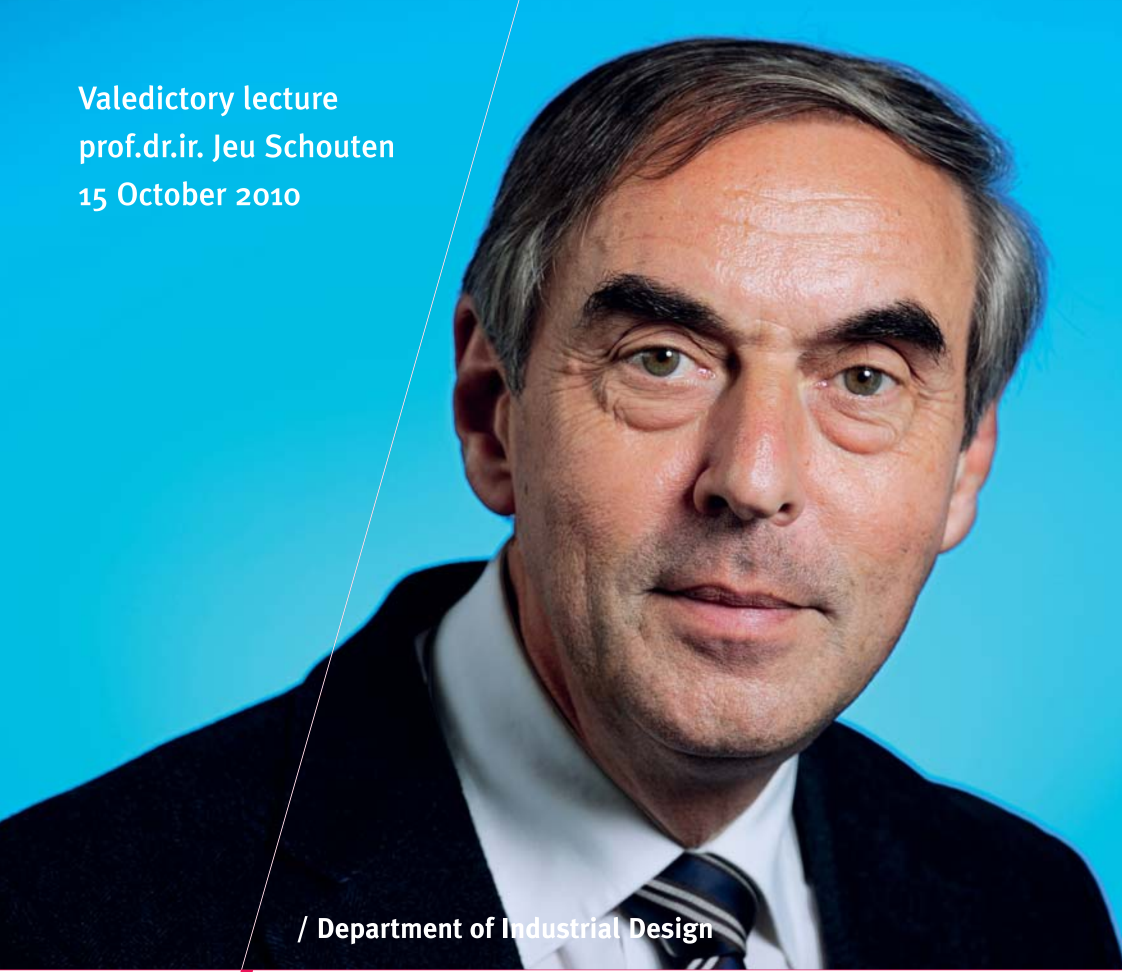
Design: from techno to human

Valedictory lecture
prof.dr.ir. Jeu Schouten
15 October 2010



/ Department of Industrial Design

Technische Universiteit
Eindhoven
University of Technology

Design: from techno to human

Where innovation starts

Valedictory lecture prof.dr.ir. Jeu Schouten

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from techno to human

Presented on 15 October 2010
at the Eindhoven University of Technology

Changing focus

During recent weeks I spent time on reflection, looking back at my long period at the TU/e, starting with mechanical engineering; the research field concerned is one I have always greatly enjoyed working in.

Ten years ago I decided to 'do something else': designing and building up the new Department of Industrial Design; with a completely new focus.
During those weeks of reflection I received an invitation to attend a scientific conference in England on my previous engineering research field. It seems that I am still 'on the list', but at that very moment I realized that I was no longer participating in one of those many scientific conferences, at which super-specialists discuss in a small sub-culture. And what happens there is very important, but nevertheless: outside the congress hall the real world is recovering from a financial crisis, there is an environmental disaster in the Gulf of Mexico, much of Pakistan is flooded, and on top of that there are our overall concerns about subjects like food, water, energy and healthcare.

So I was once again happy that I had decided in 2000 to broaden my scope, although of course that didn't mean I had turned my back on the very interesting field of mechanical engineering.
I am convinced that broadening one's scope and changing one's focus is now and then necessary in a scientific career. On university level I would also strongly recommend reflecting on the "raison d'être" of scientific fields and organizational structures, resulting in decision making e.g. about which fields/departments should continue, be adapted or stopped or which are missing in a changing environment. It may be helpful to answer the question of whether a research field or department – if it did not already exist – should now be established.

In this presentation I would like to take you on a journey through the field of technology and design. It is also a journey in time, in a context of a changing world.

- I would like to start with my first work in the mechanical engineering discipline
- then we will take a look at the broad field of Industrial Design (ID), and the design of a new department
- after that we make a brief comparison of these two fields
- finally we will arrive at the present day, and looking ahead at the future.

We will see an interesting parallel between the development of mechanical engineering towards a scientific discipline and, with a time-delay of some 30 years, an analogue development of ID towards scientific maturity.
For me it covers a period of changing focus in design: from techno to human.
I will not manage to present a complete overview of the whole period. I will limit myself to a selection from my 34-year career as professor at our university: 34 years at TU/e in 34 small pages.
My presentation is based on a mix of content and organization. That has to do with the journey that I have myself made during a period of 47 years in technology and design of which 34 years as university professor and being dean for half of that time: 7 years at Mechanical Engineering and 10 years at Industrial Design, so with a content developing from techno-specialized via generalized to strategic.
This is a report of a growth process towards 'Designing a Design Department' resulting, for the time being, in a new, transdisciplinary field and a new method for education within it.

Mechanical Engineering Design: Technology Focus

After always being interested in technology, I gained my first experiences in mechanical engineering from 1963, as a student at our University of Technology, which at that time was still named *Technische Hogeschool*.
While I was graduating in mechanical engineering design under prof. Horowitz, I saw an interesting cross-section of the entire field [1]. All the designs were new, and they were always aimed at industry, with applications in a range of sectors such as mechanical drive technology, agricultural mechanization and medical technology.
In the two years after that, at the Royal Netherlands Navy, as well as the naval military discipline there was also design attention for mechanical and hydraulic drive technology, especially for ship propulsion systems, including work on a characteristic low noise design using a fish-fin-based means of propulsion.
During a period of seven years from 1969 to 1976, research was done for the German Engineering Federation VDMA / Frankfurt in the field of elastohydro-dynamic (EHD) lubrication. This is a physical phenomenon that takes place in almost all machines in which highly loaded components transmit motion and high forces through extremely small contact areas. The high material stresses that arise, form the most important limitations to servicelife and load for many machines.

