The When of user engagement

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Introduction

One of the most important components in the design of new products is the inclusion of input from the end users and a large body of literature exists that describes how to identify and engage relevant stakeholders. Many design tools and methodologies such as concurrent engineering (McGrath, Anthony et al. 1992) or quality function deployment (Griffin and Hauser 1993) identify consumer or user input as imporant, but there is surprisingly little guidance on precicely when it should be collected. The objective of this poster was to demonstrate how the design structure matrix (DSM) can be used to identify when to collect user input to aid in the development of better assistive technology (AT) devices.

The need for optimization

Most design methodologies stress the importance of defining and understanding product needs at the beginning of the design process. This is because, often, the only time designers are in direct contact with customers is at the very beginning when design criteria are defined (Kaulio 1998). Usually, little or no direct customer input is sought while a product is physically being designed. Issues of ease of use and usability which require input are left to the end of a project after all major design work has been completed (Green and Jordan 1999).

This approach can be problematic in the design of assistive devices. By nature, many AT devices have multiple stakeholders that can and should inform the design process. Stakeholders include the end user, of course, but also may include caregivers (who are also users), clinicians (who select and prescribe the device), manufacturers (who make it) and insurance companies (who pay for it). Engaging users can be particularly challenging because the diversity in functional abilities of users complicates the selection of ‘typical’ users. Moreover, a user’s abilities may prevent them from being able to take part in initial needs gathering. For example, users with dementia may not be able to provide input for a new device until significant design and development has already taken place (Kates, Clarkston et al. 2004). The myriad stakeholders may also provide conflicting needs and desires yet all have a true stake in the viability of the device.

The need to obtain stakeholder input usually conflicts directly with the need to reduce development time and costs. This is a real possibility in AT design due to the number of potential stakeholders, but the fact that multiple stakeholders exist also validate the need for such design input. Furthermore, many AT devices exist in small niche markets (Harwin 1998) and the AT industry is populated by many small companies who cannot afford costly product development (Commerce 2003). Judicious use of stakeholder input can help insure that smaller companies design good products to survive in a limited market.

Because the purchaser of AT devices is often not the end user, usable design takes on heightened importance. Device abandonment is a major concern in AT with one study reporting that 30% of assistive devices are unused (Wessels, Dijcks et al. 2003). When a user abandons a device, payers lose revenue when it is replaced with a new device. These losses are passed on in the form of higher insurance premiums, higher taxes or more restrictive approval policies that make it even harder to sell AT devices (Jain, Usiak et al. 1996). There would be many benefits to investing more research and development resources to find ways to reduce abandonment. Even so, in a US Department of Commerce survey, nearly 60% of AT companies indicated that R&D was not a significant part of their operations (Commerce 2003).

DSM in AT design

Since the design structure matrix was first described by Donald Steward in 1981 it has been applied to many to many problems, especially in managing the design process. DSM provides an analytical way to view and study the structure of a problem (Steward 1981). It allows groups of tasks that require iteration to be identified and ordered to help reduce the number of repititions required to complete them (Smith and Eppinger 1997). Further, it can be used to estimate the time needed to complete a set of iterative design tasks by calculating the time required to perform re-work of tasks (Smith and Eppinger 1997). This ability to analyze a design problem can be exploited to identify the ideal points to include input from stakeholders.

To illustrate how DSM might be useful in assisting in the design of AT products, DSM analysis was applied to the design a pressure alleviating seat cushion (PASC). The PASC is a powered cushion that dynamically alters loading on the buttocks while also managing the microclimate of the buttock-cushion interface. Therefore, the cushion has multiple components and subsystems that can be entered into DSM analysis.

The first step involves the creation of a matrix by listing all the components of the PASC and the interaction between them. The analysis of the DSM begins with partitioning, a process which groups together tasks that depend on each other (ie are iterative in nature) and arranges the groups into the best order in which to perform them. The results of this iteration are shown in Figure 1 by the series of highlighted blocks that reflect groupings of the components listed in the left column. For readability, each block was assigned a name and is listed in Table 1.

