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DRAFT

Understanding Industrial User Experience- An Excerpt from 1st International Workshop on Industrial User Experience (WIndUX 2011)

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ABSTRACT
This paper describes background, problem statement, discussion and results of the 1st International Workshop on Industrial User Experience organized in conjunction with IndiaHCI 2011 conference Bangalore, India,. The workshop focused on discussing what user experience is in the context of hardware and software products in the heavy industry and how it could be measured. The main finding of this workshop is the understanding that in the larger context of the industry, user experience cannot focus only on individual users as in consumer domains. Several organizational aspects come into play in industrial user experience, which requires novel development approaches that could be built on human factors, industrial design, software user experience as well as the traditional engineering traditions.

Categories and Subject Descriptors
H.5.m. [**Information Systems**]: Information Interfaces and representation, (e.g. HCI): Miscellaneous.

General Terms
Human Factors, Design, Theory, Management, Measurement.

Keywords
User experience, automation industry, power industry.

1. INTRODUCTION
The 1st International Workshop on Industrial User Experience was organized in order to bring industry and academia from Information Technology and heavy industry together to discuss practical taxonomy and processes as well as relevant metrics that relate to user experience. The workshop was held in conjunction with IndiaHCI 2011 conference at Indian Institute of Information Technology Bangalore, India, April 7th 2011. Here, we describe the background, aim and scope, discussions and results of the workshop.

1.1 Evolution of Automation
Automation has grown to become an integral part of the ever increasing technology-reliant society. The power grid and the rest of the infrastructure run mostly with little human intervention. So far, the world has seen five major phases of development during the past hundred years (see [1]):

- 1900: Tedious manual work replaced by mechanical automation
- 1950: Mechanical automation replaced by electrical (analog) automation
- 1960: Analog automation replaced by digital automation
- 1970-1980: Digital automation shifts from mainframe to micro and personal computers
- 2000: Optimization of all automation (hardware, software and human performance)

Evolution of automation is an ongoing process. Complex customized industrial automation products e.g. digital control systems that consist of hardware and software have been developed in very much in the same way since the rise of the computers and the digital era in the 60's and 70's. The heavy industry is strongly affected by state-of-the-art of the ICT in each era. Because of this, human-machine interfaces in the heavy industry have consequently evolved through four phases (see [2]):

- 1960: From hardwired panels to computer-based human-machine interfaces
  - Dedicated one-function mechanical switches on operator panel replaced by keyboards
- 1980: From mainframe to personal computers
  - Mouse and color displays

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  - Color coding of information, animation

- 1990: From various platforms to Microsoft Windows
  - More homogeneous implementation technologies than ever before
  - Shift toward general office applications
- 2000: New interaction schemes emerging in consumer markets (e.g. gesture interaction)
  - Radical change in expectations because of generation shift

1.2 Business Drivers in the Heavy Industry

The products in the heavy industry are sold mainly by advertizing functionality and reliability. The latest change of wind is toward optimization of all automated functions to improve efficiency, productivity and safety. The more is automated in a reliable and safe way, the better product is understood to be. Users skillsets needed for efficient, safe and secure operation of e.g. a nuclear power plant or a paper mill are extensive and require years of training after formal higher education. As each power plant is different and each process unique, every installation of these industrial products has to be customized and tested thoroughly. When compared to consumer software, the time from a purchase to a functional installation is not minutes but several months, after which on the job training of the users can easily take another half a year. This phase, called commissioning, from the system provider's point of view is a challenge. A nuclear plant consists of a massive amount of products from various vendors and all the hardware and software should work perfectly together. In many cases, it is not even the system provider's organization that sets the installation up, but a 3rd party system integrator. For example, a control room for a new nuclear power plant is designed by a company specialized in ergonomics whereas the control and supervisory software comes from a system vendor and measurement and control hardware from a third company. In order to provide great user experience (UX) to end-users in this setting, what is actually needed?