The German machine industry, and especially the automotive industry and its suppliers, were extremely interested in an understanding of this phenomenon and the ability to calculate it. This allowed the development of new design rules, for example for vehicle drive lines or wheel bearings.
The presence of lubricating oil between the contact surfaces provides an extremely thin fluid layer so that the metal surfaces are no longer in direct contact. This is a micro-scale phenomenon that is comparable to the well-known ‘aquaplaning’, in which a rapidly rotating vehicle tire loses contact with the road surface in a pool of water, despite the weight of the vehicle.
To take a real step forward in understanding and in technical and industrial application, the challenge was to theoretically predict and experimentally verify the phenomena taking place in these lubricated contacts.

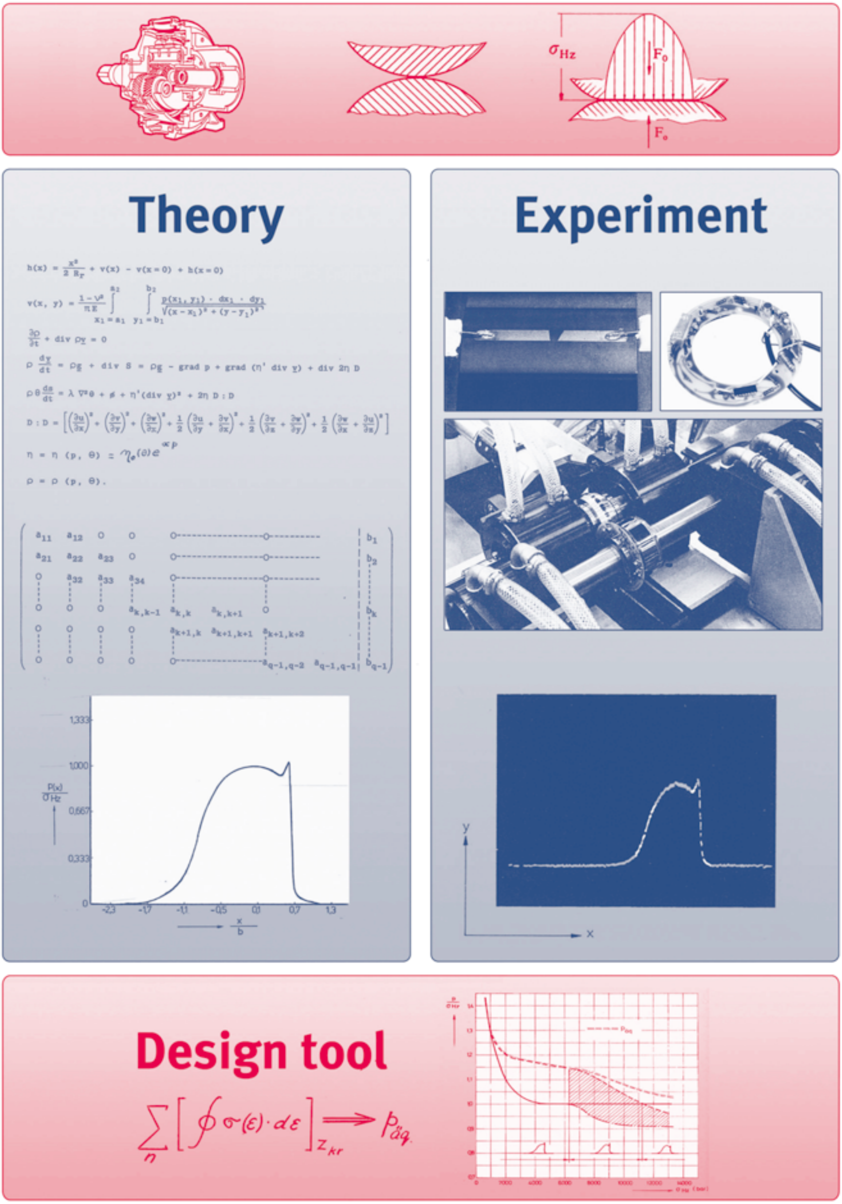

figure 1

Research in elastohydrodynamic lubrication

The fact that this was at the time internationally regarded by colleagues in the field as virtually impossible was for me an important reason for continuing under the motto: “Let’s just do it!”
The integration of different types of knowledge from mathematics, physics, electronics and mechanical engineering enabled the theoretical and experimental determination of EHD phenomena at TU/e in 1971. Fig. 1 gives a brief summary.

As well as publication for the VDMA and the German machine industry and internationally, the results were presented in the doctoral thesis *Einfluss elastohydrodynamischer Schmierung auf Reibung, Verschleiss und Lebensdauer von Getrieben* (Influence of elastohydrodynamic lubrication on friction, wear and service life of power transmissions) at TU/e in 1973, under the supervision of prof. Schlösser (TU/e) and prof. Koenig (TU Berlin) [2]. The results gained a great deal of international attention and recognition.
This served to further strengthen my great interest in the integration of analysis and synthesis/research and design in the field of technology, and as a result also in carrying out research linked to industrial applications.

This was the period in which mechanical designers first started to gain access to computers, which allowed time-consuming calculation processes to be drastically shortened.
For designers this was a revelation: it meant they had time to think about the real content for an engineer – designing. Others immersed themselves in computational processes from which they never emerged. Sometimes that was a kind of alibi, so they didn’t have to spend time as creative designers but were still able to generate results for publication.
Around the same time a remarkable process started, which is still continuing in some places: attention for the supporting tools increasingly began to replace that for the subject matter itself. Having a laboratory infrastructure gained more attention than the results that were achieved.
Mechanical engineers started to do fundamental research, and no longer built any machines; possibly supported by the publication culture.

Education and research

After my appointment as professor of mechanical engineering at TU/e in 1976, the method of approaching the scientific engineering content as an integration of analysis and synthesis was further developed in research/design and education. Of the initial mechanical application areas, it was mainly mechanical driveline technology that was further developed. The vital importance of highly loaded mechanical contact surfaces in all these constructions led to the integration of the discipline of contact mechanics, lubrication, wear and friction – with tribology as research and tribotechnology as its application in design.
Cooperation with the field of hydrostatic transmissions, led by my colleague Schlösser in the same department, developed gradually into the integrated field of Power Transmission and Tribology, to become one of the focal areas for the universities of technology in the Netherlands.
In the institute doctoral candidates and post-graduate students were all intensively involved at their own levels in carrying out research, as well as in formulating research questions.

