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HOW TO GET STUDENTS – FROM DIFFERENT BACKGROUNDS AND WITH NO EXPERIENCE IN DESIGN – GOING

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ABSTRACT
Students that participate in the Honours Master-course High-Tech Systems and Materials (HTSM) of the University of Groningen have different educational backgrounds, they meet for the first time, they have never cooperated with High-Tech companies and they have no experience in product development or product design. For these reasons, the students have difficulty starting their projects. To solve this problem the Workshop Evolutionary Product Design was developed. This paper explains how we work in this workshop to get the students going. Before the workshop takes place, we give the students a preparatory assignment they have to work on in groups. They have to analyse the history of both the product design, the used (production) techniques and the working principles of their assignment for the course, e.g., by using the Internet. They are supposed to prepare a short presentation of about five minutes (maximum ten minutes) about this product history. The workshop starts with a lecture introducing Evolutionary Product Development. After the lecture, the students get an additional assignment to adapt the presentation that they have made, and to add what they have just learned. The students have half an hour to work on their assignment. After this, one by one the groups present their results to the teaching staff and their fellow students. The fellow students are challenged to give their colleagues feedback. Then the staff members give their feedback. With this, the students have made a start with their assignment, which was the goal of the workshop.

Keywords: Collaboration in teams, evolutionary product development, product life cycle, product history, product phases

1 THE COURSE: HONOURS MASTER HIGH-TECH SYSTEMS AND MATERIALS
The Honours Master is an elective, extra course for students at the University of Groningen. The students that participate in this Honours Master excel at the frontiers of knowledge and are looking for an extra challenge during their master's degree. The Honours programme offers intensive, small group teaching with a group of like-minded, motivated students. The track offers a unique opportunity to collaborate with students from different disciplines on challenging, real-life product development assignments by the industry. Students who complete the HTSM Master's Honours Programme receive a mention on their diploma and a letter of recommendation from the Rector Magnificus of the University of Groningen. This will give them an advantage when applying for positions in academia, the business world or the public sector.

2 THE PROBLEM
Students that participate in this course have different educational backgrounds: Arts, Behavioural and Social Sciences, Economics and Business, Health and Life Sciences, Law, Philosophy, Science and Engineering, Spatial Sciences (Geography, Environmental Planning, etc.), and Theology and Religious Studies. They have never cooperated with High-Tech companies and most of them have no experience in product development or product design. In the first year the course was delivered, the staff members had problems to get the students going. In this paper a workshop is presented that was created to solve this problem.

3 THE WORKSHOP: PREPARATORY ASSIGNMENT

In the Honours Master Course, the students work in small groups. Before the workshop takes place, they get a preparatory assignment they have to work on in the same groups. They have to analyse the history of both the product design, the used (production) techniques and the working principles of their assignment for the course, e.g., by using the Internet. They are supposed to prepare a short presentation of about five minutes (maximum ten minutes) about this product history. They get the instruction to bring at least one laptop per group (without knowing why).

4 LECTURE: INTRODUCTION TO EVOLUTIONARY PRODUCT DEVELOPMENT

The workshop starts with a lecture introducing Evolutionary Product Development. Until the late 1980s product development was generally considered to be a 'linear' process. The common idea is that the development of products is entirely controlled by inventors and engineers. However, products are not simply invented from scratch. Although everybody will agree that each individual product is intentionally developed, it can be shown that, once we consider the evolution of products over the course of many decades, it is clear that they do not follow a predetermined long-term plan. Therefore, the emergence of new types of products can be regarded as an evolutionary process [1].

4.1 History Matters

Most of the products that are developed and brought to the market are nothing more than slight adaptations or improvements of earlier versions of the same product. Even when, once in a while, a completely new type of product appears, it adds some novelty but always builds on existing knowledge. The wheel is not reinvented but refined and used for new purposes. Besides that, the freedom to design newer versions is narrowed down by earlier technologies, standards or products. The development path travelled so far cannot be completely redone. This significantly limits the amount of freedom to design newer versions. In short: HISTORY MATTERS.
The method of Evolutionary Product Development consists of three parts: the Product Family Tree, the Ecosystem and the Product Phases.

