EXTRACTING MEANING FROM USER RESEARCH DATA

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ABSTRACT

Traditional user research methods and participatory research methods generate a vast amount of data. Analyzing and getting meaning from this data can be a daunting task. Often times the data collected becomes overwhelming and designers process the data based on their own intuitive methods. Intuition is a critical aspect of the design process but its success is based on the designer's experience. At times, it may become a source of mistrust between the designers and the other divisions of the team (engineering, business development etc.) There is a need for methods that allow the product development team to see beyond the obvious, and develop a deeper understanding of the user and the context of use of a product. The following paper describes methods commonly used to handle large quantities of data, and their advantages and limitations when they are used to obtain meaning from data gathered from the field during the user research phase of the product development process. The need for the utilization of both quantitative and qualitative methods during this process is highlighted, and directions for the future are identified.

Keywords: User Research, Design methods, Design Structure Matrix (DSM), Card Sort, Qualitative data analysis, Quantitative data analysis

1 INTRODUCTION

Product design is a set of cognitive activities that tap into different modes of thinking and disciplinary perspectives. The process begins with a creative leap from raw customer data to an assessment of what that data implies in terms of the context and constraints of the design. Based on this initial definition of the design problem, the team then creates a set of competing candidate designs, which can then be evaluated against one another, with the best features of each combined into a final design or family of designs [1].

It has been noted that designers rely heavily on intuition for making this leap from customer data. Intuition comes from personal experience. However, it is not clear how to go from experience with one customer, or a small set of customers, and generalize it. This suggests that a design process needs to externalize the unarticulated knowledge behind intuition [2].

2 BACKGROUND

In order to acquire useful information for design, the design team must go where the product or service adds value for the customer. The necessity of having the team actually go to the site where the artefact will be used cannot be overemphasized: it allows teams to see situations through the user's eyes [3]. Recent research has shown that product users are often the real source of innovation, because they are closest to the product in use, and frequently adapt or modify current products to better fit their needs [4].

It is often assumed that user needs are easily identifiable, and that with a combination of observation, interviews and questionnaires, the team can either identify user needs, or get the user to elicit what their needs are. In reality, actual work practice is intricate and complex; understanding it in depth can result in an overwhelming amount of data. One typical response to such large quantities of data is to reduce it – for example by summarizing the top five issues identified in all the data and responding only to those. Another typical response is to decide that the problem is too large to address, and pick only a few problems to solve in the current release of the product, and solve the rest in future product releases [2].

Both of these approaches ignore the fact that the kinds of problems encountered by real users are often *emergent*, i.e.; they are created by the interaction of specific features with tasks. Disregarding what seem to be 'minor' problems often has the unintended effect of eliminating the real source of the design problem, and hence robs the design team of the opportunity to respond to the customers' holistic work environment with a coherent set of systems.

Good products by definition are based on facts. Good facts are only the starting point. Designs are built on the interpretation of facts, on what the designers claim the facts mean in the context of the design problem [2]. This interpretation of facts requires the team to abstract from the user data in hand, and to create generalizations based on the knowledge and experience of the members of the team.

This paper deals with the process of creating abstractions and generalizations from user research data.

3 RESEARCH METHODOLOGY AND CASE STUDY

The process for obtaining and assessing user needs described here relies on the disciplinary foundations of mechanical engineering, industrial design and cognitive engineering. The process is grounded in the data obtained from researching a set of users (their activities, needs and behaviour), which is then abstracted by looking at patterns and relationships among this data. These generalizations are then applied to a context larger than that in which the initial data was obtained, to create design seeds for a product in response to the activities the product is trying to support.

The process involves the following steps:

- Primary and secondary research
- Categorization of research data
- Identifying patterns and relationships between and within categories

This process is described in the context of a design competition for students and professionals sponsored by Dell, Inc. The goal of the competition was to explore new directions in sustainable, environmentally responsible product designs for computing. This particular project was centred on educational settings, specifically a college campus. We will trace the series of process steps outlined above, showing how each step was carried out in practice by a team of design and engineering students at The Ohio State University.