Two interesting points resulted from this approach:

- Education and research were strongly interwoven. This is one of the fundamental characteristics of the university.
- It led to an interesting sustainable education/research ecosystem, which became to a large extent self-supporting in its implementation. Students were trained in working together on complicated projects, as junior employees in a team, supervised by senior staff members.

Interesting new developments were made that, as well as industrial applications, also – and above all – provided new fundamental knowledge for the engineering discipline. This was typical engineering in a technology environment: creativity based on scientific insight. Examples were:

- Crown gear transmission:
  A creative design for a new gear-transmission principle for intersecting or crossing shafts ('90° drive') which in effect was developed 'back to front' based on a theoretical proof of its feasibility.
  This principle uses a cylindrical pinion on the high-speed shaft, together with a special gear shape on the low-speed shaft.

This new design has numerous industrial applications, of which the design of an innovative tail-rotor drive for a new helicopter was perhaps the most striking at that time. Recently this crown gear technology is used in the commercial Audi-quattro-RS5-series as the heart of the drive line [3] (fig. 2a).

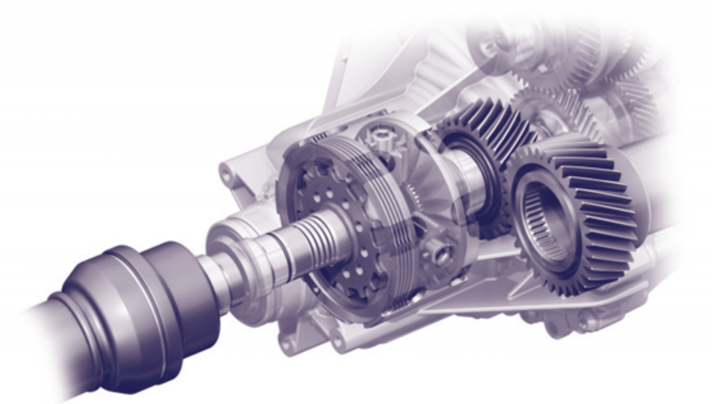

figure 2a

Crowngear differential in the Audi-quattro-RS5-series

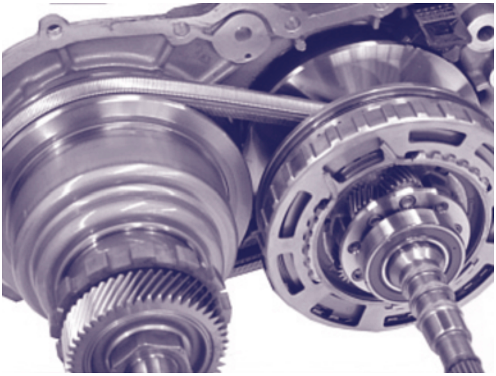

figure 2b

CVT metal belt transmission for a car drive-line

- Continuously variable transmissions (CVTs)
  In these systems the relative rotational speeds of the input and output shafts are continuously variable. The CVT with metal belt is currently used in a number of car types (fig. 2b)

Managing an existing department

A new and interesting period started in 1993 when I was asked to become dean of the Mechanical Engineering Department.
At that time the department was having difficulty in finding a direction, and was in a negative spiral in which the two approaches of research versus design were being discussed as alternatives. But in my view each of these two options, if the other is abandoned, is a dead-end street: for an academic program in the field of engineering, the integration of research and design is an essential prerequisite to allow sufficient emphasis to be placed on synthesis and creativity on the one hand, and on fundamental depth on the other. It is this that will allow us to maintain the specific position of the universities of technology as a special subset of academic education in general.

This role of managing the department, which was initially for a period of four years, eventually lasted until 2000. During this period, together with my colleague prof. Han Meijer, important decisions for the future of the department were made and put into effect. The research underwent a renewal, following an increasingly model-oriented approach, based on well understood physical models of primary phenomena that were then translated into mathematical models. This enabled computer simulation of processes, and the prediction of the behavior of constructions under changing parameters.
Once processes and the behavior of systems are understood, the required laboratory tests can often be better focused and as a result we need fewer.
It also in many cases became possible for measurements of full-scale prototypes to be replaced by well understood tests on scale models.
In fact this was an application and a continuation of the vision that Schlösser had already presented to us as mechanical engineering students since 1963 in his lectures [4].

The model-based mix of theory and experiment resulted in intelligent laboratories, which were often of a smaller size than was needed for full-scale testing.
Innovations were also introduced in education. These led to a greater integration of and coherence between the courses in the curriculum.

The renewed Mechanical Engineering Department went through an international research assessment and an educational assessment with great success.
Based on a European survey, published in the German ‘Der Spiegel’, the TU/e Mechanical Engineering Department was rated in 1998 as the best mechanical engineering department in Europe.

Industrial Design: human focus; Design of an ID Department

Despite the relative width of the Mechanical Design discipline, and despite the rapid emergence of mechatronics that was necessary to reunite the disciplines of mechanical and electrical engineering, which had grown increasingly far apart over the years, we considered by the end of the 1990s that our field had become too narrow in relation to the challenges in society that engineers felt drawn towards. As well as that, increasing numbers of students and researchers were interested in placing the results of advanced technology into a broader context, so they were better and more visibly matched to the needs of society and the economy.

In the same period, numerous discussions were held with the creative industry about the great need that was arising for more broadly trained design engineers in parallel with those who had developed their skills in narrow specializations or mono-disciplines. This 'new breed' of engineers would have to develop as a specialization the ability to integrate different types of knowledge, next to their own specific domain knowledge and creativity. Our society, after all, is not divided into specializations – they are what we at universities have introduced. Instead of the focus of the technology engineer to find a solution for a given technical problem, the starting point for the new engineer should be the 'problem finding' or 'opportunity finding' phase as first part of the design cycle for new solutions.

The idea arose to set up a new and transdisciplinary field within the engineering sciences, and with close links to the creative industry. The then chairman of the TU/e Executive Board dr. Henk de Wilt, under whose leadership TU/e went through a tremendous period of innovation and gained international recognition, was a strong driver of the process of preparation.
The demand from industry at that time was to a large extent as shown in fig. 3: 'Universities produce large amounts of knowledge and large numbers of good graduates. To allow this knowledge to be usefully applied in society and in the economy, it must be built into creative products and services which are needed by society'. The latter is of course the task of industry itself, but it requires a new kind of academically trained engineer as a creative designer and integrator.

