

Design Research at CME in Twente

Perspectives on design processes

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1. Introduction

The Construction Management & Engineering (CME) group of the faculty of Engineering Technology at the University of Twente focuses on the need to acquire better insights into the mechanisms governing innovation in the building process and its environment. Its research program concentrates on the management and governance mechanisms of construction processes, the interfaces between planning and design, and design and realisation. The program integrates various insights from different disciplines: technology, public and business management, and design (management), and the development of innovative construction processes and materials. Design research is a central core of this research programme, aiming at improving the effectiveness and efficiency of design processes in general and more specific in construction industry.

Currently, the design research group consists of Geert Dewulf, professor of planning and development, Isabelle Reymen, assistant professor design management, Karel Veenliet, assistant professor design management, and the following researchers, partly involved: Saad Al'Jibouri on constructability and risk management, and Joop Halman, Andreas Hartmann, and Hans Voordijk on innovation processes, platform driven development and (new) product development, and Henny ter Huerne on design processes.

In this paper, an overview is given of the research perspectives, central theoretical focus, and future directions of the design research group of CME.

2. Research perspectives

Research in the CME group looks from three main perspectives to design processes, namely the demand perspective, the supply perspective, and the management perspective. The same holds for the research on designing. We look at the design process from three perspectives, namely the demand perspective (the user), the supply perspective (the designer and engineer) and the management perspective (the manager), as illustrated in Figure 1. Our research focuses on the overlaps between the perspectives, namely for each perspective the overlap with the other two. The research is performed by the staff members as mentioned in the introduction and by Ph.D. (and master) students. For each of the perspectives, we discuss our results and Ph.D. projects. Finished master projects (in Dutch) are given as an illustration of our research.

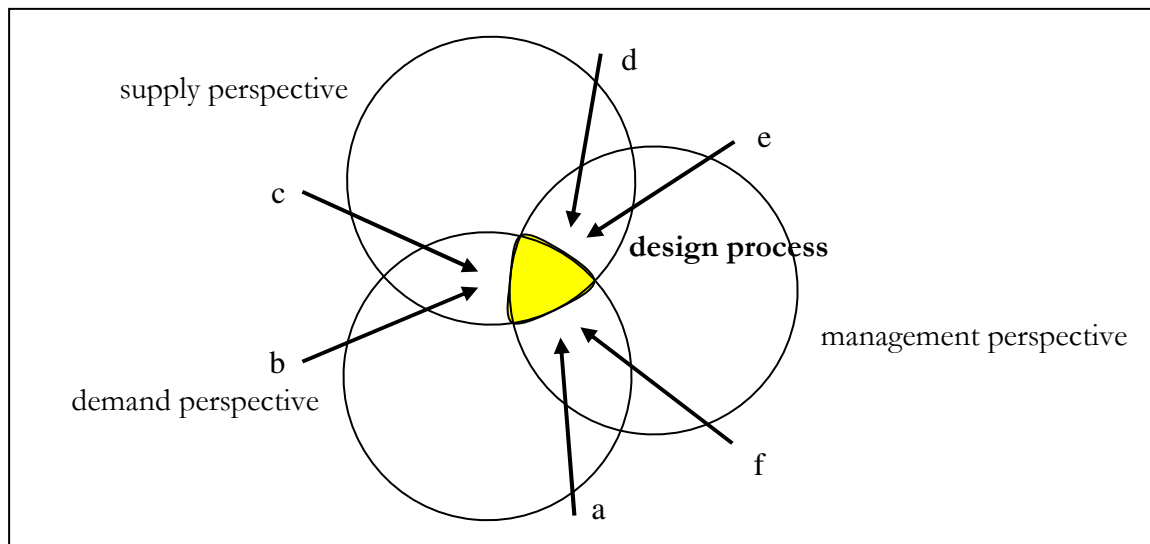


Figure 1: Perspectives on design processes, with focuses on the overlaps.