1.3 Research and Development Practices

Research traditions have evolved from human factors (HF) to human-computer interaction to design for user experience [3] and that evolution continues today. The engineering tradition is strong and softer aspects of human-machine interfaces have been covered mainly by HF research. HF research, however, is not an integral part of much of the actual product development. HF engineers are generally few and HF work requires high competence. Therefore, significant budgets as well as calendar time in projects is usually seen high in comparison to results that help companies to produce and sell industrial products. Time to market and release cycles are longer than in the consumer domains just because of the engineering effort needed to manage the scale and complexity of the systems. Few companies can afford lengthening those times further, which often leads to research-oriented projects to study end-users and their needs; however their roles are limited to supporting than determining the course of actual product development. In brief, HF work has been staying as a significant research field but has had trouble in penetrating the engineering practice of most companies in the heavy industry [4]. Customers in some industrial domains cannot afford expensive HF consultancy work for creating an equally attractive interface design as what is becoming the standard in the consumer products.

Within the last few years, number of UX professionals has risen dramatically in consumer domains. UX has become a major trend in software development, yet, there are several bottlenecks that hinder getting great design into practice as evident in current discussion [5]. There is much work left for making the ICT industry actually make use of all the best practices that have been developed over the past two decades [6,7]. If the ICT industry does not know yet exactly how to produce great design and UX, is the whole effort in heavy industry hopeless? Or is there an emerging opportunity? Assuming there is a difference between consumer domains and heavy industry, what factors play an important role here? On the other hand industrial design has gained popularity first in consumer domains and now even in the heavy industry (see e.g. [8]).

1.4 Workshop Scope

Against this background, main questions for discussion during the workshop covered were:

- What is Industrial User Experience?
- How to achieve it?
- How to measure it?

The workshop was organized into two sessions. First session focused on tentative taxonomy and the nature of user experience in industrial context. The second session discussed processes and metrics. Each session started with short presentation from the organizers followed by a group discussion of about 50 minutes. Altogether 6 groups (each of 7-8 people) chosen the topic based on the presentation given by organizers. Each group discussion was moderated by organizers by the means of giving clarification of the way of thinking and setting up a good start point.. After the group discussion, results were presented by each group and gathered into a mindmap presentation.

- Including the organizers the workshop attracted 51 participants in total Industry: ABB, Cisco, EMC[2], Fair Isaac Corporation, Hewlett-Packard, Huawei, iNautix Technologies, John Deere India, Microsoft Research, Tata Consulting Services, Samsung, NDS Bangalore and SLK Software Services;
- Academia: Birla Institute of Technology & Science, Blekinge Institute of Technology, Indian Institute of Technology Bombay, Indian Institute of Technology Guwahati, Indian Institute of Information Technology Hyderabad, National Institute of Design, Symbiosis Institute of Design and University of Mumbai.

  The workshop was organized in two sessions each of approximately 3 hours. The first session covered the setting of context and introducing basic concepts of user experience followed by group work on defining user experience from industrial perspectives. After lunch session covered the in-depth group discussions on individual concepts of industrial user experience resulted out of pre-lunch session.

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2. SESSION 1: WHAT IS INDUSTRIAL USER EXPERIENCE?

After an opening speech by Sanjay Tripathi, the first session started with an introductory presentation by Mikko Rissanen. The presentation covered challenges in today's heavy industry as described above and reflected on the differences and assumptions between general ICT and heavy industry. A hypothetical model of industrial user experience and research traditions related to it (Figure 1) was presented with the conclusion that current understanding of what user experience is and what its role could be in heavy industry is poor. UX has emerged in a trend quite recently.

In addition, we went through a number of definitions about user experience as presented by Kari Rönkkö. User experience is today one of the central topics of HCI. A number of conferences have been founded around it, and multitude of different models of UX has been developed. Still, despite the efforts made by HCI researchers there is no commonly agreed definition of user experience or model that has gained wider acceptance. And more importantly for the discussion in this workshop, the current definitions have limited value from practitioners' point of view.