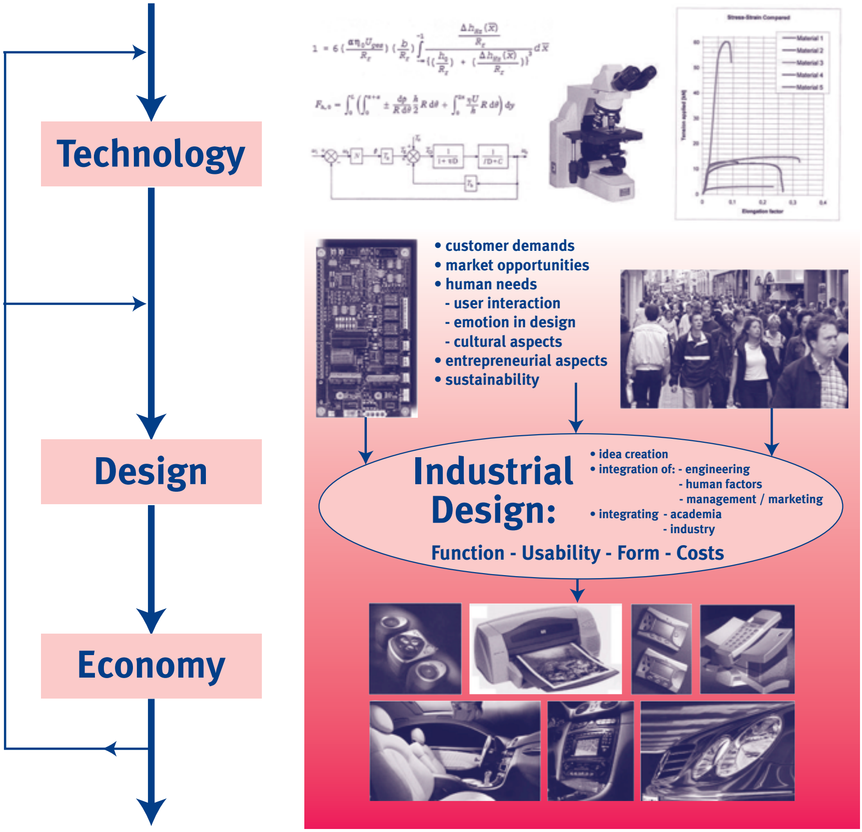

figure 3

Start of ID discussion in 2000

It was decided in the fall of 2000 to actually set up the new Industrial Design program from scratch with an extremely short preparation time. The first students started in September 2001. The presence each year of a new cohort of students in the 'program under construction' created tremendous time pressure on the building process, which then really began to look like the design process of a modern industrial product with a short time-to-market.
The issue was: 'Value creation by design, going beyond the content of the specific knowledge fields, while creating the specification during the process, and with the involvement of the customer right from the start'.

That was the official starting point for the Industrial Design Department, and I then exchanged my position as dean of the Mechanical Engineering Department for that of the founding dean of the Industrial Design Department.
Together with my colleagues professor Loe Feijs, Han Smits and Jan van Duppen and with Gemmie Crombags supporting the process, we formed the core team that started on this building process, once again with the well known motto of "Let's just do it!"

The building team was extended with Sabine van Gent as managing director and creative thinker for the new organization where everything would be different from an ordinary department, and Diana Vinke with special experience on education processes.
Our preliminary studies and the worldwide searches by industry had already shown that a program with the profile that we had in mind did not exist anywhere else, and would have to be developed completely from the ground up.

Profile

The point of departure was to educate academic design-graduates for the high-tech creative industry with emphasis on the issues:

- high-tech
- multidisciplinary
- complexity
- dynamic
- international/intercultural

As its most important characteristic the new program integrates:

- different fields of knowledge: Technology, User, Design, Business
- different paradigms: Design, Engineering Sciences, Social Sciences
- research and education
- academia and the professional field
- synthesis and analysis as equivalent and complementary academic endeavors

Field of application

Together with industry, the field of application was selected as:
'Design of intelligent systems, products and related services'.
This became the mission of the department.

Looking at the characteristics of intelligent products, we see that they are, as described in [5]: embedded, context-aware, personalized, adaptive and anticipatory.
Those products and systems change in line with the situation, needs and wishes of the user, and together with the user they form an intelligent, self-learning system that constantly refines itself further.

The product has an embedded basic specification, basic intelligence and basic behavior, together with the ability to develop further in response to each individual user in his or her individual context as it emerges over time. This results in a system of 'dynamic behavioral design', in contrast with the 'static geometrical design' in the traditional industrial design discipline of the 1960s.
This is an interesting development, moving from the traditional idea of 'static geometry follows function', to a new idea of 'dynamic behavior is intelligent function'.

Among the factors contributing to a new type of design process for this field of application, are the input required from different kinds of knowledge, the absence of a clear product specification at the start of the design process, the fact that time-to-market is becoming ever shorter and that the product develops itself in the market. This results into additional requirements for the new designer.
Key characteristics of this new design paradigm are the role of the user or customer as an important contributing partner right from the start of the design cycle, and the need for the underlaying business model to be designed at the same time.

Examples: Results of ID thinking

Smart Jacket for neonatal health monitoring

In collaboration with the Máxima Medical Center, the ‘Neonatal Health Monitoring’ project focuses on new forms of ambient care. Critically premature newborn infants are extremely vulnerable. For these neonates, the monitoring of health parameters is crucial. However, adhesive skin electrodes and wires used in conventional monitoring systems interfere with the normal growth of these babies and hamper parent-child interaction.
A novel neonatal body jacket was designed with wearable textile sensor systems that facilitate all relevant monitoring functions (fig. 4a).

figure 4a

The traditional situation:
the result of high-tech thinking

Smart jacket:
the result of ID high-tech/high-human thinking

Walk!

This is a pedometer sports-shirt concept that displays the level of activity of the wearer with dynamic light, using e.g. more lit buttons representing more steps or other information. The light-information display can be applied in several ways for ease of use or beauty of the garment (fig. 4b).

figure 4b

Wearables. Project: Walk!

Playful interactions

Focus is on interacting with products and other people not only for functional purposes, but for an engaging interaction with e.g. the playful path as important as the final goal.
In a research through design approach it is explored how to design interactive products that respond to people's behavior and seduce them to social and physical play. An example is the MOZO-project, using open-ended play objects producing musical sounds when they are moved and so challenging children to create their own games both, competitive and collaborative (fig. 4c).

figure 4c

Intelligent Playground. Project: Movable Sound

A new competency-based concept for education

To train these special designers at an academic level, we developed a new and innovative competency-based educational concept as we did not consider any existing educational concept to be suitable, for designing the dynamically developing products and content as described before.

Every kind of knowledge and skills has its own 'best' educational method which gives the best results for the particular discipline concerned, including the environment with its infrastructure in which the method is applied, and the form of assessment which is used.
The education must deal primarily with the discipline concerned, and not only with the supporting domains. History shows that this is not always self-evident in education.
Given the department's focus, educational approach and organisation, our graduates distinguish themselves from other designers in various ways.

- *Focus*: They have not only to design the next generation of intelligent systems with which people can enhance their lives, but also investigate what kind of life and society we want these products to support. Because of the rapid development of technology, students learn how to apply new technologies in innovative and challenging ways. In addition, they are driven by a design vision of what our society may look like in the (near) future. Their work is supported by solid research with users.

