need to be arranged properly and work together to form a meaning/word.

Fig. 11.1 Two RECIPE tasks (*Research* and *Components*) as delivered by two separate student groups

Similarly, another student commented that:

Having to work 'for each other' meant studio culture and sharing of skills and ideas etc.

Equally, a further learner commented the project:

Feels like working as part of a design team.

These qualitative responses suggest that the RECIPE project helped students to bond as team members. We believe what we term the 'group spirit' was crucial in helping groups to be active, motivated learners rather than—as was the case with many groups in the previous academic year—a collection of disparate individuals awaiting instructions from tutors. The above comments related to the development of 'group spirit' indicate that students have *enjoyed* the complex challenges set by the group project.

However, not all feedback on the 'role allocation' approach was favourable. One learner noted that the initiative worked only:

> when [fellow team members] pull their weight.

This sentiment was echoed by another student who stated:

> out of 6 people three worked on personas, experience or research alone.

Other students noted that the RECIPE initiative was not optimally effective as group members did not work on their assigned design tasks. On this point, one learner stated:

> sometimes not everyone put in 100% effort so other group members had to do others work for them.

In conducting this initiative we held regular tutorials with groups. In the main, affected groups noted issues with what they felt were non-productive group members *towards the end* of the project. We hypothesise that this may be due to aforementioned factors which may be familiar to design educators: students' reticence to flag up poor group management issues and concerns regarding group members who are perceived as not pulling their weight. Students are by definition inexperienced practitioners. Thus, during their first assessed group project, team members may not be aware of the potential significance of interpersonal issues between members.

In addition to the above reflections on group dynamics, a few students informed us that the 'role allocation' concomitant with the RECIPE initiative was too limiting. For example, one learner noted:

> setting a single task for a group member has been difficult. Team members proven difficult to motivate.

Another student noted the 'role allocation' approach negatively affected his group's final submission. For this student the RECIPE innovation precipitated:

> a fragmented project when the work has clearly been done by separate individuals rather than one cohesive project.

We argue these 'role allocation' issues may be a symptom of failures in group dynamics. We claim this as feedback from other students suggests groups which performed cohesively did not perceive 'role allocation' stipulations as negatively affecting their learning experiences. On this point, one student notes:

> we followed the RECIPE pattern but everyone was free to try what they wanted.

This comment in particular indicates the development of 'group spirit' has *empowered* students to grow both as individuals and passionate members of a strong and productive team.

Despite the above claims, the fact remains that some students felt the 'role allocation' inherent with the RECIPE initiative was overly-restrictive. As we aim to positively affect the learning experience of all students, in the future, methods which address students' concerns should be trialed. This would include a further introduction to successful group-working methods; workshops to facilitate alignment of group members' individual skills and interest with design tasks; explicit encouragement of peer tutorship activities (Falchikov 2001).

Notwithstanding some negative feedback, from the outset we believed that the real test of the success of the initiative would be realised in whether students felt it would enable them to manage their workflow in future design projects. We are heartened to learn that students overwhelmingly reported that it would. One student commented that:

> it is a great abbreviation to remind me about what design process I have to follow to every project. It makes sense to every stage as a design project should start with the research for the design aesthetics, for the target audience, story boarding personas. Then after having a good foundation, I can start my further process of sketching and form drawing. After having a certain base of exteriors I can work on details and slowly move on to other aspects of the RECIPE.

A further learner commented:

> RECIPE ensures that I stick to a format and draws me to manage my time wisely.

Finally, in supporting the aim to create a *peg-type, first-letter mnemonic*, one student informed us that:

> RECIPE has proven to be a good catchphrase when developing our projects.

11.6 Conclusions and Recommendations

This chapter reflects on an attempt to address important issues negatively affecting motivation in vehicle design education group-working. In tackling these issues we have reflected on our use of the peg-type, first-letter mnemonic 'RECIPE'. Our initiative aims to communicate vehicle design activity as a holistic goal segmented into memorable deliverables.

Learners' feedback suggests that groups were motivated to complete the specified deliverables. Feedback also suggests that for many groups the RECIPE structure helped to make the complex project deliverables more manageable. In terms of motivating students, the initiative helped learners overcome the lack of engagement observed with previous year's cohort. Feedback also suggests that the RECIPE structure helped students to bond as team members. We believe the 'group spirit' was crucial in helping groups to engage as active, motivated learners rather

than a collection of disparate individuals waiting for instructions (as was the case in many groups during the previous academic year). Indeed, the development of the 'group spirit' has enabled students to enjoy the process of learning and has empowered students to grow both as individuals and passionate members of a strong and productive team. In motivating students, we claim the RECIPE framework helped to provide students with the *will to learn* (Hattie et al. 1996).