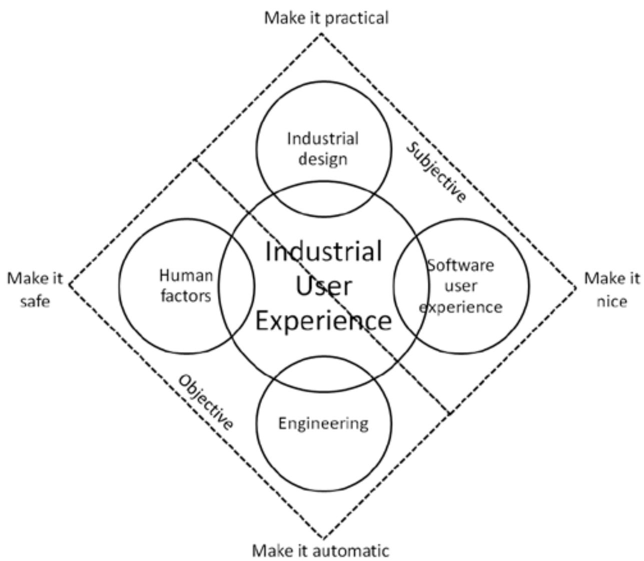

Figure 1. Hypothetical model of research fields related to industrial user experience.

This is because the definitions do not offer means to create proper tools that would help in design work including user experience [9,10]. User experience has recently been given a definition in ISO 9241-210 [11]. Still standardization of user experience is far from reaching the same level of influence as usability has gained [12].

We started listing typical things that are understood as part of user experience from the workshop participants' point of view. The first discussion session produced the following main topics (for which we only list the most interesting examples here). Three major categories emerged:

- General product quality: Adherence to industry standards, security, safety, physical resources used (e.g. energy efficiency), etc.
- Standard usability (as in [12]): Learnability, cognitive load, competence level needed for use, feedback to user, user guidance etc.
- User experience:
  - Individual
    - Ubiquity: Feeling of not needing to control a system. Everything is at your hands.
    - Transparency: Feeling of understanding what is happening inside an automated system.
    - Engagement: Feeling of security, trust, flexibility, customizability, pleasure (physical, psychological, social and ideological), anxiety, and retention of using certain parts of the system.
    - Affordance: Feeling of doing things in relation of giving power to the system.
  - Organizational
    - Total cost of ownership such as product's usefulness throughout its lifecycle.
    - Productivity.
    - Level of integration to the rest of the industrial environment, minimum dependency for collaborative work.
    - Simplicity in terms of organizational training needs.

During the discussion it became evident that it is challenging to think of feeling from engineering background. Interestingly people from usability background had the same trouble. User experience is something that needs to be defined for each product separately.

3. SESSION 2: HOW TO ACHIEVE AND MEASURE INDUSTRIAL USER EXPERIENCE?

Mikko Rissanen started the second session by presenting experiences from successful user experience work and bottlenecks in general development methodology. First example was drawn from development of robotic solutions. A case study [13] shows that a design process of next-generation assembly robots was strongly affected by common user experience design methods which helped a large group of engineering experts to define system requirements.

The second example built on the discussion on practical HF engineering methods [4] stating that a major bottleneck in HF engineering is the assumption that HF research can support actual

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product development as integral part of the standardized processes. Usually, HF engineering is too expensive and slow to be executed in all projects that might benefit from it.

Next, the challenge of metrics was presented. Bevan's discussion [14] on factors contributing to UX and related metrics were reflected against metrics originating from HF research and industry de facto practices.

The discussion session produced perspectives to how to approach the challenge of processes and metrics. There is a large body of human factors metrics and evaluation methods (e.g. NASA-TLX [15] and SAGAT [16]) that have been accepted by the HF research community and the conventional usability methods that start from use case based user testing and have been established as standardized best practices. The practices and metrics in the heavy industry (e.g. [17]) focus on a very much higher level of abstraction. For example, what kind of design on alarm management system of a power plant would deliver what kind of positive UX to which aspects of the power plant organization? To answer this type of questions research is needed. At this point of mature of UX research, we do not yet have a pragmatic approach that could be embedded to product development and commissioning processes in practice.

It is a future challenge to fill this gap in the level of abstraction. When thinking of industrial user experience, we have to move from measurable use case oriented usability and human factors tradition toward higher level of abstraction of industrial best practices and relate industrial user experience to somewhere close to this higher level. It is important to start thinking of industrial user experience in the organizational context in addition to the individual user's perspective.