- *Educational approac*h: ID students are life-long and self-managing learners who develop their expertise and identity continuously. Students learn to learn (what, how and why) and we facilitate their learning. Competency-centred learning offers students the opportunity to give equal weight to knowledge, skills and attitudes. Our students create their own program.

- *Organisation*: ‘themes’ were set up to integrate education and research, and to enhance expertise, identity and community building. Themes are fields of interests, which we use as carriers for joint research and education within the department, e.g. Wearable Senses, Health Care, Lighting and Playful Interactions. Students, staff members, external professional designers, industry, related organisations and especially users are working closely together within a theme.

Design of an ID Department

While we were defining the content of the new design discipline, we were at the same time working on the design of an Industrial Design Department.
The basic model that we chose was based on the four knowledge domains that were integrated to create the ID content: Technology, User, Design, Business. These knowledge domains can be found in all applications, and form the basic input. On top of that, another factor that is constantly present – but changing all the time – is the input of knowledge from the application field.

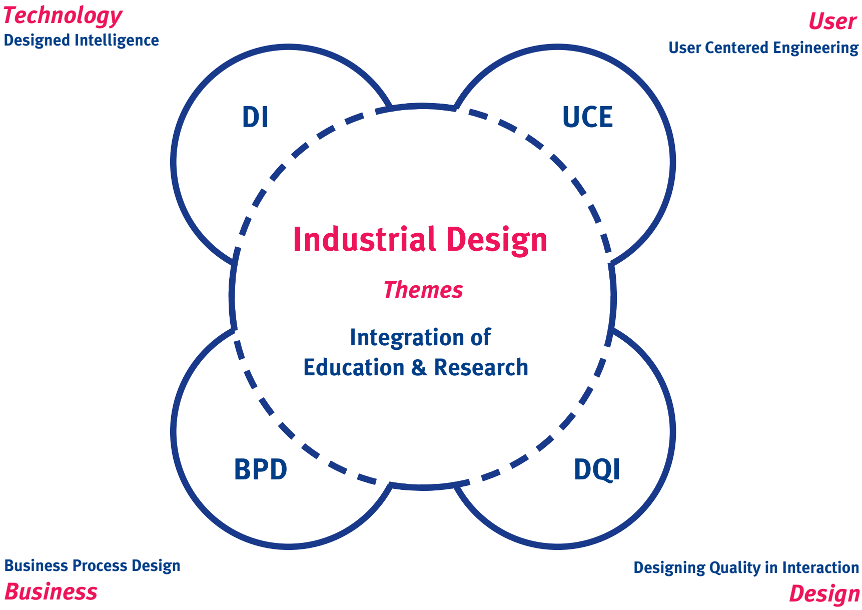

figure 5

Disciplinary structure of the ID Department

The ID discipline as shown in fig. 5 is located in the central, collaborative area. In addition, each of the four knowledge domains has its own hinterland and contacts with professional specialists to keep its own specialization at the highest level. The specialization of the ID designer is one of creative integration. This makes it possible to optimize the design task across the boundaries of the different knowledge domains, instead of going no further than a sum of partial optimizations in the separate knowledge domains.
In organizational terms, we chose to develop four separate but collaborating groups, lead by (at the end of 2009): DI: Prof. Rauterberg, UCE: Prof. Eggen, DQI: Prof. Overbeeke, BPD: Prof. Brombacher.

Because of time pressure we did not try to build up the department through organic growth, but instead we identified attractive, high-quality groups that were already operational elsewhere, and invited them to join up with the ID Department at TU/e as growth cores for the new groups.

Building on the first group, 'Designed Intelligence', which served partly as an incubator for the growth of new groups, we were able to lay the basis for UCE in 2003, DQI in 2006 and BPD in 2008.
The integration of all these different approaches was essential for the ID discipline.

The integration of the three conceptual worlds of:
Engineering Sciences - Social Sciences - Design
as shown schematically in fig. 6 was and is one of the biggest challenges in the process of building up the ID Department, and ultimately results in a unique combination.

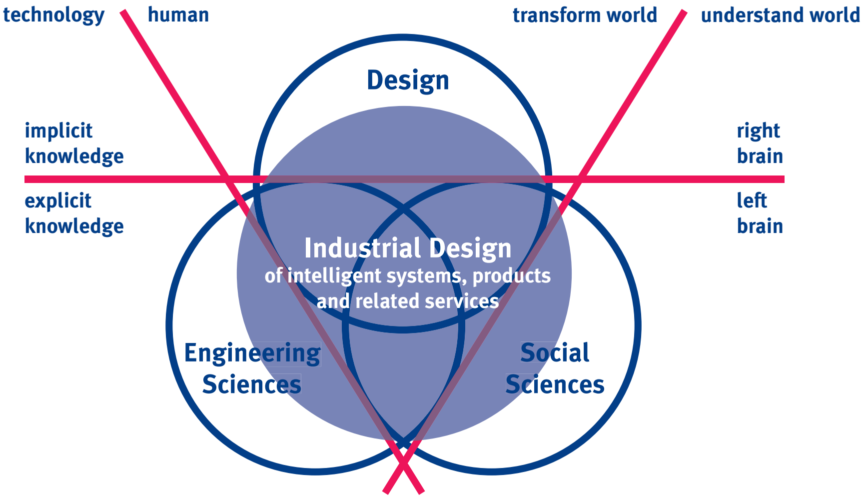

figure 6
Paradigmatic/methodological view on the ID content

Global Research Agenda

For ID internationalization is an indispensable part of the content, both in industry and at the university. This differs from the international partnerships and interactions in traditional fundamental disciplines, which take place just because fellow experts are located in other countries. In that situation, there is no need to take the cultural context of the foreign location into account.

Right from the start, the ID Department took the lead in building an international network of partner universities for staff and student exchange and cooperation in research. Today, partners from four continents take part in the network (fig. 7). The aim of this network is to reach a Global Research Agenda for the field of Industrial Design.

