ESTABLISHMENT OF AN OPEN, WIKI-BASED ONLINE RESOURCE FOR COLLABORATION IN THE FIELD OF PRODUCT FAMILY DESIGN

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ABSTRACT

Product and process platforming continues to be a fast growing and fertile field of research that includes the issues of modularity, clustering, product families, and platforming of products and/or processes. To support collaboration in the field of Product and Process Platforming, the Michigan Tech Lifecycle Engineering Laboratory has developed a Wiki-based website that we hope provides a central location for researchers and professionals in the field to learn, share, and collaborate. The initial structure of the PlatformingWiki (http://platformingwiki.we.mtu.edu), as we have termed the website, is based on a roadmap presented in 2007 at the International Conference on Engineering Design (Gershenson et al., 2007); a structure that we hope will see many iterations and improvements through discussion in this open environment. Currently, there are few public examples of inter-laboratory research-focused wikis. However, the open, collaborative nature of the wiki paradigm will lend itself well to hosting in-depth debates; allowing for the easy identification of neglected avenues of research, and eventually resulting in a one-stop information repository for all things related to product and process platforming. Such a resource will prove valuable to anyone looking to enter the field, including new graduate students, researchers in other disciplines, and industry professionals looking to reap the practical benefits of platforming research. We anticipate that the wiki will also spur collaboration and accelerated the state of knowledge of the field.

The community will essentially vote on which model will be the most useful, and the beauty is that they will vote with their participation, the only question is which model will resonate best. - Andrew Su, Gene Wiki Creator (Waldrop, 2008)

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1   MOTIVATION

As our group launches the Product and Process Platforming Wiki, our motivation is twofold. The first goal is to develop an encyclopedia of knowledge related to the field of product and process platforming. As users update this database continuously, it will represent the current state-of-the-art in product and process platforming and provide easy access to those wishing to learn more about the field. Eventually coupled with tutorials and case studies, this repository will allow users in industry to quickly assess the pros and cons of various platforming strategies, and allow them to rapidly develop a sufficient understanding to implement these systems in their workplace. Once they have done so, it will be a simple matter of returning to the website to describe their implementation experience, and thus the community as a whole is improved and both industrial professionals and academic researchers will have new data on practical implementations of platforming techniques.

The second goal is to provide the product and process platforming community with a real-time forum in which to discuss and debate definitions, methods, implementations, data, published articles, or any other platforming-related topic. This site will allow users to post excerpts, abstracts, or full text from their published or yet-to-be-published journal or conference articles and be able to receive and respond to feedback immediately. As new ideas are generated by researchers and published, this type of open, unrestricted discussion enables them to be rapidly disseminated, and also allows for the quick identification of areas of the field in need of further research. Since much of this discussion will be taking place between researchers at a variety of institutions, the likely (and desired) outcome of these

open talks will be an increase in inter-laboratory collaboration and the sharing of expertise, data, and insights.

2. PRODUCT AND PROCESS PLATFORMING WIKI

Product design has been influenced by several research topics in the last decade, many centered on the integration of design and manufacturing considerations. To determine the novelty of the concept of smart assembly among other design concepts, a short review of some related research is presented. The topics to be discussed include design for assembly, product modularity, and virtual simulations from a product design perspective, and lean manufacturing from a process design perspective.

