Creating a Flexible and Dynamic Map of Dutch Research in Design

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Abstract
In Dutch research in design, the rapid developments in the past decade(s) have caused many stakeholders to lose track of the overview in their field. Therefore, the Dutch platform for research in design (Design United) has initiated the development of a map that provides all stakeholders with various overviews for their specific viewpoints. The map should act as a basis to connect researchers, industry and government at strategic, tactical and operational level. Specific challenges in creating the map are to ensure the flexibility to integrate future changes in the field and to create different renderings that are suitable for multiple perspectives. Additionally, the ability to keep track of the priorities and developments in the research areas as well as the ability to envisage important upcoming research themes is relevant. The publication indicates the fundamental principles that are used and the way in which these principles are implemented in engendering the map.

Keywords
Information Network, Design Research, Map

1 INTRODUCTION
Doing research, in whatever discipline or subject, is never a goal in itself. It rather aims at producing new knowledge or deepening understanding of topics or issues, in close harmony with other researchers, institutes and industry. Even in the relatively small community for design research in The Netherlands, the rapid developments in the past decade(s) have caused many stakeholders to lose track of the state of the art in their field. For example, researchers may have lost touch with fellow-researchers that work on similar topics. Moreover, research is not always adequately attuned to the (strategic) needs of industry.

To regain overview and control of the situation and the shifts in it, the Dutch platform for research in design (Design United) launched the initiative to create an overview that gives a flexible and dynamic impression of the areas in Dutch research in design. The result, represented in terms of a 'map', should allow all stakeholders to gain a more profound understanding of the field. It should provide insight in the many different topics and relations, as well as in the many different stakeholders that play a role. Additionally, the map should enable stakeholders to better anticipate potential future developments in the field. If researchers have an accurate overview of research topics and the researchers related to it, the combination and integration of academic and industrial strengths becomes more effective and efficient.

This publication focuses on the considerations, challenges, principles, and requirements that are involved in the development of the map. Additionally it shows the first steps in the actual implementation and employment thereof.

2 DUTCH RESEARCH IN DESIGN; EXISTING ‘LANDSCAPE’
2.1 Domain
When creating a map of Dutch research in design, it seems inevitable to, first of all, delimitate what this actually means. To map the shifts in the field, also the definition of an appropriate time frame, indicating the addressed research period, may be required. These margins, however, are difficult to state as the opinions on these topics are dissimilar for different stakeholders. Defining the margins is likely to result in intricate discussions on the legitimacy and applicability of the map instead of on facilitating Dutch design by employing it. Therefore, issues like “Should the research be academic research / be conducted in The Netherlands / be funded by a Dutch organisation? What disciplines should be included?” become insignificant. Additionally, any possible statement would run the risk of becoming unsuitable over time, as viewpoints and insights mature.

Therefore, indicating sharp boundaries of, for example, the research area or the type of stakeholders involved contradicts the mind-set and goals that render the map meaningful, expressive and useful. Consequently, it is the aim to make an objective and non-hierarchical rendering of topics that are related to Dutch research in design that can be expanded or adapted based on new findings. All potential different stakeholders of the map should, together but independently, be able to establish the
content of the map. In this, their personal interest should be leading; not being hampered or biased by a priori viewpoints imposed. This mind-set implies that, for the development of the map of Dutch research in design, any starting point is viable.

2.2 Design United
An obvious starting point for creating the map is the work of ‘Design United’, the platform for Dutch research in design. It is an initiative by three (mostly) Technical Universities (3TU) in The Netherlands, located in Delft, Eindhoven and Twente. The three universities, from an engineering background, offer educational programs in design topics; roughly nameable as ‘Industrial Design Engineering’. By joining forces of the research chairs that are related to these programs, Design United aims to increase the quality of research. In particular, education and supervision of PhD students are harmonised, knowledge management is organised across the three institutes and large research projects are carried out conjointly.

![Figure 1 - Design United as starting point in the network of Dutch research in design.](image)

2.3 Research programmes at the 3TU
To characterise areas in the existing landscape of Dutch research in design, the formal design research programmes at the 3TU are used as an obvious, yet selective, starting point.

2.3.1 Delft University of Technology
In Delft, the department Industrial Design Engineering distinguishes foundational programs and applied programs. The foundational research programmes for the disciplines Industrial Design and Design Engineering are ‘Strategic Design’, ‘User Experience’ and ‘Technology Transformation’. Areas for the applied programmes are ‘Healthcare’, ‘Personal Mobility’ and ‘Living/Working’ [1].