3.1 Primary and Secondary Research

The goal of the research phase is to provide the design team with data that will form the basis from which designs can be created. The data collected typically covers a wide range of areas such as: user needs, behaviours, cultural preferences, and market trends. The underlying goal of this phase is to gain a coherent understanding of the work that the product will support [2].

A variety of user research techniques were employed in this stage of the project. Techniques employed included several rounds of user observation, interviews, surveys, and questionnaires from which the team gained a more thorough understanding of computer use by students, faculty and staff members in a very large public university setting. Secondary research included library and internet searches in the areas of product sustainability as well as the problems faced by the computer industry in its attempts to attain a more sustainable profile.

At the conclusion of this phase, research presentations were held in which the findings were reported, and the copious notes of all twelve researchers were combined to form a master list of research findings.

3.2 Categorization of Research Data

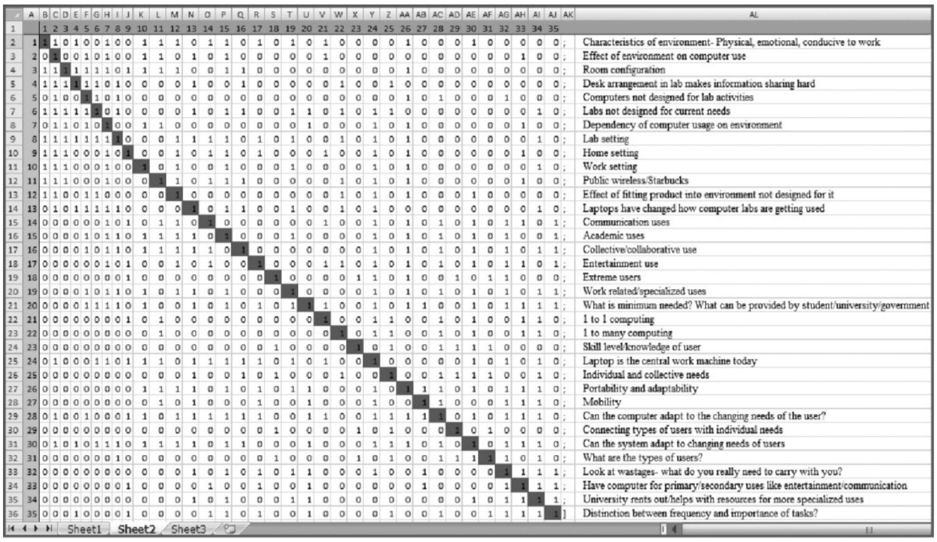
Categorization can be seen as a process of funnelling and sorting the data into relevant categories for analysis. The data loses its original form in the process but the team gains by organizing it in ways which are more useful for analysis. The data can now be organized and analyzed in terms of the categories which are developed by analysis. The master list of research findings from the previous phase was screened and the data was fit into broad meta-clusters. Initial or emergent research questions guided the formation of these meta-clusters [5]. The meta-clusters identified included: System Issues, Adaptability, Transparency, Centralization, and Design Issues/Constraints

Each meta-cluster was further split into smaller, more manageable clusters. This was done using two methods: The Card Sort method, and the Design Structure Matrix (DSM). In the card sort method, for each meta-cluster, individual bits of data are written on individual post-it notes. Each post-it note is then compared with notes around it, to check for commonalities among the data (within the meta-cluster). Interrelated bits of data are then grouped in smaller clusters by re–positioning the post-it notes and regrouping them. A total of thirteen categories were identified: Disposal and recycling, Computer re-use, Power management, Software management, Constraints, Computing environment and its effects, Adaptability to different needs of the user, Dell business model for education, Information availability and presentation, Centralizing resources, Repair and upgrading, Making the PC more transparent, Other design issues.