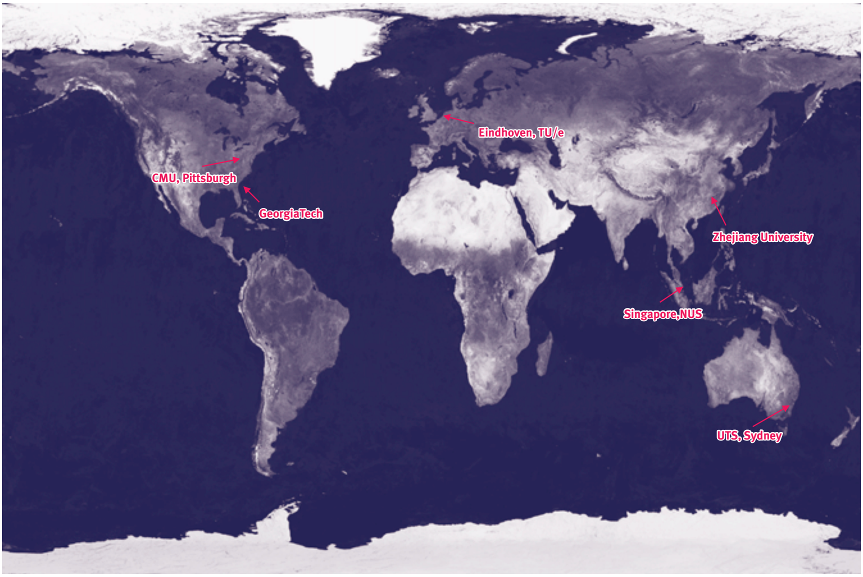

figure 7
The global partner network

Present status

An international education assessment of the ID programs was held in 2007 [6]. The results were very positive, leading to the accreditation of both programs and so the innovative educational concept gained formal recognition and appreciation.

After that, under the leadership of Caroline Hummels the concept was further developed and the program had an important renewal [7]. The program with its special focus, approach and organization receives international appreciation from colleagues in the field.

At this moment (October 2010), the department has more than 600 students, divided over the various years of their programs, and the inflow is continuing to increase.

An international research assessment was held in 2010 [8]. The provisional report is positive. It makes excellent recommendations for the future, and expresses high expectations of the department as the future leader in its field.
This, together with the international recognition which has been received on many occasions, for example at the CHI 2009 Conference in Boston [9], has created an awareness among professional colleagues in both academia and industry that the ID Department at TU/e is now 'on the world map'.

Reflection

Differences and simularities

After this look at aspects of mechanical design and industrial design, it's time for reflection.

Looking back at designing in technology and in industrial design we see a number of interesting points.

In the examples of mechanical design we don't see people but technical specifications at the start of the process. While in the ID examples, people with unclear requirements are always at the heart of the design process. In my experience this has always been the biggest difference, between the two approaches.

For the ID field the user is the central factor in the design process, and the resulting intelligent product is effectively an extension of the user. Together, these two elements form an integrated system in which both are continuously adjusting to each other.

Knowledge from the social sciences therefore forms one of the four most important pillars which together make up the content of the ID design process.

It is clear that the individual disciplines are necessarily treated in less depth than is the case for the real specialists in those specializations. This is necessary to leave (conceptual) space for the creative process as a whole, and for the integration of the various forms of knowledge input. The specialization of the industrial design engineer is that of a creative and scientific integrator.

This is in fact not different from the mechanical designer who also integrates specializations in a way that is just as creative, although in this case all those specializations are located closer to the underlying technology domain.

What **is** different is the width of the spectrum of types of knowledge that are integrated.

Leonardo da Vinci was frequently mentioned as an example in our ID discussions.
At the time of Leonardo (1452 – 1519), all the available knowledge could – so to say – be contained in detail 'in one person's head'. For example:

- technical designs
- building and testing
- medical knowledge
- all kinds of art forms

At that time, integration was self-evident. Because no disintegration had yet taken place.
After that, the amount of knowledge grew, and was subdivided into more detailed areas. The world became more complex. Specializations were created so that research could be done into specific areas within them, and so that education could be given in those areas, which were populated by specialists and super-specialists. Today, some specialized areas no longer have any direct contact with the real, integrated society, and do not even need that contact as far as their own specialization is concerned.
However, society is not made up of specializations. To allow all this knowledge to be applied usefully in society requires creative synthesis and integration.
Typical and interesting for today's discussions on scientific integration is Leonardo's view that scientific research cannot exist without mathematical description and argumentation.

In mechanical engineering the conceptual worlds of engineering science and design are integrated, while in ID there is the further addition of the conceptual world of the social sciences.

Looking at the start of the engineering design process there is usually a reasonably clearly defined technical problem and task description, while ID design often starts with a problem-finding phase. At that stage, a problem or (economic) opportunity in society has hardly any technical elaboration, let alone any idea of a solution. The specification of the intelligent product, system or service to be designed comes into existence gradually, with input from the user, while the design process is actually taking place, in parallel.

A new approach in science and *l'histoire se répète*

It is particularly interesting and instructive to compare some aspects of the development of the mechanical engineering and industrial design disciplines.

As mentioned earlier, a model-based approach gradually came into being in mechanical engineering, together with the application of fundamental sciences and the corresponding tools. The use of models made parts of the process understandable, predictable and able to be optimized.

- That was an obvious step for research/analysis, and it was and is a global development, leading to a kind of standardization in the supporting theoretical and experimental methods and their software and hardware tools. As a result of that, mechanical engineering departments worldwide, look very much the same showing hardly any distinguishing features.
- For design/synthesis the situation was clearly different, because the development of a model-based approach was and is much more challenging. There were all kinds of supporting software tools, but they had no function in the real creative design process, apart from saving time which the designer was then able to invest in conceptual thinking. Attempts to also give the creative process of synthesis the necessary modeling basis, and thereby to help the discipline reach academic maturity, did not produce the desired results. I will come back to one particular mechanical engineering group at TU/e in the following passages.

Achieving a model-based approach was a must in the industrial design discipline, which has creative synthesis as its core. Work was done in this direction right from the beginning, although this goal was not defined explicitly. In particular it was professor Kees Overbeeke and his group who followed a 'Research through Design' approach with doing as a mechanism for gaining insight into the process. This early work had a tremendous influence on the whole department.
In an environment that closely resembles the practical setting of the user, innovative designs are created in a constant series of iterative cycles of creative idea development, elaboration and building right up to the working prototype, followed by testing, reflection, improvement and repetition of the cycle, in which synthesis and analysis are integrated.

The creation of many different kinds of designs, all of them within the ID domain and based on the Research through Design approach, leads to generally applicable knowledge and insights that are fed back into education.
In fact this is how new scientific knowledge is developed through the process of synthesis; supported by, integrated in, and in interaction with, analysis in a series of cycles.
As well as the analysis (research), the synthesis (designing) in this way is an equally useful method for the development of new scientific knowledge.

If we put the clock back 30 years and look again at the work in the Department of Mechanical Engineering, we can see an interesting parallel. Although at that time we were unaware of it, the development of a model-based approach to the creative process in the field of mechanical engineering was taking a big step forward: from the beginning of the 1960s, prof. Wim van der Hoek was working with a small group in the department, and also at Philips, on a model-based approach to the creative design process by means of a series of 'case studies of incidental problems with incidental solutions leading to generally applicable insights'. This method developed into 'a good and generally recognized means of knowledge transfer' [10].