2.3.2 Eindhoven University of Technology

2.3.3 University of Twente
At the University of Twente, the Laboratory of Design, Production and Management has several research programmes that express a strong relation with the topic design. Examples of these programmes are ‘Design Engineering’, ‘Product Design’, ‘Management of Product Development’, ‘Product Realisation’, ‘Packaging Design and Management’, ‘Design History’ and ‘Maintenance Engineering’ [3].

3 APPROACH

3.1 Goals and requirements
The goal of the map is to provide stakeholders with adequate overviews, from their specific viewpoint. However, different stakeholders benefit from differently structured overviews. In terms of a map, projections are required based on different characteristics; a projection based on geographical location (see figure 2) is only one of the options.

Therefore, a major goal in developing the map is to define an underlying structure that allows for projections based on many different characteristics. The proposed structure should provide different ‘map-like’ overviews that allow all stakeholders to:

- acquaint oneself with other stakeholders and with relevant areas of research and industry
- keep up with developments in the areas of Dutch research in design
- address potentially interesting future research areas / themes
- address characteristics in the field dependent on the level of aggregation (e.g. operational, tactical and strategic level)

![Figure 2 - Simplified map of Dutch research in design based on geographical location.](image)

3.2 Challenges

3.2.1 View independent structuring
A major challenge in complying with the goals and requirements is the diversity of potential stakeholders. Regarding the mind-set in creating the map (see section 2.1), it is not the intent to predetermine a selection of stakeholders and the information and overviews the map should provide. Essentially, future use should be prescribed nor limited by the constitution of the map. Where it is impossible to anticipate all possible stakeholders, it is also impossible to outline the viewpoints required to facilitate those stakeholders. Consequently, it is infeasible to define all different hierarchies the map must provide to structure the information content in a suitable manner. Moreover, to anticipate any possible hierarchy, information in the map should be defined independent of its context. Therefore, any
predefined hierarchical structuring as a backbone for the map is unsuitable. Consequently, most conventional ways of structuring information are impracticable.

3.2.2 Actuality of information
To keep up with developments in Dutch research in design, the map and its content should be able to grow based on future developments. Otherwise, the map will become a static representation of an obsolete situation. Consequently, the requirement to make the information content updateable without significant effort becomes very relevant.

3.2.3 Stakeholder involvement
If it is accepted that a predefined hierarchy for the information structuring cannot exist, it is therefore impossible to fill the information structure based on the answers to sets of well-defined questions. Consequently, stakeholder participation is a prerequisite for obtaining adequate and valuable information in the structure. However, not having defined a distinct selection of research and stakeholders, the initiative runs the risk that none of the stakeholders feels truly involved. Yet, this involvement is certainly required in order to improve the map by providing useful information content.

3.3 Solution directions
3.3.1 Information networks
Only by structuring information in a non-hierarchical, flexible way, the map content can become inherently independent of the perspective that is taken. This non-hierarchical structuring of information can, among others, be realised by merging multiple hierarchies. This will not result in a larger hierarchy, but rather in a network structure in which individual hierarchical relations lose their dominance. A network in itself is not the most appropriate rendering of the information content, as, without imposed perspective, it is deprived of any denotation. Therefore, a map that uses a network structure should allow users to address the appropriate information content in an appropriate (temporal) structure in the right context at the right time (like also visualised in figure 1).

3.3.2 Clustering techniques
When information networks are used to structure information, so-called clustering techniques can be employed to recognise information clusters in the network. These clusters are groups of information that have strong mutual relations and that can be used to uncover areas in Dutch research in design. Applying clustering techniques based on different criteria, makes it possible to render the information network in a meaningful manner and to discover different types of clusters.

The benefit of using clustering techniques over traditional classification approaches (e.g. taxonomies) is that clustering techniques help to discover groups based on the actual information content. If new information is added to the information network, that information is henceforth used in all clustering efforts. The addition of topics can therefore also lead to new clusters, and with that to e.g. the identification of new research areas.

Figure 3 - Clustering creates a flexible and dynamic (temporal) structure in an information network

3.3.3 Stakeholder involvement
The best way to achieve actual stakeholder involvement is to ensure that the stakeholder desires to be involved, as he recognizes and appreciates the added value of the fact that he has access to the map. Only then, he will be well-disposed to contribute to the map. In other words, the map must be established in such a way that it exposes and propagates its own added value. Moreover, stakeholders should not be hampered by complex formats or procedures for interacting with the map. To facilitate the contribution of stakeholders, a web-based interface seems ideal. Once initiated, it is envisaged that the then existing map will, on its own, attract more stakeholders, because they simply want to have presence in and access to the map.