Students' willingness to collaborate has been beneficial in both aiding learners to understand the holistic nature of vehicle design and to practice relevant tasks in a group-working setting. Accordingly, we have argued that the RECIPE initiative provides good preparation for professional practice. Furthermore, quantitative university data informs us that the overall student satisfaction in the relevant module increased to 70% during this academic year. This was an increase of 10% over the previous academic year.

Students' feedback does however highlight that group-working issues remain. In revising the RECIPE initiative we suggest exploring the following provisions:

- Further information on successful group-working, including examples from industry and presentations from students who attempted the project in the previous academic year.
- Workshops which aid group members to effectively align individual skills and interests with design tasks.
- Further encouragement for students to engage in peer tutorship with group members.

With regard to the above, this chapter argues it is necessary to scaffold assessed group work into the curriculum at an earlier stage. This may help address some of the issues highlighted in students' feedback.

Additional research related to the RECIPE innovation may include:

- The development of a diagrammatic representation of key components of the holistic nature of industrial practice and successful group-working.
- Evaluation of its applicability to individual projects.

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Chapter 12
Four Factors of Happiness as Design Parameters of a Product/Service

Takashi Maeno

Abstract This chapter describes factor analysis results of mental/psychological factors of happiness. We conducted a 29-item, 87-question Internet survey on psychological traits of happiness on 1500 people and performed factor analysis on the results. As a result, we obtained 4 factors: factor 1 "let's try it!" (self-realization and growth), factor 2 "thank you!" (connection and gratitude), factor 3 "it will turn out all right!" (positive and optimistic), factor 4 "be yourself" (independence and "my pace"). If we use these as design parameters for products and services, we think that we can develop products and services that can make people happy.

12.1 Factor Analysis of Happiness

Since the beginning of the 21st century, research on happiness and well-being began in the West, and then proliferated to countries worldwide. As a result, it has been shown that many factors influence happiness. If all these factors are met, will one become happy?

We answer this question in our study through factor analysis (Maeno 2013). Factor analysis is one type of multivariate analysis (analysis of the relationships among a large amount of quantitative data), and is a technique to analyze a substantial amount of data and reveal its structure. Specifically, it is a way of finding some axes on which to represent and organize the data.

First, we survey many people on many items related to the subject we want to know about. Next, the results are entered into the computer, and we search for a number of factors. Each factor is named based on the results of the survey that have a deep relationship to each factor. Then, based on the result, we discuss questions such as whether the subject we wanted to know about is represented by which factor axis, or what the relationship is like between each question and the factor axis.

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There is one premise for conducting a happiness factor analysis. This is to select only psychological factors for survey subjects. There are two reasons for this.

One is that because happiness factors other than psychological factors are either external or physical, and these often cannot be controlled by the individual. For example, things such as whether public security is good or direct democracy is being adopted are not things that can be decided on one's own, and instead depend on the environment one is placed in. Thus, these should be considered in a different category from psychological factors.

Another reason is that while psychological factors are often non-positional goods, external factors are often positional goods. Happiness based on positional goods such as money, things, and status is happiness that does not last long, and aiming for these is said to be a focusing illusion. In contrast, most psychological factors, such as autonomy, freedom, and love, are non-positional goods. With non-positional goods, there are also non-psychological factors, such as health and a favorable environment; however, these were removed based on the above reasons (they are external/physical factors that cannot be controlled on one's own).

In other words, factors that fulfill the two reasons above are psychological factors. Therefore, we first found the psychological factors that are known to influence happiness.

For this, we used Diener's survey results (1984, 2012; Diener et al. 1999) as the main resources. This was part of the forty-eight items stated previously.

Next, we created the questionnaire. When creating the questionnaire items, if there was an existing scale, we used that, and if there was not, we created questions of our own. We ultimately created eighty-seven questions, three for each of the twenty-nine items as follows.