4.2 Product Family Tree

The Product Family Tree is a tree-like diagram, similar to the family tree based on the Linnaean taxonomy known from biology. The Product Family Tree maps the main relations between products through time, connecting a new type of product with later ones as lines of descent. The evolution of products is based on progressing know-how and know-what. This accumulation is not restricted to a particular product lineage. Rather, it is a common pool of knowledge from which many product lineages draw. Dominant designs constitute successful incarnations in a lineage of products. New types of products that give rise to new product families are rooted in prior accumulated knowledge. Consequently, Product Family Trees cannot unambiguously be combined into a single continuous branching tree, starting at the earliest products through to present-day products. Instead, a Product Family Tree is intended to be an analytical instrument to map how products evolve from a new type of product into a product family. It is therefore a simplified representation, limited in scope to a single product family and intended to explain the process of establishment of new types of products and their further evolution into a family of products. Various Product Family Trees connect to other earlier products or technologies via their roots.

4.3 Ecosystem

The Ecosystem describes how new types of products emerge and what influences their subsequent development. In the case of biological species, it is widely known that the ecosystem in which they live and reproduce plays a crucial role in their evolution. Changes in climate may, for example, lead to the extinction of one species (such as the mammoth) while causing another species to thrive. In the case of products, it has been demonstrated that, despite it being made up of man-made elements, their ecosystem is part and parcel of their evolution [1].
New types of products are not just invented from scratch but are developed on top of what has been invented before. Their evolution is fed by technologies developed for other purposes and is, to a large extent, determined by the way people deal with these products. The origin of these products can be explained by a process of descent with modification, but then, of course, in a way that is different to what we are familiar with in nature. Although it is not yet commonplace for designers to think about

evolutionary next versions when designing products, tools – such as PEST [2] – are now being provided for this purpose.

4.4 Product Phases

The most important conclusion of the model of Product Phases is that the focus of the product development activities is influenced by the place the product has in its life cycle. In this model the well-known six phases of the economic product life cycle (development, introduction, growth, maturity, saturation, and decline (or ossification)), are combined with a qualitative model of six product phases called performance, optimization, itemization, segmentation, individualization and awareness. A practical implication is that designers need to take explicit account of this relationship when choosing specific product development activities. Besides that, the chance the product development process will deliver a successful product can be enhanced when consideration is given to the life cycle.

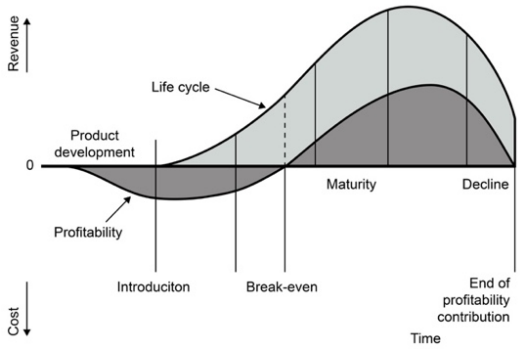

Figure 1. The six phases of the Economic Life Cycle

In the early phases of a new type of products' existence, the attention of the designer will focus mainly on functional aspects: first on technical functioning and later on the improvement of quality, ergonomics and safety. Next, the designing activities focus on price, styling, extra features and offering a line of products. However, in the later phases of a product's existence, there is a shift in emphasis. The development of extra features and accessories is an ending process: at a certain moment, the performance delivered exceeds what is needed. As a product progresses into later life phases, the importance of the experience provided by the product increases and so-called 'emotional benefits' are added to the product.

4.4.1 Product Phase 1: Performance

New types of products – that is, products that provide a new basic function – normally suffer from teething troubles for some time when they first appear on the market. By implication, improving the basic function (i.e., the primary purpose of the product) is the most important aspect of product development in this phase. New products often start as status symbols, and usually perform worse than the existing alternatives. The product characteristics of the product phase 'performance' can be summarized as follows. Technically speaking, the product is new and often results from a 'technology push.' The performance of the product is often poor (i.e., the performance of the basic function is still poor). Product development is primarily aimed at improving performance. Design in the limited sense of 'overall form giving' is unimportant and product aesthetics are, therefore, of minor concern. The product is often launched into the market by a monopolist or a small number of heterogeneous oligopolists, so competition is low. As a consequence, the price per unit can be relatively high. The product is frequently produced by standard equipment, it often has more parts than the minimum amount technically feasible, and assembly is mostly done by hand. In terms of adoption of innovations [3], the product is bought only by the innovators, a type of user willing to take risks with new types of products, and to adopt technologies that might ultimately fail.

4.4.2 Product Phase 2: Optimization

In the second phase, product development is broadened to include ergonomic aspects and issues of reliability in use and safety. The 'optimization' product phase is characterized as follows. Although the product is technically speaking still new, consumer awareness of the product is starting to develop. The performance of the product is reasonable, but product development is still aimed at improving performance. Other aspects, like increased reliability, improving ergonomics, and safety aspects, are

becoming serious considerations. The price per unit is still relatively high, but increasing competition creates a tendency toward lower prices. In this and the following phase, it can be advantageous to involve clients in the product development process to improve the performance and ergonomics.