3.4 Priorities for development
In the development of the map, a number of topics deserve more elaboration. Firstly, the stakeholders of Dutch research in design, including their viewpoints and interests, are essential starting points for selecting the first information to add to the map. It is important to anticipate the information that stakeholders would like to discover.

Secondly, the gathering of information, and the way in which it subsequently becomes part of the map, requires attention. As the map is a means to an end, the efforts invested in creating it must be proportional to its added value. Therefore effective and efficient ways of realising the map are required.

Ultimately, the information needs to be represented to users in a way that is comprehensive, efficacious and transparent. This requires attention to the interface that presents the information to the user.

Sections 4, 5 and 6 elaborate on these topics. They describe characteristics of the topics, explicitly without aiming at exhaustive depictions. The characteristics mentioned are preconditions for the
map to fulfil its function; certainly, other aspects can be influential as well.

4 STAKEHOLDERS AND VIEWPOINTS

4.1 Anticipated stakeholders and interests

4.1.1 Researchers

The most obvious stakeholders of the map are researchers. They are interested in finding related research and related fellow researchers. For this purpose, formal structures of research in design (like e.g. the structure in section 2.3), are often not adequate. Everyday practice frequently indicates that two researchers may have strong interest in each other’s work, whereas their respective research groups are (hardly) related and are even quite dissimilar. A map that gives insight in the relations between the actual work of researchers would provide this information.

4.1.2 Industry

To ensure that research has a practical embedding in industry, companies are important stakeholders in many research projects. This safeguards the valorisation possibilities of research. Industrial interest in the map would e.g. be in finding new research projects to collaborate in. Additionally, it is an effective way to keep up with new and evolving research topics.

4.1.3 Financial enablers

Subsidies are important in Dutch design research, as a lot of the research is (partially) funded by e.g. Dutch or European governmental organisations. Many financial enablers are, for example, interested in identifying trends in research, and with that, in nominating research gaps. This kind of information enables the definition of strategies and the initiation of meaningful new project calls. Moreover, these stakeholders can benefit from using the map by presenting their profile and project calls/tenders by means of this medium.

Besides the stakeholders mentioned here, also interest groups (e.g. consumers, production, logistics or retail) are prospective users of the map. Moreover, Design United feels that the map is a way to open up the research field to the general public.

5 CAPTURING INFORMATION

5.1 Information repository

As mentioned in section 3.3, information networks structure the content of the map in a flexible and non-hierarchical way. For this reason, a so-called conceptual graph is used [4]. It typically consists of two kinds of nodes, being entities and relations; this enables the graph to capture content that is non-hierarchical in nature (see also figure 1).

One of the ways to build a conceptual graph is to start from scratch, and to manually relate all information entities. Also, in applying so-called tagging techniques, chunks of information are characterised by attaching several ‘tags’ to it. Tags are keywords, identifications or terms that characterise an entity. As tags (i.e. meta-data) can be used to relate entities with similar characteristics, they provide means to find and employ any relation between any set of entities a posteriori. This obviously allows for a structuring that is not only extremely flexible, it also follows the available information content and is therefore dynamic in nature.

5.2 Initial input information

Information that is not yet used as input for the initial implementation of the map can become part of the content at any later stadium. This is why the first initiatives in creating the map merely constitute a basis that can develop over time. As it is important to immediately convince stakeholders of the added value of the map, the first version should show relations between researchers that are not directly obvious. For this purpose, the following types of input information are included in the first version.

5.2.1 Formal information and relations

Formal information, like e.g. the faculty in which a researcher is employed, the title of a research project or an industry partner involved, is information that is formally established. Little room is left for discussion on, or change of, this information. This makes this kind of information relatively easy to find and to use in the map.

It, however, is not very likely that such information will provide stakeholders with many new insights. However, the relation between formal information and less formal information, which will be described next, will show some interesting new relations. Moreover, without the relation with formal information, informal information might lose its context, making it difficult for stakeholders to determine the meaning thereof.

5.2.2 Informal information and relations

To reveal the hidden relations between and among research topics and designers, ‘formal’ topics do not always give the best indication of the content of the research. Therefore, a more objective approach is chosen that defines topics, or keywords, based on the actual work of researchers.