> Questionnaire Items for Happiness Factor Analysis
>
> Optimism, lack of orientation toward social comparison, tendency toward self-acceptance, competence (strength), self-realization scale, tendency to please people, humor, self-esteem, love, tendency toward gratitude, strength of hope for the future, will to work, tendency to fully enjoy something, having religion and philosophy, responding to societal demands, autonomy, degree of mastery, active relationships with others, having no worries, degree of personal growth, clear tendency toward meaning of life, clarity of goals, kindness, good at switching emotions, clear tendency toward self-concept, lack of pursuit toward a maximum effect, control of environment, clear tendency toward purpose of life, lack of perceived constraints
>
> (In actuality, these were asked in statements such as "I think things are going as I thought they would" (optimism) and "I do not compare myself much to others" (lack of social comparison).)

We surveyed the psychological characteristics of fifteen-hundred people via the Internet with a twenty-nine-item, eighty-seven-part questionnaire. Questions were answered on a seven-point scale "does not apply at all," "mostly does not apply," "does not apply much," "neither applies nor does not apply," "somewhat applies," "pretty much applies," "very much applies."

Next, we performed the factor analysis of the questionnaire results. The software package SPSS was used for calculations.

Let us introduce the four factors that we named while looking at the results and some of the questions that were strongly associated with each of the factors (factor loading was high). In the actual questions, reverse items were used to ask the opposite and ensure balance in the items. For example, "I am competent" → "I am incompetent." Here, we have rewritten the positive side of the questions.

First, let's simply state the answers.

Factor 1 "Let's try it!" (Self-Realization and Growth)

- **Competence (I am competent.)**
- **Societal demands (I respond to societal demands.)**
- **Personal growth (My life thus far has been full of change, learning, and growth.)**
- **Self-realization (The person I am now is the "person I really wanted to become.")**

"Let's try it!" (self-realization and growth) is the name of Factor 1. The next four lines are examples of questions that were deeply associated with the factor (factor loading was high).

There are a series of items such as "Do I have a personal strength?", "Do I use that strength in society?", "Am I who I wanted to be?", and "Have I worked hard to become a better version of myself?" Therefore, we named it "Let's try it!" (self-realization and growth factor). As was revealed in the forty-eight items, having big goals, having big goals and immediate goals that are aligned, and learning and growing for that purpose all contribute to happiness.

What about the second factor?

The second is the "Thank you!" factor.

Factor 2 "Thank you!" (Connection and Gratitude)

- **Pleasing people (I like to see people's happy faces.)**
- **Love (I have people who care deeply about me.)**
- **Gratitude (I have an abundance of gratitude for my life.)**
- **Kindness (I am kind to others and want to help others in my daily life.)**

We state the factors and examples of questions with high factor loadings just as we did for Factor 1. We later do the same for Factors 3 and 4.

What would you think? There are a series of questionnaire items related to "pleasing people," "love," "gratitude," "kindness," and "understanding relationships with other people." While Factor 1 was happiness aimed at oneself, such as self-realization and self-growth, we can say that Factor 2 is happiness aimed at others.

While Factor 1 involves seeking personal change and innovation, we can say that Factor 2 involves aiming at stable relationships with others. Self and others. Change and stability. Perhaps we could call these two factors a pair?

If we compared these to a meal, Factor 1 are the carbohydrates, fats, proteins, the ingredient that makes energy, and Factor 2 represents the ingredients that maintain body functions, such as vitamins and minerals. The five great nutrients (three and two). When you have both, for the first time, you have a well-balanced meal.

Conversely, you may think these two cover it all, but what do the other two do? Let's look at the third factor.

Factor 3 "It will turn out all right!" (Positive and Optimistic)

- **Optimism (I think things are going as I thought they would.)**
- **Switching emotions (I do not drag failures or anxiety from school or work into other areas.)**
- **Active relationships with others (I am able to maintain close relationships with others.)**
- **Self-acceptance (I have achieved a lot of things in life.)**

The third factor changes ideas and reflects positivity and optimism. We named it the "It will turn out all right!" factor.

This is different from Factors 1 and 2. Still, it is just as important to be optimistic and positive as it is to aim for self-realization and growth (Factor 1) and to cultivate connections with others (Factor 2).

Optimism is so important that you could almost disregard the other factors. After all, if you are optimistic, even if you are somewhat lacking in self-realization, growth, connection, or gratitude, it will not bother you significantly because you will think, "Oh, it's all right. I'll get to those things eventually." In this sense, optimism is the must-have spice for happiness.