In an effort to create an open, active community resource for the product and process platforming field, the Product and Process Platforming Wiki has been created. This site is intended to be used by researchers and professionals in the product design and platforming fields to develop a unified and mutually-understood framework from which to identify, discuss, and explore new avenues of research while developing a comprehensive description of the state-of-the-art of the platforming field in general. A secondary use will be for those new to the field – new graduate students, new researchers, and industry looking for implementation support – to find the most current and thoroughly peer reviewed information on the topic. The structure of the site, at least initially, is based on a roadmap presented in 2007 at the International Conference on Engineering Design (Gershenson, Khadke, and Lai, 2007), so that a common framework and point of reference is available for those wishing to contribute to the page. As with most wikis, this initial framework can be morphed by the community of users.
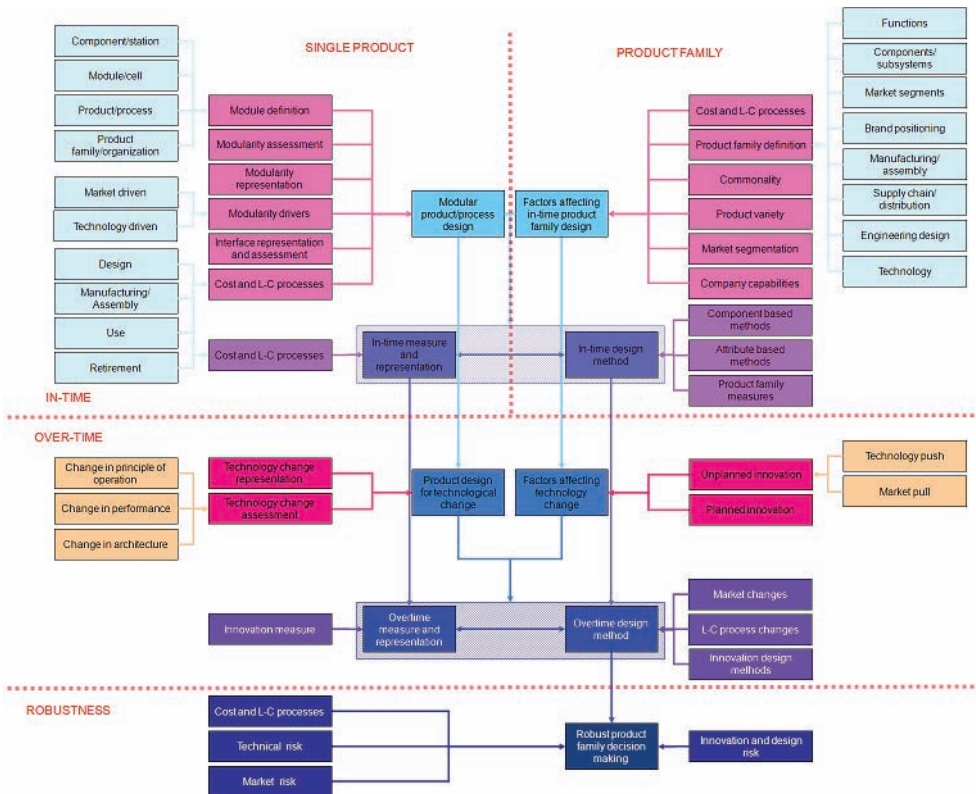

Figure 1: Robust Product Family Design Roadmap (Gershenson, Khadke, and Lai, 2007)

"Product family design is a complex and multi-faceted research topic. It is necessary to approach this topic in a piece-wise fashion, and that is what the design research community has been doing with significant help from the marketing and product development research communities. However, to approach this very large topic without a roadmap that defines the necessary pieces, their relationships, and the manner in which they build upon each other will obviously delay the achievement of the goal and cause great inefficiencies." For that reason, we proposed in 2007 a research roadmap to guide the research community in their individual efforts to achieve a collective research goal. "The single goal that this research roadmap shows is the achievement of robust product family design methods. The roadmap is broken down into four layers – single product factors, product family factors, over-time factors, and robustness factors – each requiring significant research on multiple topics. It is our hope that, using this roadmap, researchers will have a clearer concept of the role of their individual research in the larger community's goals. Additionally, those that are typically outside of the design research community will better understand their role in achieving this collective goal. This research roadmap is not intended to diminish the need for nor the goals of individual research projects. Many of the topics within the research roadmap are important, implementable design research goals in themselves. However, if the outcomes are stated with this roadmap in mind, these individual projects may also serve a greater goal." (Gershenson et al., 2007)

The PlatformingWiki and the roadmap serve similar goals. By shaping the site around the roadmap, it should be possible to identify what portions of the product and process platforming field require the most work, and which are relatively mature. By drawing on the expertise and experience of the entire field, progress towards robust product and process design should become faster and easier, and result in a more useful end product. The wiki should also accelerate both the exploration of this roadmap as well as the reformulation of the roadmap itself over time.