To define these informal topics, a tool is used that allows for the objective definition of the finger print, or ‘profile’ of a (set of) document(s). These profiles can be used to ‘tag’ for example representative publications of researchers. Based on these tags, the strength of the relation between multiple publications can be determined, and with that the relations between researchers.

This profiling technique cannot only be used for determining the characterisation of individual researchers based on their work; also departments, industries, projects, and many other ‘carriers’ can be
characterised by using a profile. As a consequence, questions like “this article is interesting, who is also working on this topic?, I have written this MSc thesis, at what research department should I look for PhD vacancies?, I am looking for an industry partner in this project, who can I approach?” will become equivalent questions.

Most important, the form allows researchers to add representative publications for their work in their research projects. These publications are used to extract subjective topics (profiles) as described in section 5.2.2. This information is very important in revealing the implicit relations between researchers; as such, this is of major interest in the prototype implementation.

The form with the input fields is one explicit perspective on the information network; therefore the answers provided can directly contribute to that network. The merger of all input provided by various researchers will immediately be interrelated, because of overlapping tags and profiles. Especially these profiles allow for indicating and denoting relations between carriers based on the informal information content. This certainly contributes to the added value of the map.

6 REPRESENTING INFORMATION

Information networks are rather ‘raw’ to present to an unsuspecting user. Therefore, quite some customisation is required to present the user with something that gives him overview. In the search for providing suitable overviews, various relations between and amongst topics, researchers, projects etc. need to be encountered. In showing these relations graphically, the ‘distance’ between entities, representing the proximity of elements based on a certain characteristic, is considered important to create a dynamic representation. Also the ability to use filtering techniques will be needed to make the entire content manageable. Figure 5 shows some examples of cognitive tests for suitable representations. Inspiration is found in the field of dynamic infographic design.

7 INITIAL IMPLEMENTATION OF THE MAP

7.1 Gathering information (input)

A first proof of concept of the map is made with a small selection of researchers at the University of Twente. The proof of concept is made in such way that it demonstrates the approach for a small selection of stakeholders, and that it enables future expansion.

The input information for this proof of concept is gathered via a survey that is conducted via a digital form. Researchers are e.g. asked to specify their personal information, (intended) year of obtaining PhD title, and employer (organisation, department, research chair). Additionally, because most researchers do research in the context of a project, some information is requested on this project. Here researchers can, amongst others, specify financer(s), industry partners, supervisors, keywords and the (intended) period the project will run.

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7.3 Evaluation
As a first assessment, a number of researchers, employees and students are exposed to the prototype. Based on a set of simple questions, they were asked to use the prototype to find answers to these questions. Despite the rudimentary character of the prototype all users intuitively understood the concepts used to interrelate information and to present it in the user interface. Additionally, none of the users recognised that part of the information had a formal background, and part of it stemmed from profiling the documents. This stresses the fact that the information content does not hamper the perspective taken by the user.

All participants answered the questions by effective and efficient browsing. The most striking observation in the test was that nearly all participants tended to rush through the questions so they could interact with the map on their own initiative. With some wishful thinking, this can be explained as stakeholder interest.

As the participants were quickly used to the content and concepts used, they quickly proposed additional ways of using the map and of rendering it. With this, the initial proof-of-concept is certainly furnished.

8 OUTLOOK

8.1 Providing input hints
Even when stakeholders feel involved in the map, it is not likely that any of them will show proactive behaviour as concerns the updating or adding of information without directly perceivable results or effects of his actions. Therefore, stakeholders should be supported in their assessment of the completeness or adequacy of own information, or receive suggestions on information to add to the map. For this purpose the ontology of the conceptual graph can be used. The notion ontology is explicitly meant in its original sense: as a flexible depiction of the information content that a posteriori ensues that information content. Practically it means that the ontology of the conceptual graph can hint stakeholders on information interesting to add [5].

How this use of ontologies can be implemented in practice is a topic of investigation that is highly valued for implementation in future versions of the map.

8.2 Expansion of the map
Next to using the map for its main purpose and investigating the future use of ontologies, subsequent steps also focus on:

- Gathering information on e.g. researchers, industries, subsidies to add to the map;
- Finding the most suitable way to represent information in the map to its users;
- Employing the map on the website of Design United

9 REFERENCES

10 BIOGRAPHY

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