If we compared these to a meal, "self-realization and growth" (Factor 1) are the carbohydrates, fats, and proteins, "connection and gratitude" (Factor 2) are the vitamins and minerals, and "positivism and optimism" (Factor 3) are the seasonings. The five great nutrients (Factors 1 and 2) served alone, just meat, fish, rice, and vegetables, are an incomplete meal without seasonings. And of course, seasonings alone do not make a meal. A combination of Factors 1, 2, and 3 is necessary to make a delicious meal.

Now, what is the fourth factor?

Factor 4 "Be yourself!" (Independence and "At One's Own Pace")

- **Lack of social comparison (I do not compare myself much to others.)**
- **Lack of perceived constraints (Whether I am able or unable to do something is not the fault of external constraints.)**
- **Clear tendency toward self-concept (My beliefs about myself do not change much.)**
- **Lack of pursuit toward a maximum effect (When I am watching television, I do not really change the channel frequently.)**

This factor reflects a tendency to not compare oneself to others and to have a firm sense of self.

In short, this is an important factor in the sense that it restrains the eye that may easily wander to positional goods due to the focusing illusion. In other words, without this factor, one could go off in the wrong direction.

For example, when aiming for "self-realization and growth," one may make a mistake, such as saying "I am going to get ahead of that person." These are mistakes that turn self-realization into a struggle against or comparison to others, when it should be a struggle against oneself. As stated earlier, this is not long-lasting happiness (seeking positional goods). To avoid this, it is important to move toward happiness at your own pace in a way that suits you and is not concerned about others' opinions.

Further, while it is good, for example, to make friends with people around you for the sake of "connection and gratitude," if you only seek to please others and not yourself, you will not be happy. You should continue to be yourself even as you make friends with others. To use a traditional Japanese saying, "Get along without agreeing." This saying represents how important both Factors 2 and 4 are.

What would this be in our meal comparison? If Factors 1 through 3 are the five great nutrients and seasonings, Factor 4 is not food but rather the cookware and tableware.

In other words, Factors 1 and 2 are essential items for nutrition, and Factors 3 and 4 are essential items for making a proper, delicious meal. If any of these were lacking, you would not have an ideal meal.

It is like a four-leaf clover. If you have all four, you can obtain happiness.

However, we must reiterate here: Is happiness the same as a meal? That is, will you not find happiness if you do not have all four? There is room for discussion there. Let's examine this issue using cluster analysis.

Although there are many happiness factors, when we summarize these based on factor analysis, the four factors are the keys to happiness.

This brings up one question. If all four factors are met, will you find happiness? Or can you be happy even if one of these is not met? If we assume that there are various happiness patterns, which pattern could we classify Japanese individuals in? The cluster analysis method sheds light on this.

12.2 Cluster Analysis of Happiness

Cluster analysis is also a type of multivariate analysis and is a method for analyzing people and things based on a lot of data. In the case here, we used a computer to calculate the similarity of answers of the twenty-nine item, eighty-seven-part questionnaire on happiness among one-thousand five-hundred respondents. As a result, people were divided into five groups. In other words, we classified people into five groups so that each group contained similar people.

There are several cluster analysis methods; however, here, we used a technique called the non-hierarchical method.

Cluster analysis results divided people into five clusters (groups).

The conclusion was that happiness is like a meal. That is, results showed that although there are various happiness patterns, if all four factors are met, you find happiness; if one is not met, your degree of happiness drops; and if none are met, you are the unhappiest.

Let us explain each group.

Cluster 1 was the happiest group. These people accounted for twenty percent of the Japanese people surveyed.

Cluster 2 was the second happiest group. They were strong in "self-realization and growth" and "connection and gratitude"; however, they were weak in "positivism and optimism" and "independence and my pace." They made up seventeen percent of the people.

Cluster 3 was the middle group, and this type was slightly lower than average on all four factors. Amazingly, this accounted for forty-five percent of the fifteen-hundred Japanese people surveyed.

Cluster 4 was weak in "self-realization and growth" and "connection and gratitude." This group made up seven percent of the people and was a somewhat unhappy group.

Lastly, Cluster 5 was unfortunately low in all four factors. They comprised eleven percent of the group. These individuals stood out because of their low positive feelings and high negative feelings.

In this survey, because we divided the fifteen-hundred people into five large groups, we did not address the existence of small groups. If we further subdivided the clusters, we might find a cluster that projects only a single feature such as optimism. At least when we divide them into five groups, the happy group was just one kind of group.