Along with merely filling in the roadmap, a wiki-style site contains unlimited potential for other types of content. We would like to see what would amount to an encyclopedia of platforming related terms, which would allow the establishment of common definitions and enable researchers throughout the field to have a standardized reference point from which to work. By performing this task on a wiki, these definitions will come to an iterative consensus that is satisfactory to the most people in this research community. As this site is a wiki, there exists for every article a discussion page that allows users to debate which changes should be made to an article and why, and all of this occurs in real-time.

The second addition to the content that we would like to see users author is a set of tutorials and case studies that lay out in clear and understandable terms how to implement the design methods described in the PlatformingWiki and also what are the practical results of those implementations. Providing tutorials, would allow design professionals in the field to implement platforming tools without having an extensive background in the field (perhaps a debatably scary feature to include). This would enable the benefits of the platforming field to be realized by a much larger segment of the design community. It is also our hope that design professionals will realize the need to share with PlatformingWiki the end results of their use of the methods the research community has devised, thereby returning the favor and informing researchers on the difficulties of implementation, and showing us where to best focus our energy for the largest real-world benefits. Through this process, it should be possible to validate methods so far tested only in laboratory settings.

Third, we would like users to develop a database of open source product and process information, including bills of materials and processes for product families on the PlatformingWiki, so that researchers have the opportunity to compare work based on a common set of information. By making this data freely accessible, it will be possible to directly contrast various design methods. This direct comparison would allow researchers to identify strengths and shortcomings of various approaches, and allow professionals to quickly determine which methods would work best for them. All of this would occur in an open forum where the community can discuss the information itself and most importantly the results of the use of this information. By doing this, the community then has a one-stop location to acquire data, discuss the data, present results of its use, and discuss those results.

In Figure 2, you can see an early screenshot of the front page of the PlatformingWiki, as it appears to a user when they first visit the page. In this particular iteration, the site design is similar to many MediaWiki (www.mediawiki.org, 2009) implementations, and contains all of the standard wiki features users have come to expect. Notice, even as an unregistered user, there are a number of 'edit' links that are accessible. When these links are followed, it is possible to modify the page content,

even without a registered account. It is our hope to keep this level of accessibility or one as close to it as possible, though if vandalism does become an issue, there are a number of higher levels of security that can be used to limit access to editing functionality. However, it is our goal to maintain an accessible website, so all content will be available to anyone to read. Even if undesirable edits are made, by following the "History" link at the top, every version of the page ever created is available, and it is possible to discard the current version for any of these at any time. To avoid having to do this, there is also a 'discussion' link, which goes to a similar page that is available to post any information or questions that is not yet ready for the main article. Along the left side of the page are a number of links to portions of the webpage of interest to users, including a community portal, current events, lists of recent changes, a link that goes to a random page, and a help file. Below this users can search the website for topics of interest to them. If a page does not exist, the user is invited to create it on their own. In this way, the wiki is able to expand to topics that were not foreseen by the administrator. Below the search box are a number of links that go to special pages that contain utilities to make certain operations possible, like uploading of images or permanently linking to a version of an article. The main body of the page contains an introductory description, along with further information detailing how the website works. In addition, notice the table of contents, and how it closely mirrors the structure shown in Figure 1. As the site continues to mature, it is this structure that will initially be followed, along with a separate structure for dictionary or unrelated encyclopedia entries.
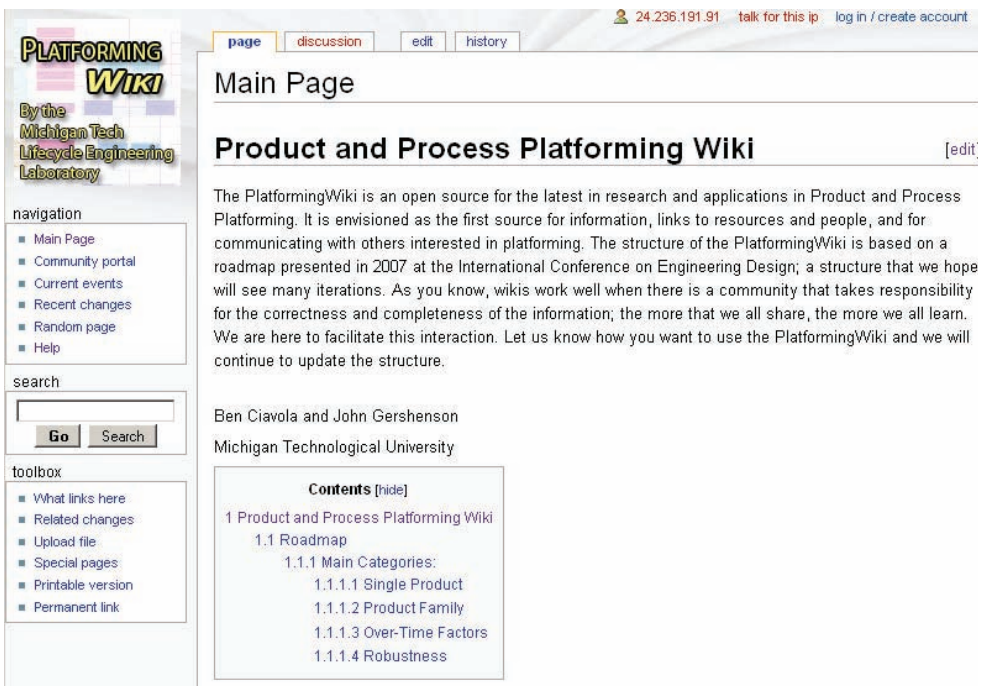