An alternate, more rigorous method for clustering is the DSM. The DSM has traditionally been used as a representation and analysis tool in Systems Engineering for purposes of decomposition and integration.

A DSM is a square matrix with identical row and column labels. An off-diagonal mark (of 1) signifies the dependency of one element on another. Reading across a row reveals what other elements the element in that row provides to; scanning down a column reveals what other elements the element in that column depends on [6].

The use of the DSM for the purpose of further decomposition of the meta-clusters of user research data into smaller clusters was explored. One meta-cluster (Adaptability) was chosen as a test case, and was decomposed using the DSM method. The DSM documenting dependencies between the data bits of the meta-cluster ‘Adaptability’ is shown in Figure 1.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35		
1	1	1	0	1	0	0	1	0	0	1	1	1	0	1	1	0	1	0	1	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	;	Characteristics of environment- Physical, emotional, conducive to work
2	0	1	0	0	1	0	1	0	0	1	1	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	;	Effect of environment on computer use
3	1	1	1	1	1	1	1	0	1	1	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	;	Room configuration
4	1	1	1	1	1	1	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	;	Desk arrangement in lab makes information sharing hard
5	0	1	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	;	Computers not designed for lab activities
6	1	1	1	1	1	1	0	1	0	0	0	0	1	0	1	1	0	0	1	1	0	1	0	1	1	0	0	0	0	0	0	0	0	1	0	;	Labs not designed for current needs
7	0	1	1	0	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	;	Dependency of computer usage on environment
8	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	0	1	0	1	0	0	1	0	1	0	1	0	0	0	0	0	0	0	1	0	;	Lab setting
9	1	1	1	0	0	0	1	0	1	0	0	1	0	1	1	0	1	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	1	0	0	;	Home setting
10	1	1	1	0	0	0	1	0	0	1	0	1	0	0	1	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	;	Work setting
11	1	1	1	0	0	0	1	0	0	0	1	1	0	1	1	1	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	1	0	0	;	Public wireless/Starbucks
12	1	1	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	1	0	0	0	0	0	;	Effect of fitting product into environment not designed for it
13	0	1	0	1	1	1	1	1	0	0	0	0	1	0	1	1	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	;	Laptops have changed how computer labs are getting used
14	0	0	0	0	0	0	1	0	1	0	1	1	0	1	0	0	0	0	0	0	1	0	0	1	0	1	0	1	0	1	0	1	1	0	1	;	Communication uses
15	0	0	0	0	1	0	1	1	0	1	1	1	1	0	1	0	0	0	1	0	0	0	0	1	0	1	0	1	0	1	0	1	0	0	1	;	Academic uses
16	0	0	0	0	1	0	1	1	0	1	1	1	1	1	0	1	0	0	0	0	0	0	0	1	0	1	0	1	0	1	0	1	0	1	1	;	Collective/collaborative use
17	0	0	0	0	0	0	1	0	1	0	0	1	0	1	0	0	1	0	0	0	1	1	0	1	0	1	0	1	0	1	0	1	1	0	1	;	Entertainment use
18	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	1	0	0	1	0	1	1	0	0	0	;	Extreme users
19	0	0	0	0	1	0	1	1	0	1	0	1	1	0	1	0	0	0	1	0	0	0	0	1	0	1	0	1	0	1	0	1	0	1	1	;	Work related/specialized uses
20	0	0	0	0	1	1	1	1	0	1	0	0	1	0	1	0	1	0	1	1	1	0	0	1	0	1	1	0	0	1	0	1	1	1	1	;	What is minimum needed? What can be provided by student/university/government
21	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	1	0	1	0	0	1	1	0	;	1 to 1 computing
22	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	1	0	1	0	0	1	1	0	;	1 to many computing
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	0	0	0	0	;	Skill level/knowledge of user
24	0	1	0	0	0	1	1	0	1	1	1	0	1	1	1	1	1	0	1	0	1	0	0	1	0	0	0	0	0	1	0	1	0	1	0	;	Laptop is the central work machine today
25	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	1	0	0	1	0	0	1	1	1	1	0	0	1	0	;	Individual and collective needs
26	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	0	1	0	1	1	0	0	0	1	0	1	1	1	0	1	0	1	1	1	0	;	Portability and adaptability
27	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	1	0	0	0	1	0	0	1	1	0	0	0	1	1	1	0	;	Mobility
28	0	1	0	0	1	0	0	0	1	1	0	1	1	1	1	1	1	0	0	1	1	0	0	1	1	1	1	1	0	1	0	1	1	1	0	;	Can the computer adapt to the changing needs of the user?
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	1	0	1	0	0	0	0	;	Connecting types of users with individual needs
30	0	1	0	1	0	1	1	1	0	1	1	1	1	0	1	1	0	0	0	1	0	0	0	1	1	1	0	1	0	1	0	1	1	1	0	;	Can the system adapt to changing needs of users
31	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	1	0	1	0	;	What are the types of users?
32	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	1	1	0	0	0	1	0	0	1	0	0	0	0	1	1	1	1	;	Look at wastages- what do you really need to carry with you?
33	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1	1	1	1	;	Have computer for primary/secondary uses like entertainment/communication
34	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	;	University rents out/helps with resources for more specialized uses
35	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	1	0	0	1	0	0	0	0	1	0	0	1	0	0	1	1	1	1	1	]	Distinction between frequency and importance of tasks?