Still, Cluster 4 was close to being a group of people with high optimism. This group was strong in "positivism and optimism" and "independence and my pace." However, their happiness was somewhat low. They differ from my students, who have high optimism and are happy. Apparently, the type that projects optimism and is happy is a minority.

12.3 Product/Service Design Considering Happiness and Well-Being

So far we have described the four factors of happiness. When using these results to design products and services, we can understand that it would be beneficial to design in such a way that meets these four factors.

For example, think about a camera that makes people happy.

Can we all imagine a camera that meets Factors 1 through 4? A camera that fulfills self-realization and growth, connection and gratitude, positivism and optimism, and independence and my pace. If we think only of designing camera hardware, we may never find the answer. But how about adding a feature that

allows people who purchase the camera to join an online photography group? By improving their photography skills, camera purchasers can grow, connect with people, and dynamically enjoy themselves in their own way. It is a user service that meets the four happiness factors.

Next, let's think about care for seniors and people with special needs.

How can we create care as something that brings happiness to people both receiving and giving care? Care that fulfills self-realization and growth, connection and appreciation, positivism and optimism, and independence and one's own pace?

One example is the hula dancing hosted by a long-term care facility with which I am involved. For the senior citizens, this became one type of self-realization as they learned a new dance that they could do even as seniors, and thus fulfilled happiness Factor 1. Since you can pass on pleasure to society through dance and contribute to society, this fulfills happiness Factor 2. You can be positive, optimistic, and behave like yourself, fulfilling Factors 3 and 4. Of course, because satisfaction, connection, and enjoyment are felt on the caregiver side as well, the level of happiness increases. By introducing fun activities that fulfill the four happiness factors to care facilities, which tend to be scrutinized as having generally harsh settings, these facilities can be redesigned as happy places.

We described above examples of a camera and care as examples of products and services that can improve from integrating happiness factors. This kind of thinking can be applied to all kinds of products and services. That is, if we design products and services considering the four happiness factors to be design parameters, we believe it is possible to make products and services that make users happier the more they use them.

In contrast, there is a risk that products and services that do not fulfill the four happiness factors will not contribute to people's happiness. In a broad sense, all human activity serves to contribute to people's peace and happiness. If that's so, shouldn't all human activity be determined from an engineering perspective that incorporates happiness into design variables? We hope this study will be helpful to all those wishing to contribute to others' happiness.

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Chapter 13
Win-Win Solutions Are Not Realized by Compromising and Yielding Behaviors

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Abstract In this essay, I will introduce "Collaborative Negotiation," which has been taught at the Department of Organization and Leadership at Teachers College, Colombia University. The art of "Collaborative Negotiation" is an effective method for conflict resolution and problem-solving. It can be used in conflicts to seek a Win-Win solution satisfying both parties to the conflicts. The first and most important step of the method is to determine the needs and desires of both parties. "Collaboration" from both parties is the key to this method. Thinking it could be helpful for many people, I began introducing this negotiation method in Japan soon after I went back here.

13.1 Introduction

When I was a child, I frequently quarreled with my father. He used to say to me, "You should behave yourself, and refrain from expressing your opinions because you are a woman." My father was born at the end of the Meiji Era (1868–1912) and grew up in Kagoshima, a prefecture of Japan infamous for its male-dominated society. I was helpless against my father. I had to obey him.

In my late 40s, I quit my job in Tokyo and move to New York to study at Teachers College, Columbia University. When I took the "Graduate Studies in Conflict Resolution" course offered as a part of a master's program in the Social-Organizational Psychology Program, I finally found out the answer to questions that had long perplexed me: "Why did I frequently quarrel with my father?" and "How could I have dealt with him?"

"Social conflict," the main theme of this essay, is defined by researchers as "the interaction of interdependent people who perceived incompatible goals and interference from each other in achieving those goals" (Hocker and Wilmot, "*Interpersonal Conflict, 2nd ed.*," 1985).