Figure 2: The Product and Process Platforming Wiki front page

3 STATE OF THE ART OF ONLINE SCIENTIFIC COLLABORATION

Since Wikipedia (www.wikipedia.com) came to prominence in the early 2000's, collaborative websites of every type have seen an explosion in usage across the internet, as well as an increase in online collaboration in general. Many of these sites focus on research in academic fields, and have resulted in large, active communities with researchers at many institutions working together towards common goals. In their 2006 book, Wikinomics: How Mass Collaboration Changes Everything, authors Tapscott and Williams make the claim that this new paradigm of communication is causing a fundamental shift in how science is performed. They claim that this new, digital environment will

cause science in the 21st century to be an "increasingly open and collaborative endeavor characterized by: rapid diffusion of best-practices, stimulation of technological hybrids and recombinations; availability of 'just-in-time' expertise and increasingly powerful tools for; faster positive feedback cycles from public knowledge to private enterprise, enabled by more nimble industry-university networks; and increasingly horizontal and distributed models of research and innovation, including greater openness of scientific knowledge, tools, and networks" (Tapscott and Williams, 2006). In support of this thesis, the authors describe a number of websites and projects that have benefited from this approach in the past decade.

One of the biggest successes in this new scientific environment is the Cornell physics website ArXiv.org, a repository for published and pre-publication physics journal articles. Since its founding, the site's mission has expanded and it now describes itself thus, "arXiv is an e-print service in the fields of physics, mathematics, non-linear science, computer science, quantitative biology, and statistics" (Cornell University, 2009). The primary benefit that this site brings to these fields is the ability to disseminate the findings of research as soon as an article is completed, without a lengthy peer review process. Instead, authors can receive feedback directly *via* email from anyone who has read the paper, allowing for many more potential reviewers. This system has become extremely popular, and now hosts over 500,000 academic papers whose full text is available for free to anyone.

While the arXiv.org open, collaborative effort shows the possibilities of free, centralized information dissemination, it is lacking in interactivity and still utilizes a constrictive (though familiar) article format. Unlike a wiki, content on arXiv consists primarily of full text PDF files of the same format as standard published journal papers, which results in the only form of feedback being direct email correspondence with the author. Because of the nature of the files and feedback system, arXiv is truly more of a free scholarly archive than a collaborative community in the style of a wiki.

One website that has taken the next step is MIT's OpenWetWare (ocw.mit.edu), a wiki-based website devoted to the biological sciences. On this page are hundreds of in-depth tutorials on how to perform difficult laboratory operations, course web pages uploaded by professors, general-knowledge biochemistry articles, research group web pages, and blogs. The website describes itself as, "… an effort to promote the sharing of information, know-how, and wisdom among researchers and groups who are working in biology and biological engineering" (MIT, 2009). As evidenced by the enormous community that this site has developed, researchers have found this open and freely-editable resource valuable in their work and use it actively.