2.1 The demand perspective

The demand perspective looks at the relation between the user/client and the design process. More specific, we focus on design management from the demand side and on briefing.

a) **Design management/demand** focuses on managing the design process from the demand side (a combined user-manager perspective). Important topics are:

- User participation and collaborative design (Dewulf and van Meel, 2002), (Dewulf and van Meel, 2003), (De Graaf and Dewulf, 2004) (Reymen et al., 2005)
- Role and selection of designers
 - Master: *Selecteren van ontwerpers in de B&U sector. Een onderzoek naar het ontwikkelen van een instrument voor de selectie van ontwerpers binnen het bouwproces (Selection of designers in the Building and Utility sector. A study into the development of an instrument for the selection of designers in the construction process)*, Gerwin van der Panne (2004 – 2005), supervision by Dewulf, Reymen
- Design communication
 - Ph.D.: *Design communication: Communication on values between stakeholders*, (to be started, PSIB project (Proces en Systeem Innovatie in de Bouw)), supervision by Dewulf, Reymen

b) In **briefing** we study the interface and interaction between the demand perspective and supply perspective.

- Design quality (Dewulf and van Meel, 2004)
- Key performance indicators and value management
 - Ph.D.: *Key performance indicators: From values to performance criteria*, (to be started, PSIB project), supervision by Dewulf, Al'Jibouri

2.2 The supply perspective

Much research concentrates on the supply perspective. Topics in the overlap between the demand and supply perspective are mass customisation and engineering to order. In the overlap between the supply and management perspective, we focus on design management from the supply side and on constructability.

c) **Mass customisation** researches process and product approaches that offer large variety for the user and that are designed and constructed economically.

- Possibilities and limitations of platform driven design and development of products (Halman et al., 2003) (Halman, 2004). More information about this research program can be found on the website of CME.
 - Ph.D.: *Modular consumer-oriented housing construction*, E. Hofman (since 2004), supervision by Halman, Voordijk
 - Master: *De rol van de overheid binnen consumentgericht bouwen in de Nederlandse woningbouw. Een benchmark tussen platform gedreven ontwerpen en uitvoeren in de algemene theorie, de scheepsbouwindustrie en consumentgericht bouwen binnen de overheid (Role of the government in consumer oriented building in Dutch housebuilding. A benchmark between platform driven design and construction in general theory, shipbuilding and consumer oriented building in governmental organisations)*, Wouter van Drie (2003-2004), supervision by Halman, Voordijk, Reymen
 - Master: *De rol van de toeleverancier binnen consument gericht bouwen in de Nederlandse woningbouw. Een benchmark tussen platformgedreven ontwerpen en uitvoeren in de theorie, de auto-industrie en de toeleveringsindustrie (Role of the supplier in consumer oriented building in Dutch housebuilding. A benchmark between platform driven design and construction in theory, automotive industry and supplier industry)*, Robert Dalenoord (2003-2004), supervision by Halman, Voordijk, Reymen
 - Master: *Platformgedreven ontwikkelingen binnen de Nederlandse bouwindustrie. Onderzoek naar platformgedreven ontwikkelingen kijkend naar theorie, de Nederlandse bouwindustrie en consumentgericht bouwen vanuit het perspectief van bouwbedrijven (Platform driven developments in Dutch construction industry. Study into platform driven developments looking at theory, Dutch construction industry and consumer oriented building from the perspective of builders)*, Arjen Roosen (2003-2004), supervision by Halman, Voordijk, Reymen
 - Master: *De rol van de architect in de Nederlandse consumentgerichte woningbouw. Een onderzoek naar de platformtheorie, de vliegtuigindustrie en consumentgericht bouwen vanuit het perspectief van de architect (Role of the architect in Dutch consumer oriented housebuilding. Study into platformtheory, aircraft industry and consumer oriented building from the perspective of the architect)*, Mohammed Bodra (2003-2004), supervision by Halman, Voordijk, Reymen
 - Master: *Modulair consument gericht bouwen. Een onderzoek als een aanzet voor een modulair consumentgericht bouwprincipe (Modular consumer oriented building. A study as a starting point for a modular consumer oriented building principle)*, Erwin Hofman (2003-2004), supervision by Halman, Voordijk
 - Master: *Procesverbeteringen in de consumentgerichte woningbouw. Een onderzoek naar verbeteringen ten aanzien van de efficiëntie en effectiviteit in het koopproces van consumentgerichte woningbouwprojecten (Process improvements in consumer oriented housebuilding. A study into improvements concerning efficiency and effectivity in the buying process of consumer oriented building projects)*, Arjan Horstman (2004 – 2005), supervision by Halman, Reymen, Voordijk

Engineering to order uses value engineering and value management as theoretical basis to improve (construction) design and engineering processes.