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Social conflict may occur among any two or more groups of people such as family members, classmates, colleagues at work and even among nations. Conflict may also occur within an individual, a group or a nation. The former is called intergroup or international conflict, while the latter is called intra-person, intra-group or intra-nation conflict. In the following pages of this essay, we refer all of them except intra-person conflict as "*social conflict.*"

Any conflict has two aspects, a negative side and a positive side. This was one of the most eye-opening and important concepts I learned at Teachers College. Previously, I had seen conflicts as negative matters, and thus I always tried to avoid facing them. But what is a positive side of a conflict? Facing a conflict gives us an opportunity to understand each other more deeply and precisely, because facing it exposes the hidden gaps between the thoughts and goals of the two parties. To become aware of the existence of gaps and to understand the nature of those gaps are the necessary first steps towards deriving a real solution. Without them, no real solution is achievable.

Dr. Morton Deutsch (born in 1920), who for decades has been one of the world's leading social psychologists and researchers in conflict resolution, wrote in his book ("*The Resolution of Conflict*," 1973) that conflict prevents stagnation, it stimulates interest and curiosity, and that the point is not how to eliminate or prevent conflict but rather how to make it positive. I had never thought of conflict this way.

Soon after finishing the theoretical and practical courses in conflict resolution at Teachers College in 1998, I went back to Japan and began introducing the art of "collaborative negotiation," which was offered as an effective conflict resolution and problem-solving method at the college. Since then, I have continued to introduce this negotiation method at colleges, at local governments and in businesses. Without the knowledge and skills to deal with conflicts, people tend to see only the negative and destructive side of conflicts. As a result, people are afraid to be in conflict with others. People sometimes yield too much or behave overbearingly. These attitudes merely hide the conflicts, pushing them beneath the surface. Another conflict will surely pop up between the two parties in different situations.

13.2 Some Cultural Aspects of Conflict

In the classes at Teachers College, Columbia University, there were a variety of students from different nationalities and backgrounds. I noticed from discussions there that one thing everybody seemed to have in common was negative impressions of conflicts. Nobody seemed to like to be in conflicts. When it came to dealing with conflicts in case studies and other situations, however, the way they dealt with conflicts looked to me quite different from what I used to observe in Japan. I felt at that time that the way people face and deal with conflicts may have something to do with nationalities and backgrounds—"culture".

The term "*culture*" as used in this essay refers to the patterns of communication styles, behaviors and judgmental criteria shared by a group of people. It is observed

that the individual's self, as well as his/her capacity for reflective thought, develop in the course of social interaction with the members of his/her family and other groups in the community to which he/she belongs (G.H. Mead, "*Mind, Self, and Society*," 1934).

Reflecting on what my father used to say to me, I think now that it was advice to his daughter regarding how to behave with the group of people he lived among and that he thought I would live among. Not only families but also any group of people (ranging in size from a small one like a family to a large one like a company, school or a nation) may share opinions, behaviors and judgmental criteria in common. When people in a group interact, they are exposed to the behaviors and opinions of others and are influenced by them. Thus groups of people in a community foster their own indigenous cultures.

Negotiations between people from different cultures may fall into an impasse because of their differences and incompatibilities. We often see this situation in international negotiations. Even in negotiations among family members or intimate friends who share many things in common, negotiators may fall into impasses frequently. Each individual has been culturally influenced by many different communities, groups and others. Everybody is different. Even if they share many things in common and get along well on ordinary days, a difference may pop up on a certain matter, bringing in a conflict.

G. Hofstede, a noted social anthropologist, observed that cultures differ depending on whether people emphasize the individual or the group and that the group-oriented cultures are more likely to value the needs of the group above those of the individual (G. Hofstede, "*Cultural Dimensions in Management & Planning*," 1984). Negotiators from individual-oriented cultures such as the United States think that it is important to assert their positions at the negotiation table. In contrast, negotiators from group-oriented cultures such as Japan do not assert their positions strongly.

13.3 The Point Is People's Attitude Towards Conflict

Everybody comes from different backgrounds: age, gender, religion, education, culture and so on. These "differences" among people often cause conflicts when they work together in a group.

On a football team, individual members are always competing for their playing positions. But when it's time for a game, they play cooperatively together towards the shared goal of their team's victory. In an office, a boss and his employees may fight over their work and vacation schedules. But they can work cooperatively to achieve their company's business goals. In other words, it is possible for individuals even in competitive situations to work cooperatively when common goals are appropriately set.

For conflict resolution, it is very important for people in a group to work with explicit emphasis on their common goals and interests. If people see only their

mutual differences without seeing what they have in common, they may find it difficult to work collaboratively. People's attitude is key for successful collaboration.