In the everyday practice of education, design and research, teachers in Van der Hoek's group worked with small groups of students in a kind of master/apprentice relationship, using creative thinking, developing and selecting ideas, calculating and simulating, building and testing models, building real prototypes, testing these and developing them further, all in a continuing series of cycles.
This was the 'Van der Hoek school'. Today it is clear that without the engineers from the 'Van der Hoek school', we in Brainport Eindhoven would for example have no ASML, one of the largest high-tech companies in the Netherlands and world market leader in wafersteppers for the integrated circuits industry, machines whose quality depends on super-fast repetitive positioning with an accuracy on a nanometer scale. While it was hardly possible for mechanical engineering departments around the world to distinguish themselves in the field of research or analysis, this possibility does indeed exist in the field of designing and creative synthesis, although very few departments are actually able to do this in practice.
If we compare scientific design practice in mechanical engineering and industrial design, we can see that after around 30 years history is repeating itself: a model-based approach is now emerging in industrial design, making it complete as a necessary discipline at a university of technology. Fig. 8 shows a rough qualitative diagram.

The question of how to implement education in creative synthesis for larger groups of students still requires attention. The 'themes' in the ID Department have an important role in this respect.

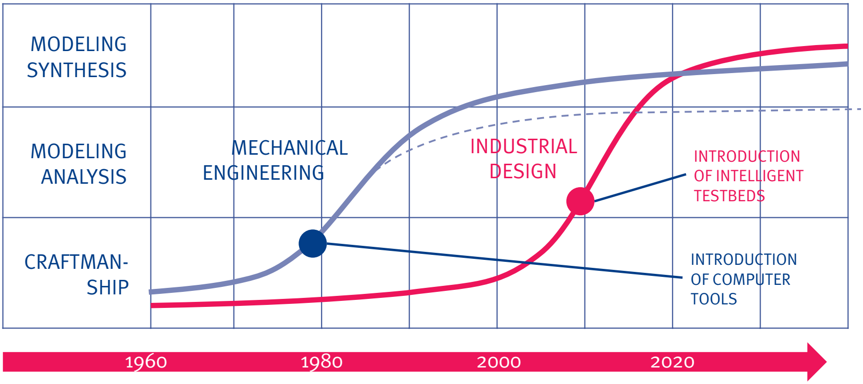

figure 8

Development to a scientific/model-based approach

Responsibility of the technical university:

- education
- knowledge development (science).

Knowledge development (science) by:

- analysis (research)
- synthesis (design) and their integration

The ID "Research through Design" approach is:
Knowledge development by synthesis (= science by design)

A model-based approach is being developed for the process of creative synthesis:

- new knowledge is added to the field of ID
- knowledge is captured, stored and re-used, so that each next step can add on the previous level
- the developing body of knowledge is part of university education
- the process of creative synthesis will increasingly be a part of the 'left brain domain' as well

Developments were and are pushed by new tools:

- for analysis: computers (growth in the 1980's)
- for synthesis: intelligent testbeds (from 2005 on)

Design and research: How to value the output

The tasks of the university are usually referred to as ‘education and research’. In my opinion it would be better and more complete to refer to: education and the practice of science, with as its most important element the development of new scientific knowledge through which the boundaries of the field of knowledge are constantly pushed further forward. In other words, extending ‘the body of knowledge’.

The development of new scientific knowledge takes place via two tracks:

- Analysis (research), which means trying to understand and explain existing phenomena, with the results mainly being presented as publications in international journals, and
- Synthesis (design), which means trying to realize not yet existing products, systems and services, with the results being presented in the form of new designs, prototypes, publications and patents, for example with the PhD thesis on design as a typical form of output.

Scientific design integrates both these tracks [11].

Both research output and design output are evaluated against two criteria:

- scientific quality with as its crucial aspect the addition of new knowledge and methods to the field
- social quality such as societal relevance and impact, and economic value

The output assessment for both analysis and synthesis is carried out in analogous ways, as shown in fig. 9; for both tracks the results must be new and relevant.

> Measuring quality of scientific work in both tracks analysis and synthesis, as well as their integration, is preceded by defining an appropriate standard for “quality” and developing an appropriate method to compare actual results with this standard.
> The standard as well as the method for comparison depend on the scientific field concerned. Compare the measurement of performance in Olympic sports. In some sports, such as the 100 meter free-style swimming, time measurement is the right method. While for other sports such as figure-skating, this method is unsuitable even though a time element is involved as well.

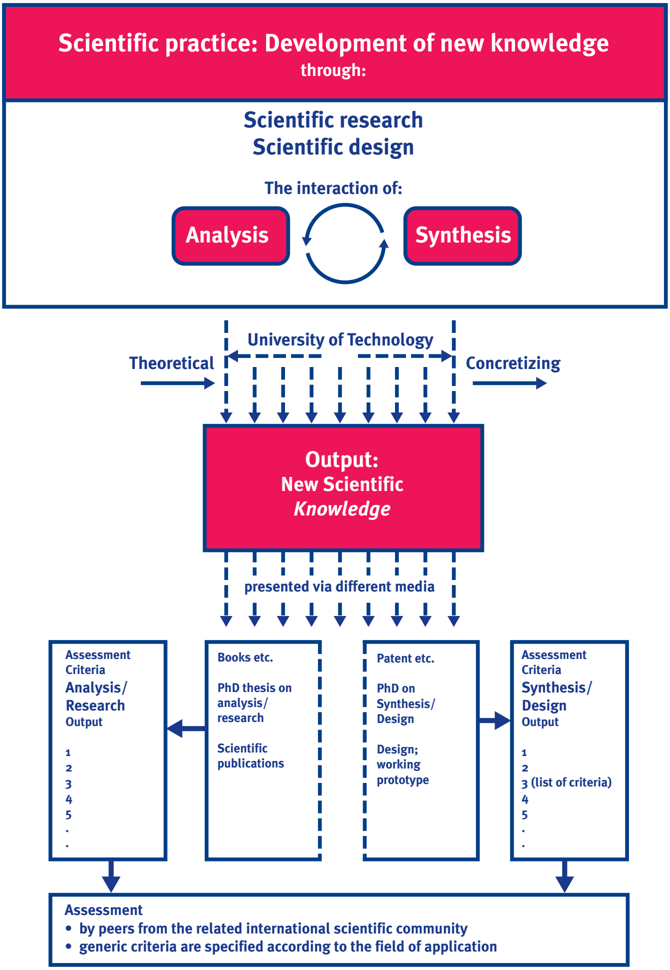

figure 9

An assessment methodology of scientific work in a design environment

Reviews by peers from the international scientific community of the appropriate field are essential in this process.
This method would help to get our feet back on the ground. In other words to move away from models that force scientists to opt for the most lucrative behavior under financing and career models, and to go back to activities that are driven by their scientific content.
For scientists at universities this should be combined with the – equally important – assessment as scientific teacher.

Outlook

If we look at the future, it seems as if everything in our society suddenly started to change at an accelerating speed in the first decade of the 21st century.
We are going back to keeping both feet on the ground; we are no longer just going for bigger, faster, higher and more, but for: **better**. We should exchange quantity for quality.
Now that the time of excess to some extent seems to be behind us, I think we are going to start looking at what is useful to society, and what is not. That means setting new priorities.