Another biology-focused wiki-based group with a very different approach is the WikiProject RNA group, a subgroup of the Molecular and Cellular Biology Wikiproject, which is a group of biology professionals that have organized to update content on Wikipedia itself. Their description states that, "[t]he Molecular and Cellular Biology Wikiproject aims to organise some of the vast amount of information that has been and continues to be collected about genomes, proteomes and cell function which is currently stored in obscure databases and journal articles. This daughter project is focusing on doing just that, for the information on RNA including RNA genes and RNA regulatory elements" (Wikipedia, 2009). The RNA group is particularly interesting because the journal *RNA Biology* will soon require of anyone submitting to their journal that they develop a Wikipedia page summarizing their work (Butler, 2008). This requirement reflects how openness and accessibility of information is becoming a central cause in academic circles, and is being harnessed to improve the freely available technical information on Wikipedia.

For some, the open platform is somewhat disconcerting; given that it is possible to copy nearly any digital source, especially if it is publically accessible. However, there is now a licensing system called the Creative Commons that has developed a set of customizable copyright licenses that are attachable to any work made available on the internet. The Creative Commons website (creativecommons.org) describes the organization's mission to provide "… free tools that let authors, scientists, artists, and educators easily mark their creative work with the freedoms they want it to carry" (Creative Commons, 2009). Thus, it is now possible to protect one's work from plagiarism and theft without sacrificing openness and access.

One wiki-based website, WikiEducator (www.wikieducator.org), uses the creative commons license system to protect the work of its site members. WikiEducator focuses on developing free educational tools and enabling the creation of open education resources. The site also enables educators to network and collaborate to develop funding proposals as free content, and then to submit the proposals

for funding so long as the outcomes of the funded work is freely available and the researchers contribute status updates back to the community (WikiEducator, 2009).

4 COLLABORATIVE USE OF THE INTERNET IN THE PRODUCT FAMILY DESIGN COMMUNITY

Within the design community, there have been a number of attempts at starting open communities, each resulting in various amounts of success. Three of these are the Decision Based Design Open Workshop, The Design Society Special Interest Groups, and the Design Repository at the Missouri University of Science and Technology Design Engineering Lab.

The Decision Based Design Open Workshop (http://dbd.eng.buffalo.edu/) was a series of workshops and a website (that is still available) that was developed by researchers in the late 1990's to fill a very similar niche to the PlatformingWiki in the then nascent decision-based design community. However, it was different from a wiki in that there were a series of face-to-face meetings during which deliverables were developed and posted to the website, and contributions were limited to participants (sometimes selected participants). From these position papers, there was additional work that was done on a community-wide basis on the website to expand the definitions and concepts of the field. Available on the site is a case study simulation, extensive discussion of the engineering lexicon, and all PowerPoint files for each of the meetings that took place. It is apparent that significant amounts of collaborative work took place on the development of the lexicon itself, as well as much other discussion. While the results of the workshops are available online, the last update to the site was in 2004 at the conclusion of the funding, and much of the website is now defunct (Chen *et al*., 2004). In particular, the word list and definitions are no longer available, and it is not possible to access the "Open Research Issues" portion of the website, as critical website functions no longer exist. Thus, while the Decision Based Design Open Workshop appears to have generated a very respectable amount of community interaction, much of the deliverables from this process are no longer available, and thus the website is of limited use today.

The Design Society (www.designsociety.org) operates another webpage that seeks to bring academics together through Special Interest Groups (SIGs). These SIGs consist of groups of researchers seeking to collaborate in their respective fields, though there is no singular method by which they operate. Some of these SIGs have web pages through which members collaborate, but membership and participation is generally limited to professionals within each area of interest. There currently exists a product modularization SIG – a subfield of product platforming in our definition – though there does not exist a webpage on which members might collaborate (The Design Society, 2008). In fact, out of a total of 16 SIGs, only five currently have a website, and, of those, only one appears to have any kind of support for an online community, in the form of a closed forum. As a whole from the outside, the SIG paradigm appears to be more akin to mailing lists with small, focused, closed workshops than it does to a set of online collaborative communities.