4. CONCLUSIONS AND FUTURE WORK

Previous research has had difficulties in defining UX in software domains. In this workshop we started the discussion on how UX is even more challenging to be defined in the heavy industry context where organizational factors play a more important role than in consumer software products or internet services. UX in industrial multi-user products require an organizational perspective that builds on the best practices from engineering, human factors and various design traditions. Currently, there are different traditions that use different definitions, methodologies and metrics, which should eventually become a unified pragmatic approach that could deliver industrial user experience.

Future research is needed for defining a logical chain that starts from use case based usability thinking to higher level of abstraction that is closer to the level of industrial best practices. Also an examination from the opposite perspective, from industrial practices toward use case level, could be beneficial in future research.

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6. REFERENCES

[1] Sheridan, T.B. 1992. Telerobotics, automation, and human supervisory control. MIT Press, Cambridge, pp. 7–11.

[2] Totherow, G.K. 2006. Human-machine interface evolution. In Instrument Engineers' Handbook, 4th Edition, Vol 2: Process Control and Optimization. CRC Press, Bela Liptak, pp. 790–804.

[3] Grudin, J. 2005. Three faces of human-computer interaction. IEEE Annals Hist. Comput. 27, 4, 46–62.

[4] Andersson, J., Bligård, L-O., Osvalder, L-A., Rissanen M.J., and Tripathi, S. 2011. To develop viable human factors engineering methods for improved industrial use. In Proceedings of the Human-Computer Interaction International (HCII 2011). LNCS, Springer. (To appear)

[5] Hong, J. 2011. Matters of design. Communications of the ACM 54, 2, February 2011.

[6] Gulliksen, J., Boivie, J., Persson, J., Hektor, A., and Herulf L. 2004. Making a difference: a survey of the usability profession in Sweden. In Proceedings of the third Nordic conference on Human-computer interaction (NordiCHI '04). ACM, New York, NY, USA, 207–215.

[7] Gulliksen, J., Boivie, J., and Göransson, B. 2006. Usability professionals—current practices and future development. Interacting with Computers 18, 568–600.

[8] Keeping, S., Tinggren, R. and Leffler, N. 2004. Looking good. In ABB Review 4/2004, ABB, 6–12.

[9] Kuutti, K. 2010. Where are the lonians of User Experience research? In the proceeding of NordiCHI 2010, October 16-20. Reykjavik Iceland.

[10] Roto, V., Lai-Chong Law, E., Vermeeren, A.P.O.S., and Hoonhout, J. 2010. User Experience White Paper. http://www.allaboutux.org/files/UX-WhitePaper.pdf (last visited 2011-05-11).

[11] International Organization for standardization, ISO 9241-11 1998, Ergonomic Requirements for Office Work with Display Terminals (VDTs) – Part 11: Guidance on Usability.

[12] ISO DIS 9241-210:2010. Ergonomics of human system interaction – Part 210: Human-centered design for interactive systems (formerly known as 13407). International Standardization Organization (ISO). Switzerland

[13] Björndal, P., Rissanen, M.J., and Murphy, S. 2011. Lessons learned from using personas & scenarios for requirements specification of next-generation industrial robots. In Proceedings of the Human-Computer Interaction International (HCII 2011). LNCS, Springer. (To appear)

[14] Bevan, N. 2008. Classifying and selecting UX and usability measures. In: COST294-MAUSE Workshop: Meaningful Measures: Valid Useful User Experience Measurement.

[15] Hart, S. G., and Staveland, L. E. (1988) Development of a multi-dimensional workload rating scale: Results of empirical and theoretical research. In: Hancock, P. A. & Meshkati, N. (Eds.), Human Mental Workload. Amsterdam. Elsevier.

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[16] Endsley, M.R. (1995) Measurement of Situation Awareness in Dynamic Systems, Human Factors 37, 65–84.

[17] EEMUA 191: Alarm Systems. A Guide to Design, Management and Procurement. ISBN0859310760. (1999) http://www.eemua.co.uk (last visited 2011-05-26).