As professor Horowitz already said when I myself was graduating: “If you’re poor, you think carefully”. The same applies to the engineering sciences and to industry: I think our products are becoming more serious, and that the time of an excess of gadgets and the ‘useless designer products’ industry is coming to an end.
In my view that will also apply in education, and especially for the choice in the available programs. It will then no longer necessarily be possible to ‘do whatever you like’, with the assurance of a job in that field afterwards.

Coming back to my outlook for the development of the university or the department, I could now talk about what I would have done in the coming period if I had stayed in my role as dean of the ID Department.
But I am not going to do that: my successor and the new dean of ID professor Aarnout Brombacher and his team have excellent ideas about the future strategy of the department; ideas that make me think “I wish I had thought of that”, and my own ideas for the future could well be a distraction to them. I have 100% confidence in them.
However, I do have a few well intentioned recommendations to the university, to the department and to the students:

To the Executive Board of the university I recommend, when considering the future of the university, above all not to assume that what we and other universities have for decades been working on, as separate and well defined specializations, is also automatically the right choice for the future. Society has totally changed, but university lectures still start at a quarter to nine in the

morning, just as they did 47 years ago when I started my own studies.
Make everything open to discussion from time to time. Start by thinking about the new paradigm for the international university to educate the leaders for the society, not about what we have now. Define where we want to be in the year x, and count backwards from then to the measures that need to be taken today. The choices to be made today will then be the conclusions of a conscious thought process, and not its starting points. I am convinced that this is already part of the TU/e 2020 discussion.

I do not need to make any **recommendations to the Departmental Board**.
Under their direction the department is in excellent hands.
One important concern is the fact that the present ID building is not suitable for the content of the ID activities and it is not a match for the international and industrial ambitions of ID, nor for the function of the industrial design field for our economy.

I was recently asked by Zhejiang University, to support setting up an International Design Institute in China.
China is now moving forward in the process of creative design.

> This is part of a worldwide trend in which countries that possess ever-scarcer raw materials no longer want to restrict themselves (only) to exporting them, but also want to focus on the lucrative links in the value chain: the design, production and export of intelligent products using these materials, together with creative ideas. This applies to the oil reserves of a country like Saudi Arabia together with the products derived from them, and also to rare metals from China and the products of the electronics industry.

The firm belief of the Chinese government that industrial design will enable the creative industry in China to be an economic powerhouse in the future has led to a great deal of attention for and investments in the creative sector.
Coming back to the matter of a building that is suitable for the ID discipline, that is designed to train designers, and that has an image matching the future importance of the discipline for the country’s economy: this building has already been completed on the campus of Zhejiang University in Hangzhou:

Zhejiang University
Hangzhou/China (2010)

NTU
Singapore (2009)

TU/e

figure 10

ID accommodation at three locations

Of course these photos only show the outside. But even so they are an indication of the economic importance that strong, growth-oriented economies – in this case both in the Asia-Pacific Region – place on industrial design.

Recommendations to ID students

I have tremendous appreciation and admiration for our ID students and graduates.

- Stay who you are: your own identity is the most important.
- In designing, don’t follow the rules: creativity isn’t driven by rules.
- Be different, and don’t do the same as everyone else: there are already so many others who do that.

In other words:
Be the friendliest anarchist in your profession.

Standing back and view in perspective

To conclude, it is a good thing to put the presented content into perspective. Strategic thinking is often about standing back, putting things in perspective and making choices. It invites you to take a broader view.
An interesting question to conclude with nowadays is, looking back at everything: "What are you proud of?"

I am proud of a lot of things that have been achieved together with the efforts of many other people. So I am proud also on behalf of them.

- At Mechanical Engineering we were able in the early days to give the department an attractive content.
- In my own research into tribotechnology we achieved things that many experts thought were impossible: that gave us extra encouragement to do it.
- We built up an attractive ID Department, a new discipline with its own educational concept and involving collaboration between what were formerly very different conceptual worlds. Here again many people thought, that it would not be possible.
- The field has now gained recognition and appreciation on the international map.
- I am proud of the Chinese invitation to support them building up an International Design Institute. This is a major recognition for our ID team at TU/e.
- I am pleased with what we have achieved together as ID team.
- And I am especially proud of the people at ID, the staff and students in fig. 11, as well as all those who are not shown in the photo. This is the real ID Department.

figure 11

The Department of Industrial Design

I may have the privilege of presenting this overview, but it was also the work of many others. I was able to lead the building process, and I was fortunate enough to be able to surround myself with colleagues and friends who were able to do all the things that I could not.
I am also grateful for all their loyal support, their partnership and their determination, and for often being ready to join me in going against the flow.
I offer them my excuses for 'going gray' together. Now, there is an attractive department that was not there before, and we have built that department together.
I would like to thank my successor, Aarnout Brombacher and his team, for being prepared to take over the torch from me. We have known each other for a long time, and I have 100% confidence that he will provide tremendous leadership to the further building up of the department. I am sure he will do that much better than I have been able to. There is a lot of work to be done.
Aarnout: I wish you every success!
I feel good about being able to finish my time as professor at our excellent university in this way.

"Design: from techno to human"
34 years; it has been a tremendous project.

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Curriculum vitae

Prof.dr.ir. Jeu Schouten was full-time professor at Eindhoven University of Technology (TU/e) from 1 October 1976 to 1 September 2010.

He studied mechanical engineering at TU/e from 1963 to 1968. After two years in the Royal Netherlands Navy, he worked during seven years for the German Engineering Federation (VDMA/Frankfurt). Research for the German machine-building industry led to his PhD thesis (1973) on elastohydrodynamic lubrication with applications in mechanical engineering design, which was recognized among other distinctions by the Swedish Jacob Wallenburg Award.

In 1976 prof. Schouten was appointed professor of mechanical engineering. He supervised many graduates and doctoral candidates, and set up his research field focusing on power transmissions and tribology. He was dean of the Department of Mechanical Engineering from 1993 to 2000; a period in which important choices for the future of the department were made. He chose to focus on the synergy between analysis and synthesis; a subject that has been a *leitmotiv* for his work at TU/e. In 1998 the renewed department gained the number one position in a European ranking.

From 1998 to 2004 prof. Schouten was also professor for mechatronic design at the National University of Singapore, where he was jointly in charge of the Design Technology Institute.

In 2000 prof. Schouten laid the basis for the new TU/e Department of Industrial Design. Under his leadership as its first dean from 2000 to 2010, the Department took shape with the focus on 'Design of intelligent systems, products and related services'. The integration of an innovative educational concept and high-level research, of different knowledge domains, and of analysis and synthesis, resulted in a new transdisciplinary field that has gained international recognition.

Prof. Schouten was recently asked by Zhejiang University to support the establishment of an international Design Institute in China, which will as well further strengthen the existing relationship between Zhejiang University and TU/e.

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