The third example, Missouri University of Science Technology's Design Engineering Lab in conjunction with the University of Texas at Austin, the National Institute of Standards and Technology, and other universities has developed a repository of product designs that are freely available for download, and which includes information on subassemblies, bills of material, bills of process, and component relationship data (http://function.device.mst.edu/delabsite/repository.html). This group's work consists of a webpage on which one could access product and process data for a number of different items and automatically generate prototype concepts and output product component-function matrices. Their work so far has catalogued over 130 products and has developed an extensive dictionary (Stone, 2008). This database is, content-wise, identical to a small part of what we wish to develop. The repository has built up a considerable database over the years for which we can easily see a connection to the PlatformingWiki. However, it lacks the critical component of allowing for interaction with users beyond simply uploading new data and features no way to display the results of any research performed using the available data. The force behind which much of it was created was also quite different as much of the data was from students, often undergraduate students, funded to specifically develop data for the repository. This was necessary for the goals of the repository, but contrary to our goals of developing a community behind the PlatformingWiki.

5 EDITING AND CONTENT

Many users, when first confronted with the idea of a website on which anyone can edit any information, have the instinctive reaction to not trust the information, or are afraid that someone might damage or remove any work they put into the website. However, in both cases experience has indicated that this is not the case. A 2005 <u>Nature</u> study (Giles, 2005) compared the accuracy of Wikipedia to that of <u>Encyclopedia Britannica</u> on a number of technical topics, and came to the conclusion that despite the completely open nature of Wikipedia, the articles reviewed were of very similar factual quality to their <u>Britannica</u> counterparts. The article in <u>Nature</u> states that, "[o]nly eight serious errors, such as misinterpretations of important concepts, were detected in the pairs of articles reviewed, four from each encyclopaedia. But reviewers also found many factual errors, omissions, or misleading statements: 162 and 123 in Wikipedia and Britannica, respectively" (Giles, 2005). Likewise, others' experiences show that vandalism is generally not an issue, "[t]he experience with RNA WikiProject suggests that vandalism will not be a big problem; if anything, Wikipedians chipped in to fix typos, add links and generally tidy up the entries" (Butler, 2008).

Another issue that arises when multiple users edit the same document is that it may take time to reach consensus on what is 'correct.' However, the PlatformingWiki, like other wikis, deals with this issue by providing a discussion page for each article that allows users to freely make edits, express their viewpoints, and to respond to other users' comments. In this way, it is possible to debate back and forth about what should or should not be committed to the main article until a consensus is found. The help page for the PlatformingWiki states:

> It is guaranteed that there will be no perfect definition for every term, no perfect answer to every problem, and no perfect approach to the field of product platforming. It is with this understanding that this wiki was created. We are looking to accumulate the combined knowledge of all those involved in product platforming research and provide a forum in which the community can discuss and explore the contradictions, redundancies, and gaps that we hope will make themselves apparent as the wiki develops and its content becomes more representative of the field as a whole.

6 WHO SHOULD USE THE PLATFORMINGWIKI

While Wikipedia is a site geared towards the general populace, the PlatformingWiki is obviously targeted towards a much smaller community: professionals and researchers interested in product and process platforming. We envision that this website will be primarily be used by two types of users: academic research groups - including faculty, senior researchers, and graduate students – and industry professionals – including experts experienced with platforming and professionals looking to learn more about the platforming field. Each type of user will bring particular skills and expertise that will allow the website to become a well-rounded and diverse resource containing many types of information.