At the COP21 international conference for saving the Earth from global warming, delegates from different nations participated with a strong sense of crisis in common. As a result, participants could exchange constructive opinions and work together for "their mutual goal." The COP21 team finally reached an agreement that was satisfying to all of the conference participants.

Dr. Deutsch wrote in his book (Deutsch 1973) that the fate of the participants in a situation of conflict is not inevitably determined by the external circumstances in which they find themselves and that the occurrence of conflict as well as the process and outcome of negotiation for conflict resolution are affected by the psychological factors of the people involved in conflict. Accordingly, a basic idea underlying the "collaborative negotiation" introduced at Teachers College is that conflicting issues and conflicting people should not be separated for conflict resolution.

Negotiation is a very sensitive matter. There is always a possibility that a listener will feel that he/she is being attacked by a speaker based on facial expressions, tone of voice, body language and so on. If the listener doubts the sincerity of the speaker, the listener will begin faking or counterattacking. In negotiation, people's sincerity should not be fake. Their attitudes and communication skills also matter.

13.4 The Two Dimensions of People's Negotiation Behaviors

When I teach classes, I use an inter-human communication diagram developed by R. Kilmann and K. Thomas ("*Developing a Forced-Choice Measure of Conflict Handling Behavior,*" 1977) It is called "The Thomas-Kilmann Conflict Mode Instrument." The diagram shown below with the title "The Modified Dual Concern Model" is my modification of their diagram to explain the difference in human attitudes in various two-person (or two-group) negotiation situations.

This diagram maps people's attitudes towards negotiation. It has horizontal and vertical axes both ranging from 0 to 100%. Point B represents the (x = 0%, y = 0%) position, point A represents the (x = 100%, y = 0%) position, point C represents the (x = 0%, y = 100%) position, and point H represents the (x = 100%, y = 100%) position, respectively (Fig. 13.1).

The percentage on the X-axis represents the degree to which the negotiator is concerned about his/her gain (outcome) from the negotiation. For instance, 100% on the X-axis represents an attitude of never compromising (The negotiator tries to achieve 100% of what he/she wants to gain). The 50% point on the X-axis represents an attitude of trying to obtain at least 50% of what he/she wants in the negotiation. This indicates room for yielding or compromising–but not more than 50%.

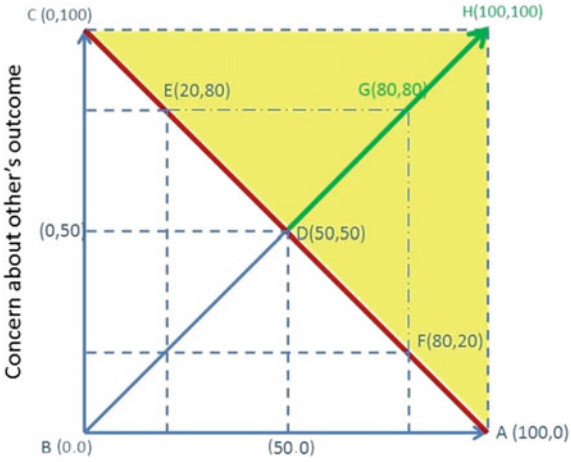

Fig. 13.1 The modified "dual concern model"

On the other hand, the Y-axis represents the similar concern for the counterpart in the negotiation. The 0% point on the Y-axis represents an attitude of never caring about the opponent. The 50% point on the Y-axis represents an attitude of "I will be concerned that my counterpart will also gain at least 50% of what he/she wants."

In my "collaborative negotiation" classes at colleges, I used to draw this diagram on a board. Then I asked students to come to the front and to draw a mark ● at the position reflecting his/her everyday communication attitude, particularly when in a conflict situation with others. One student placed a mark at (X = 20%, Y = 80%), another marked (X = 50%, Y = 50%), a third marked (X = 100%, Y = 0%) and so on. It is very interesting to observe that almost all of the students drew marks on or near the A-C diagonal line (Red line). Surprisingly, nobody drew ● near the positions B or H. From this, I concluded that most Japanese people (all of my students at least) perceive conflicts as zero-sum affairs. If I win, my opponent loses. If my opponent wins, I lose. Or both can compromise to end up with half-and-half. From the dots on the board, it could be seen that all students imagined themselves in conflict over a matter on which interests were incompatible, and that all conflicts would end up on the A-C diagonal line (Red line). Please note, however, that there is no "Win-Win" resolution on the A-C diagonal line.