4.4.3 Product Phase 3: Itemization

When producers have improved their product to the point that they satisfy generally accepted standards of functionality and reliability, the edge of competition shifts to convenience. Buyers will prefer those products that are the most convenient to use and – especially in the business-to-business market – sellers that are convenient to deal with. Often in this phase there is a dominant design. Sometimes there are more dominant designs, e.g., in the case of shavers: wet shavers and electric shavers, based on either rotating or vibrating knives. Mass-produced products make personal selling impossible. The market grows less, and the number of competitors increases. As the product range grows, prices fall, and promotion costs increase. Endeavours are made to develop extra features and accessories, including special editions of the product that are developed for different trade channels and target groups. Design becomes more important, and product aesthetics become a major concern. The number of product parts of the basic (cheapest) products decreases, but accessories or extra features can cause an opposite effect, namely an increase in the number of parts. Mechanic and/or automatic assembly also becomes more important. If needed, well-organized service organizations are set up to support the product.

4.4.4 Product Phase 4: Segmentation

In the first three product phases (i.e., performance, optimization, and itemization), the focus was on improved functionality, reliability, ergonomics, and safety. An attempt to add extra features and accessories in order to differentiate the product from its competitors takes place somewhere in the third stage. However, this kind of development comes to an end. Indeed, there comes a time when the performance offered is actually greater than the performance required. For relatively uncomplicated products, such as furniture and trinkets, the possibilities for adding features or accessories are limited. Moreover, products become less attractive to innovators and early adopters during the latter product phases. The market share is such that the product is considered 'accepted.' Owning the product is no longer distinctive, as it does not offer any form of status. Adding emotional benefits to a product is now possible. Research [4] has shown that involving customers in the design of emotional benefits (experience design) does not improve the success of the product.

Characteristics of the product phase 'segmentation' are that the product is part of the daily life of almost all members of the target group. As the product, technically speaking, has entered the domain of some 'dominant design' (or a limited number of 'dominant designs'), product development is aimed at adding extra features and accessories, including special editions of the product for different trade channels and target groups. Design has reached a stage of complete integration of the various parts of the product into a completely unified and recognizable form and the design focus shifts from form giving proper to expressive features, aimed at increasing emotional benefits. The market approaches perfect competition.

4.4.5 Product Phase 5: Individualization

Extrapolation of segmentation (continuous fine-tuning of products on ever-smaller target groups) ultimately leads to a product that is properly attuned to one individual. The developments in information and production technology make this kind of individualization even more possible. These developments imply the following changes in characteristics in the 'individualization' product phase. Product development is geared to mass customization and cocreation, allowing the customer to influence the final result. Although prices approach average technical production costs of the dominant design, cocreation and mass customization offer possibilities to realize higher prices. Interactive media are used to customize the product to the needs of the individual customer.

4.4.6 Product Phase 6: Awareness

Marketing-related research on the importance of ethics in influencing consumers' purchase decisions shows contradictions [5]. If consumers are asked if they are willing to pay a higher price for ethical behaviour, the results are positive. According to this kind of motivation research, this group is growing [6]. But when the purchase decisions are observed, it shows that these consumers still buy products from unethical firms if the price is lower [7,8,9]. These researches show what is called the 'citizen-consumer paradox:' as a citizen, one finds sustainability important, but as a consumer, one does not always take sustainability into account in purchases [6]. The purchase motivations of consumers who

buy sustainable products also show that the personal motivations of consumers are more important than ethics: the trigger for consumers to purchase sustainable goods is rather their own interest than the public interest. For consumers who find sustainability important in their purchase decisions, this is especially the case when they benefit from it personally. This becomes apparent from how the number of consumers who find sustainability important differs per product type. For products where sustainability leads to cost savings such as white goods, cars, energy, and electric products, this is 60%. For food, this is 50%, with motives such as health, taste, or animal welfare. In contrast with products that have a high impact on the planet but fewer personal benefits, products such as household and personal care products, mobile phones, clothes, and flights, only 30% to 40% of consumers find sustainability important [6].
From this research, it can be concluded that a substantial proportion of the consumers is willing to contribute to a better environment and to help solving societal problems by changing their consumption patterns, but only if this can be done without much effort, and only if it does not lead to decrease in consumer satisfaction and a too big increase in the financial burden. Most people expect companies to play an active role in solving common societal problems. A company can successfully tempt a small group of consumers by offering them the possibility of showing their ethical involvement by acquiring products that in some way claim to be more environmentally or socially beneficial than their competitors.