The group that we envision as the foundation of the community will be academia, as the primary goal of the site is to enable the identification of aspects of the field of platforming that require the most attention, so that the research community as a whole can progress towards robust product family design as efficiently as possible. Faculty and senior researchers that form the core of research groups will function as resident experts, as they will be the ones with the most experience in the field of platforming. When a user posts an article, claim, or paper on the site, it is the senior members of the community who are likely to be best equipped to respond with criticism, provide perspective, or verify the accuracy of the new information. However, faculty and senior researchers are those who are likely to have the least amount of time available to provide extensive edits and updates, and it is for this reason that we see graduate students as another very important part of the mix of users. We see likely primary tasks for graduate students to be the uploading of the results of research their group has performed, as well as the development of much of the core content, such as early versions of term definitions. Graduate students are also excellent candidates for the (very important) job of article maintenance and formatting, the proper execution of which results in a much more useful and accessible website. We envision these students staying aware of the content on a very regular basis and bringing key components, concepts, and needs to the attention of faculty whenever they arise. This will greatly strengthen the sense of community of the next generation of researchers in this field. New graduate students will benefit greatly from the site as well, as it will provide a concise description of the state of the field as a whole and act as an excellent guide to become acquainted with the field of

platforming. They will also act as usability test subjects, and will be able to advise their research groups and site administrators on how accessible the site is to those unfamiliar with platforming.

We foresee research groups obtaining much value from collaborating on articles with groups at other institutions. Besides the obvious benefits of obtaining multiple points of view, by working together to develop and improve content, groups will have an excellent opportunity to develop relationships with researchers elsewhere.

The second group of users at whom we are targeting this website is industry professionals, whom we view as being of two types: platforming practitioners and those new to platforming. Platforming practitioners are those professionals who have experience applying the philosophy and methods of product platforming to real-world problems. As they are the people with the most experience developing product families and have access to information and data that those in the research community may not, they have a unique perspective on the field. Even if they are unable to share actual numbers due to confidentiality, their view of the direction of the field is highly relevant to research, since they are the ones who stand to benefit the most from advancing the state-of-the-art. We see these users as being more active in commenting on the content of the wikis, rather than uploading significant new content, although it would be great to be proven wrong on this account.

Industry users with less platforming experience, on the other hand, will have a very different use for the site – learning the ins and outs of product platforming so that they might implement the methods. We hope that they will spend significant time reading, learning, and in discussions with the community before implementation. This group is likely to consist primarily of consumers of the information on the wiki, and will spend less time than the other groups contributing back to the articles, at least at first. However, once they have had a chance to attempt the methods described on the site, they will prove to be an excellent resource of information on how to improve tutorials and descriptions. Along with being able to find information on the wiki, they will also have the chance to communicate directly with both industry and research experts so that they will be able to forge relationships with other professionals.

7 CONCLUSIONS

This paper describes the initial development of the PlatformingWiki. This webpage will function as an open, collaborative environment for the product and process platforming community to discuss various aspects of the field and generate a view of the state of the art within the field. This type of page lowers greatly the barrier to entry to new users, and enables many people to work together on the same topic so that each article represents consensus amongst a large group of researchers and professionals.

We envision this page to be used by both academic research groups and professionals in industry, with the contributions of each group adding to and reinforcing those of the other. Academics will provide the pure research perspective on the field, and will perform and disseminate the majority of new information as they complete research projects for publication. Industry professionals, on the other hand, will have the chance to examine the results of the academics' work and then implement these new methods and theories in the real world, eventually returning to discuss the results of their work. This feedback loop should greatly increase both the rate at which academics will know if their findings are correct, and the speed with which new design methods will propagate through industry so their benefits are realized.

Going forward from this initial development, there is still some work to make the PlatformingWiki fully operational. The most important need is to build the initial community that will drive the content. Without this community the PlatformingWiki is just another place for unsubstantiated work or worse yet, just a website for one researcher's work. Now that the structure is in place, we are spending time planning for the growth of this community. This paper is the first step towards that end. We will use this conference as a platform from which to launch interest and involvement in the PlatformingWiki. ICED has the perfect international community based in which to accomplish this, and we look forward to working with the product modularization SIG. A similar effort will be made to advertise the community at the IDETC conference. We think that care must be taken to both advertise the wiki and to explain how wiki communities work.

After creating an active community on the PlatformingWiki, we will then work to expand the community to industry practitioners. We cannot see that they will be eager to participate until there is significant content and activity. It is our hope that this content alone will be a significant draw, but we

anticipate extending invitations to many of those that have participate in research with those in the community and to those companies that are known to have made progress in product and process platforming. From this point, it is up to the community itself to attract those new to the field – the learners.

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