Figure 1 DSM interactions within Adaptability meta-cluster

The DSM output after clustering is shown in Figure 2 and the identified clusters and their constituent elements are shown in Figure 3.

Upon comparison with the Card Sort results for this meta-cluster, the clusters identified from the DSM method consisted of more related elements, and yielded overall better clusters for analysis; the clusters seemed to have a better definition, with clearer boundaries. However, as the process was time consuming, to obtain results for the remaining meta-clusters within the time constraints of the academic quarter was not possible. Therefore, the Card Sort results were chosen for the next stage of the process.

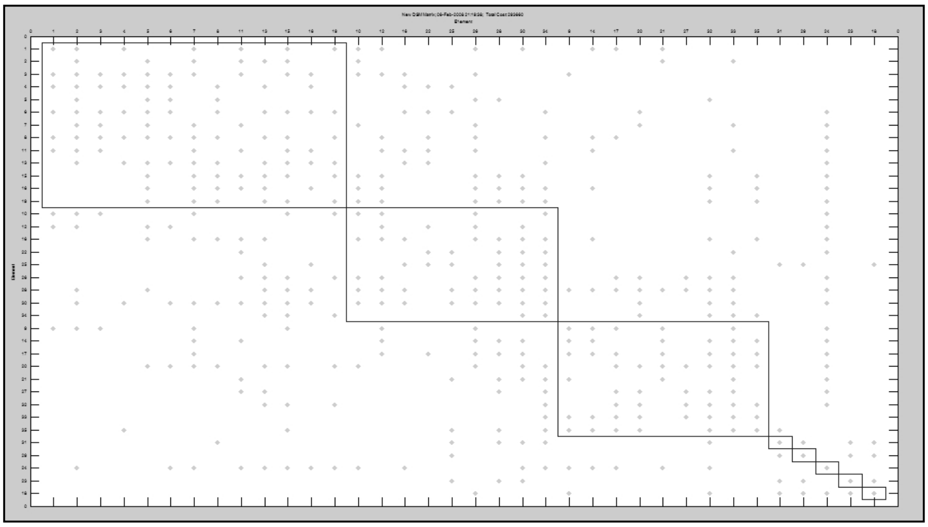


Figure 2 DSM output (clustered using algorithm from [7]