Must all conflicts have a zero-sum nature? That is not true. A hypothetical example can prove that non-zero-sum conflict can exist.

> You (a boy) and your friend (a girl) are walking on a street. You find a beautiful pouch on the street. You take it, open it and find money inside. You think the pouch is 100% yours because you found it and picked it up first. But your friend insists that she should get half of it because you were walking together. You and the girl are in a conflict.

If an observer on the scene were to listen to the boy and the girl, he might find out that the boy's interest is in the money, while the girl's interest is in the beautiful pouch. Knowing the needs of both, an optimal solution can easily be devised. The boy takes the money and the girl takes the pouch.

If the boy and the girl are mature and intelligent enough, they might express their needs precisely and listen to each other very carefully. If that happened, the two might have found the mutually agreeable solution. In general, however, it seems to be difficult for anybody, even ordinary adults and even large groups such as nations, to communicate in that way in negotiation. That is why there are mediators, courts and judges.

Then, I asked the classes to look at the positions of G and H in the diagram on the board, and said, "When people are collaborating for resolution of conflict together, it could be possible to settle the conflict at Win-Win resolutions such as G and H. But in order to reach G and H, it is very essential that you respect your opponent and inform him or her of your needs very clearly. At the same time, you must listen intensely to what the opponent is saying and, if needed, ask questions to get more information, and/or paraphrase what the opponent wishes."

With the help of this diagram, the classes seem to understand clearly that reaching points in the area above the A-C line (Yellow area) is possible. But what we ought to try is to reach points in the neighborhood of the D-H line (Green line). Note that any points on the D-H line give more than 100% of satisfaction as sum of the results for the two sides (For example, 160% at point G and 200% at point H). Also, points on the D-H line give same degree of outcome satisfactions to both. Solutions on the D-H line are well-balanced and sustainable.

Whether two negotiators can reach H or can only reach D or G depends on how much the desires of the two overlap. If one wants to have (a: money) and another wants to have (b: pouch), then for one to take (a) and the other to take (b) will yield a resolution at point H. In the case of an inheritance, one may want to have (a) the house and (c) cash in the bank. The other may want to have (b) the art collection and (c) cash in the bank. In this case only (c) is in conflict. The best solution in this case will be—one to take (a) the house and the half of (c) the cash and the other to take (b) the art collection and the other half of (c) the cash. This composite solution is an example of point G.

We always have to try our best to reach H, or at least work collaboratively towards a position on the D-H line, when two sides are in conflict.

As we observed in the case of saving the Earth from global warming (in page 5 of this essay), collaborative and productive discussion among the delegates from different countries made it possible for them to discern the priority needs in common for all. As a result, they could work together and reach an agreement at, let me say, point G. Even though the agreement was not 100–100% but 80–80% satisfactory, this agreement can be regarded as a large step forward, possibly enabling the delegates to reach point H in their next conference.

13.5 Conclusion

Clarifying one's needs and informing others of these needs clearly and precisely seems to be a little difficult for Japanese people in general.

I found that the attitude of mothers towards their babies at meal-time differs between those in the United States and those in Japan. The American mothers in general would let their babies choose what they want to eat, by asking such questions as "Which do you want to eat, bread, oatmeal or cornflakes?" and "Which drinks would you like, a cup of milk or orange juice?" The American mothers, perhaps, assume that learning to identify one's own needs at an early stage in infancy helps one to survive in competitive American society. The Japanese mothers, in contrast, are apt to bring their prepared meals into their babies' mouths automatically, not paying any attention to the babies' own needs. The differences in mothers' attitudes towards babies, I think, comes from cultural differences.

What happens if the individual's needs are left unsatisfied? If people cannot get their important needs met, they are sure to find themselves feeling neglected and sacrificed, finally becoming depressed and losing confidence. Owing to these negative feelings accumulated in their minds, I am afraid, people become unstable and mentally sick. The unfulfilled needs of people, more often than not, turn into rage and/or anger.

It is important to respect each other as independent human beings and respect the needs and desires of yourself and others. This is an underlying, important idea of "collaborative negotiation" for conflict resolution. Analyzing the needs of both sides in a conflict is an important preparatory step for successful "collaborative negotiation." The details will appear in my book, which is now being prepared for Japanese college students. I hope the book will serve as a helpful guide for young Japanese to deal with the unprecedented conflicts they may face in the future.