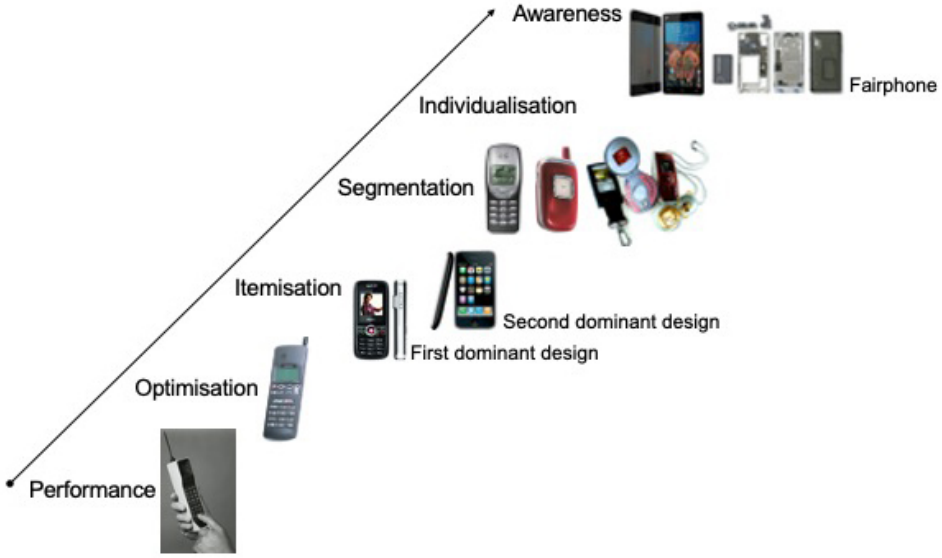

Figure 2. The Product Phases as they appear in the development of the smartphone

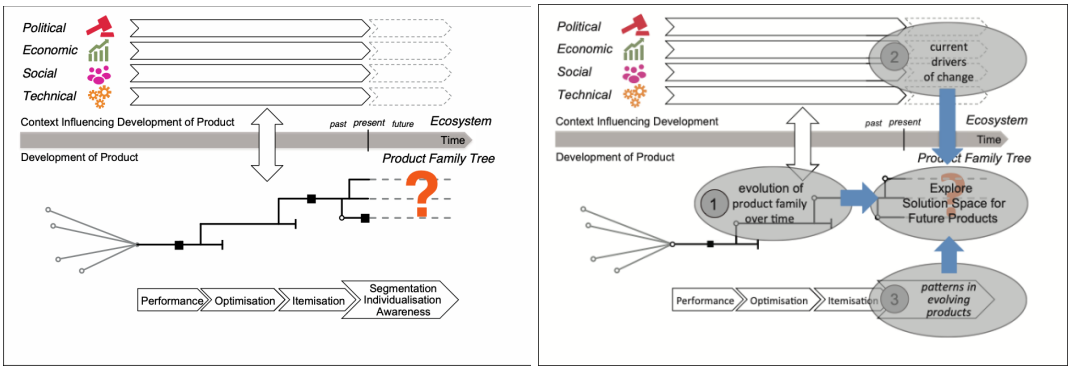

Figure 3. How the parts of Evolutionary Product Development determine the Solution Space for Future Products

5 ASSIGNMENT AT THE END OF THE WORKSHOP

After and during the lecture the students have the possibility to ask questions about the theory of Evolutionary Product Development. Then they get an additional assignment to adapt the presentation that they have made before the workshop, and to add what they have just learned.
They have to:

- analyse the history of the product of their assignment based on the theory of Evolutionary Product Development,
- give the product phase that they think the product of their assignment is in and substantiate their choice,
- give possible strategies for new product development for the product of their assignment (and again substantiate),
- make a presentation of between five and ten minutes of their results.

The students have half an hour to work on their assignment. After this one by one the groups present their results to the teaching staff and their fellow students. The fellow students are challenged to give their colleagues feedback. Then the staff members give their feedback. If all went well, the students have now made a start with their assignment.

6 CONCLUSION AND DISCUSSION

The Honours Master-course HTSM has been given since 2014. In practice it has been shown that the workshop had the intended result. In the first few years the workshop was given halfway through the course. However, since 2018, it has been brought forward to the second day of the course, immediately after the introduction and the students' acquaintance with the companies involved. Although the course has so far only been taught to students who had no, or very little experience with product development and design, we expect that it will also work for product design and engineering students.

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