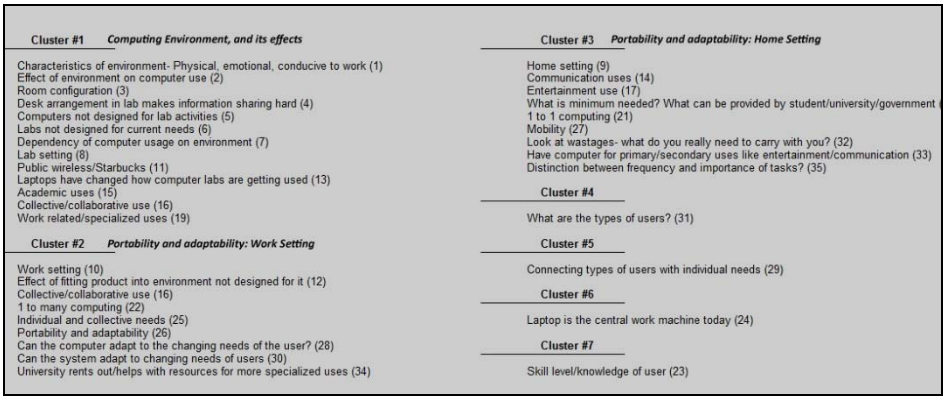


Figure 3 Identified clusters and their constituent elements

3.3 Identifying patterns and relationships between and within categories

After the categories were formed, the contents of each category were analyzed further. Raw data becomes meaningful based on the relationships among the data [8]. The data bits *within* each category were compared with each other and potential relationships were noted. By paying attention to these relationships, higher level trends were noted in each category. The relationship *between* categories was then looked at, and further higher level trends were noted. Diagrammatic displays help in this process of extracting meaning by revealing relationships. They are not just a way of decorating our conclusions; they also provide a way of reaching them. Mind maps, a method of conceptual visualization that emphasizes the connections between ideas, can be created for each category. These maps show the constituent data elements of each category, and explicitly show the nature of the relationship between them.

A master list of trends and interpretations was created this way. The master list was loosely divided into system and design issues. These identified trends about the system and design issues were used to guide the subsequent phases of design. They helped in the creation of problem statements and product requirements that better characterized the problem domain the design team was trying to address. The detailed design phase was implemented by keeping in mind the requirements and guidelines created.

4 CONCLUSIONS

Designs are built on the interpretation of facts. Interpreting the facts carefully is very important, as these interpretations guide subsequent phases of design. A methodology for a more rigorous process of user research analysis, to help in interpretation was discussed in this paper. While the quantitative approach of using the DSM adds rigor, the usage of methods like mind-mapping and other diagrammatic displays help the design team see the underlying relationships among the data elements.

Usage of the method helped develop good system level solutions. The challenge the team faced was in designing products that responded to and supported the system level solutions created.

A variety of reasons might help explain the difficulty faced by the team in designing products to satisfy system and device level requirements. The complexity of the problem space, where possible product solutions seemed to create more problems than they solved, led to a feeling that the team couldn't adequately address all the requirements. The structure of the course with two different teams handling the problem formulation phase and the detailed design phase also contributed to making the transition from requirements to designs more difficult. Graduate students involved in the problem formulation phase contributed significantly to the team dynamics, but were not present in the detailed design phase. The team handling the detailed design phase was comprised almost entirely of senior industrial design students, and their knowledge of sustainable development was limited to device level materials and energy consumption. Getting this team to overcome political and religious biases, and embrace system level solutions to tackle the problem of sustainability was a challenge.

On the other hand, the method helped the faculty identify problem areas that may have otherwise been overlooked. Identification of these areas helped in dividing the team into groups in order to address these specific areas. The test study further highlighted the need for multidisciplinary teams when addressing system level problems.

This method adds complexity to the design process. While it is of the authors' opinion that this complexity is necessary, the success of the method will rely on making the method fit in better with the needs, capabilities and experience of the design team. Upon completion of the test study it was felt that the method might work better with more experienced members, perhaps at the graduate level. At the undergraduate level, the method may have potential with a less complex project.

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