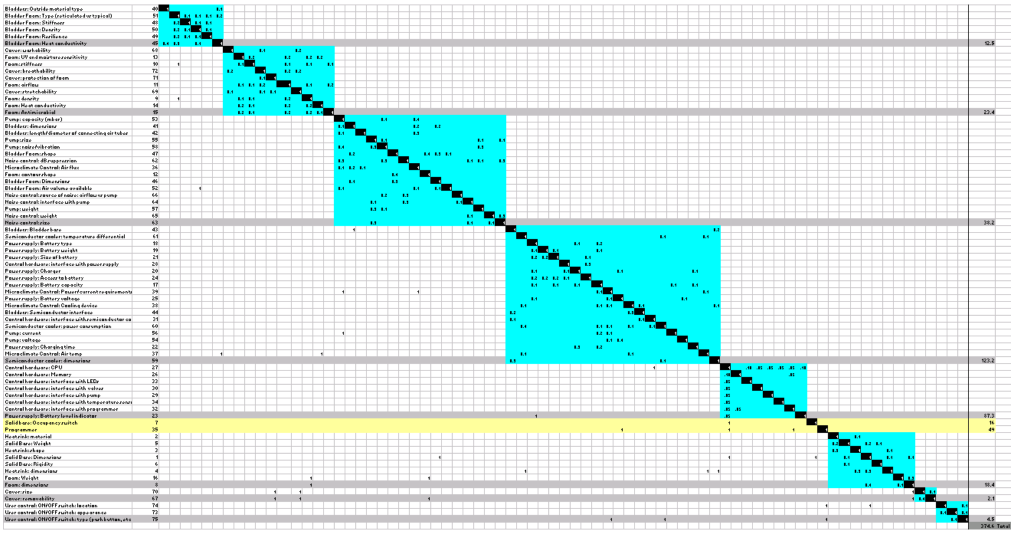

Figure 1: A fully analyzed DSM of the alternating pressure cushion

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Module	Module Name
Module 1	Bladder material properties
Module 2	Internal foam and cover material properties
Module 3	Major mechanical components
Module 4	Electronics and mechanical component integration
Module 5	Control hardware and interface with electronics
Task 1	Design occupancy switch
Task 2	Design Programmer
Module 6	Solid base heat sink
Module 7	Cushion cover features
Module 8	on/off switch properties

Table 1. Design modules in the PASC cushion design project identified by DSM analysis

Each of the blocks revealed in the DSM can be thought of as a module, an independent part that works together with others to form a larger system (Baldwin and Clark 2000). Because stakeholder input can range from a few weeks (Green and Jordan 1999) to several months (Wind and Mahajan 1997), this modular design plan can be used to define when stakeholder input should be sought. If done correctly, it can reduce project disruption by allowing designers to complete part of a design's function while providing stakeholders concrete information upon which to base their input. It also empowers project managers to utilize different stakeholders at different times.

For example, users and payers might be engaged prior to Module 1 to collect design criteria as well as allowable device costs. User input can also be gathered after Module 2 when the cushion and bladder have been designed in order to insure acceptability. Clinical input might be useful prior to Modules 4 & 5 to discuss programming options since clinicians will be setting the parameters to individualize the timing and sequence of off-loading the buttocks to achieve desired clinical outcomes. Finally, users will again be engaged toward the final modules as the device interaction and usability becomes important feedback.

Most importantly, stakeholder input throughout the process allows needs that can only be captured after design work is underway to be included. If a major need is missed and only discovered after the device is finished (based only on initial input), it is possible that aspects of the design process would have to be repeated. At the least this would cause extreme delays and be very expensive. At the worst, it may prove to be too expensive to fix and cause the project to be dropped with nothing to show for the effort. A third outcome is that the device is released anyway with the knowledge that it has a major deficiency. Knowing the ideal points to solicit stakeholder input allow the maximum amount of input to be collected usefully throughout the design process. This can reduce the possibility of a poor outcome by identifying design weaknesses or omissions before valuable time and resources are devoted to a flawed concept.

Conclusion

The design and development of AT often differs from traditional product design. The nature of AT's importance to users requires, above all, that AT products function correctly and are reliable. In addition, the process of selecting and obtaining an AT device involves multiple stakeholders. A design process that only engages stakeholders at the beginning may not produce a product that meets everyone's needs. This approach is likely to miss critical needs that can only be captured from stakeholders after the design of an AT product has begun. Using a tool such as DSM can provide a way to include input throughout the design process to help create products that are more profitable for the producer and better meet the needs of stakeholders.

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