- NAP/DACE project (Nederlandse Apparaten/Dutch Association of Cost Engineering): concentrates on certifying Value Engineering for Construction in the Netherlands, based on European Directives. Involvement by Veenvliet
- Master: *Beheers het beheersen van het ontwerpproces. Verwachting t.a.v. de doorlooptijd van Civiele*

Ontwerpprojecten (Manage the managing of the design process. Expectations concerning the throughput time of civil design projects), Roderick Roelfs, (2000-2001), supervision by Al'Jibouri, Veenvliet

d) **Design management/supply** studies how the design process can be managed from the supply side (a combined designer-manager perspective).

- Design reflection (Reymen, 2003) and design expertise development of designers (Dorst and Reymen, 2004) (Reymen et al., 2005) (van Overveld et al., 2003). Part of this research is performed in collaboration with the Technische Universiteit Eindhoven and Imperial College London.
- Composition (Peeters et al., 2004) (Peeters et al., 2005) and management (Faissal et al., 2004), (den Otter, Reymen, 2005) of design teams.
 - Ph.D.: *Relating design team composition to design processes and effectiveness*, M.A.G. Peeters, performed at Technische Universiteit Eindhoven (since 2001), supervision by Rutte, van Tuijl (TU/e), Reymen.
 - Master: *Integraal ontwerpen. Communicatie en samenwerking in multidisciplinaire ontwerpteams (Integral designing. Communication and collaboration in multidisciplinary design teams)*, Faissal Kanjaâ (2002 - 2003), supervision by Veenvliet, Reymen
- Design co-ordination (product and process co-ordination), design integration
 - Master: *Afstemming in het ontwerpproces. Onderzoek naar het afstemmingsproces tussen ontwerpdisciplines bij complexe spoorprojecten (Co-ordination in the design process. Study into the co-ordination process between design disciplines of complex railway projects)*, Jan Mors (2002 – 2003), supervision by Reymen, Veenvliet
 - Master: *Afstemmen door 3D modelleren. Een onderzoek naar het gebruik van 3D modellen binnen een organisatie om afstemming te verbeteren (Co-ordination by 3D modelling. Study into the use of 3D modelling in an organisation to improve co-ordination)*, Dominique Dankkaart (2004 - 2005), supervision by Reymen, Veenvliet

Constructability focuses on the interface between design and realisation (Langkemper et al., 2003) (Veenvliet and Wind, 1992)

- Ph.D.: *The Organisation of Integrated Object Design in Construction*, Karel Veenvliet
- Master: *Toepassing van Constructability op het bouwproces van binnenstedelijke infrastructuur (Application of Constructability on the building process of inner-city infrastructure)*, Jeroen Langkemper (2002 – 2003), supervision by Al-Jibouri, Reymen

2.3 The management perspective

The management perspective on design processes focuses on topics rooted in organisation studies, applied to designing in the construction industry. We distinguish three levels in this perspective, namely project level, corporate level, and branch level. They are closely connected, but differ in the way they look at the design process. The project level focuses on characteristics of a building process organisation (project characteristics and dynamics). The corporate level focuses on the building organisation (business characteristics and dynamics). The branch level focuses on the building sector (inter-organisational characteristics and dynamics). The overlap between the management and supply perspective focuses on supply chain management and logistics (project, corporate and branch level) and design management from the management perspective (project and corporate level). On the overlap between the management and demand perspective, innovation management, risk management, planning and control are our topics (project, corporate and branch level).

e) In **supply chain management and logistics**, the focus is on the operations management perspective of the supply chain, more specific the management of information flow through the supply chain.

- The use of ICT (Adriaanse et al., 2004)
 - Ph.D.: *Preconditions of the inter-organisational use of ICT in construction projects*, Arjen Adriaanse (since 2003), supervision by Dewulf, Voordijk

Design Management/organisation studies the design process from the management perspective. Possible topic in the future will be

- Design alliances

f) **Innovation management, risk management, planning and control**. The research programme in the area of planning and risk management is intended to provide stakeholders with tools and support mechanisms for their decisions (Al-Jibouri and Mawdesley, 2002) (Mawdesley et al., 2003).

- Managing innovation (Hartmann and Girmscheid, 2004) (Hartmann, 2004)
 - Ph.D.: *Managing innovation in project based organisations*, Jasper Caerteling (since 2002), supervision by Doree, Halman
- Design tools for risk management (Keizer et al., 2002)
 - Master: *SCRUM in Projectontwikkeling; Door meer chaos minder onzekerheid? Een onderzoek naar mogelijkheden en beperkingen van ontwerpmethodiek SCRUM voor beheersing van onzekerheid in projectontwikkeling (SCRUM in real estate development: by more chaos less uncertainty? Study into possibilities and limitations of design methodology SCRUM for the managing of uncertainty in real estate development)*, Sjoerd Blokpoel (2004), supervision by Dewulf, Reymen, Veenvliet

3. Central theoretical focus

Systems engineering is our central theoretical focus on design processes; it comes back in each perspective, of course from a critical point of view. “Systems engineering (SE) is a requirements driven way of controlling the design process. It is the discipline of translating customer requirements into a specification of components which, when combined together, will satisfy the requirements. This is usually done in several phases.” (Veenliet, 1997) “Systems Engineering is an integrated approach which bridges the gap between project management and the product to be developed. The SE concept takes care of a goal-directed structured and multi-disciplinary design process and a coherent set of design and management principles, techniques and tool especially for a customer order driven engineering.” (Veenliet, 1999)

- COINS project (Civil engineering Objects and Integration of processes and Systems). One of the objectives is to improve the interaction between design and construction during the development of civil engineering objects, so waste will be diminished. Concepts and approaches of the development process, like concurrent engineering, systems engineering from the industry and constructability and lean construction from the construction industry are studied to describe and compare the way interactions manifest during projects. Involvement by Veenvliet
- Master: *Systems engineering, RAMS en Arcadis. Een onderzoek naar het integreren van Systems engineering en RAMS en de toepasbaarheid in de Arcadis ontwerpomgeving (Systems engineering, RAMS and Arcadis. Study into the integration of Systems engineering and RAMS and the applicability in the Arcadis design environment)*, Maarten Stoutenbeek (2004 – 2005),

supervision by Veenliet, Reymen

- Master: *Naar een geïntegreerde projectaanpak voor infrastructurele projecten. Een onderzoek naar het geïntegreerd toepassen van Prince2 en Systems engineering voor complexe infrastructurele projecten (To an integrated project approach for infrastructural projects. Study into the integrated application of Prince2 and Systems engineering for complex infrastructural projects)*, Paul Hendrikx (2004 – 2005), supervision by Veenliet, Reymen

4. Conclusions and future directions

For our research group, writing this paper was a learning experience in the sense that we now created a structured overview of our research activities. In the future, we want to reinforce our focuses. A main goal of our design research is, as mentioned in the introduction, improving the effectiveness and efficiency of design processes in general and more specific in construction industry. A second goal is to develop insight in design processes for educational purposes. A third goal, but not least, is to obtain a prominent position in (some fields) of the international (building) design research community. To obtain these goals and to strengthen our research, we do need collaboration with other research groups in the Netherlands (and outside the Netherlands).

We think, for example, about strengthening the demand perspective with knowledge about architectural design and management (for example, with TUDelft and ADMS of the TU Eindhoven). For the supply side, collaboration can take place on mass customisation with TUDelft and TU Eindhoven. For our management perspective, collaboration with management faculties can improve our research (for example BBT at UTwente and TM at TU Eindhoven). Also collaboration with industrial design faculties might offer advantages for both parties. Currently, we do not focus on the development of tools, but they are necessary to operationalise our knowledge for design practice. For each of the perspectives, design tools should be developed (likely in collaboration with others); for example, tools for user participation, design collaboration, decision support, and design management.

Researchers who like to participate in our research program are invited to take contact with us. We can exchange knowledge about the state of the art in research and education (including own publications and courses) and developments in practice, develop project proposals for Master and Ph.D. students, make joint publications and develop joint courses.

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