Keyword Mingling workshop - a method for identifying and consolidating industrially perceived needs and requirements of future operators

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ABSTRACT

Investments into the production technology of the future require a firm basis in the needs of production industry. However, gathering, sorting and ranking cross-industrial future needs remains a steep challenge to technology developers. Gathering feedback from just one or a few case companies can result in a biased set of priorities, since feedback from specific industrial sectors may often be highly influenced by their industry- and product-specific challenges. This paper describes a structured method called “Keyword Mingling” that addresses the collection of such feedback in a multi-partner workshop format.

The workshop method presented in this paper resolves this by using a highly interactive "mingling" technique to get participants in a large group workshop (between 15 - 20 people) to answer a specific question. The participants discuss ideas in smaller groups, share their findings to the group at large, co-operatively organize the input from all participants into functional categories, and finally perform a 'ranking' of the results. The outcome is a prioritized list of concerns to focus research efforts on, providing workshop analysts with a finished structure for reporting the results. The method was tested in two workshops within the project "The Operator of the Future" and resulted in plenty of positive feedback from participants, who felt that the input was relevant, well-structured, and easy to agree with due to the consensus categorizing.

Keywords: workshop, interactive, consensus, needs identification, requirements

1. INTRODUCTION

One of the greatest challenges facing Swedish manufacturing industry today is that of preparing proactively for the future. The world is constantly shifting, in a macro- and micro-perspective, in terms of economic developments, demographics, technological familiarity and accessibility, cultural awareness, global competition, new markets, environmental concerns and resource management. In light of all this, Swedish manufacturers also face the challenge of being a small but knowledge-intensive country that primarily benefits from a cross-sector approach when developing new industrial technologies. Some envisioned needs [1] for this future state of Swedish industries include:

- Both radical and incremental innovations;
- Developing production system concepts beyond *Lean*;
- Developing strategies for *Corporate Social Responsibility*;
- Communicating an *updated identity* for industrial workers in order to increase young people’s understanding of what the profession means;
- Encouraging gender equality and cultural diversity in the workplace;
- Developing industrial work environments;
- Encouraging participative processes in the workplace.

Investments into the technology of the future require a firm basis in the perceived future needs of production industry, in order to support necessary developments of systems, operative challenges, and the well-being and competence of operators. Due to Sweden’s modest size, it is of national competitive interest that technological research efforts should involve and benefit as many diverse industrial sectors as possible. Gathering feedback from just one or a few case companies may be a usual and pragmatic approach, but can result in a skewed or biased set of priorities, due to the fact that feedback from specific industrial sectors may often be highly influenced by their industry-specific problems and product-related challenges.

One way to approach this challenge is to invite representatives from a wide range of industrial sectors to discuss the future needs of Swedish manufacturing

industry in a workshop format - something which was done in the project “The Operator of the Future” [2], carried out in the first quarter of the year 2012.

However, the gathering, sorting and ranking of industrial needs and requirements in a workshop format remains a steep challenge to technology developers. A study from 2004 by Engelbrektsson and Söderman [3] showed that eliciting user requirements in the early stages of a product design process has been dominated by one-to-one interviews and questionnaires, rather than group elicitation techniques such as clinics and focus groups. In the case of this project’s aspiration for visionary consensus, getting companies from many different industrial sectors to meet and agree on what their future operators need can be logistically and conceptually difficult, which emphasizes the need for such workshops to be effective, fair and clearly structured.

Literature on how to carry out workshops is often of a pragmatic and diverse nature, and primarily practical rather than academic. Exceptions to this exist but tend to be profiled towards a specific goal of application, e.g. “Consensus conferences” and “Scenario workshops” geared at non-expert input toward policy-making [4] or participative product design methodologies, such as the “Future Technology Workshop” [5]. There are no hard and fast rules on how to correctly handle the information that can be elicited from a workshop format, and for certain proactive ‘probing’ endeavours such as “The Operator of the Future”, the intent is to quickly consolidate a fair and common vision among participants rather than to generate research data.

Among other methods for gathering expertise and consensus on a forecasting or issue identification/prioritization subject, perhaps most famous is the *Delphi Method* [6],[7],[8]. Frequently lauded as a rigorous and well-established pathway towards consensus among a group of experts, Delphi studies generally involve input from experts through a survey format, in order to preserve their anonymity toward each other. They are asked to give input on the subject in several rounds, gradually arriving at a reliable consensus answer [8]. Ranking-type Delphi studies also exist, with the purpose of arranging the importance of issues in a priority list [9].

Critique of the Delphi method includes the considerable time taken to reach consensus due to multiple rounds of input from experts (sometimes with time delays). To improve the speed of the process, Gordon & Pease [10] designed a “real-time” Delphi method based on simultaneous participation of several experts via computer, to gradually work towards a consensus via real-time updated graphics reflecting the input of the other participants, while maintaining their anonymity. This eliminated the “rounds” procedure that typically consumes a lot of time in Delphi studies.

Although the lack of direct confrontation between the consulted experts is thought of as a strength of a Delphi study, it was not suitable for “The Operator of the Future” due to a parallel conflicting goal of the project; namely to intentionally bring industrial companies together to meet and collaborate face-to-face and establish an awareness among partners of the profitability of developing cross-industrial technology and subsequently openly recruiting some companies as testing grounds for that technology.

The workshop method presented in this paper resolves this by using a highly interactive "mingling" technique to get participants in a large group workshop (between 15-20 people) to answer a specific question, co-operatively organize the input from all participants into functional categories, and finally perform a 'ranking' of the results. The functional categorizing builds a consensus among workshop participants regarding which results are similar and cross-industrially relevant, and also provides workshop analysts with a finished structure for reporting and prioritizing the results. The paper is intended as a “how-to” exercise, with our reported experiences of using it in the context of the two workshop sessions – participants came from companies based in different locations all over Sweden, although one workshop had participants mainly from process industry while the other had participants mainly from workshop industry.

Fig. 1: Ongoing workshop discussion

The method was tested in two workshops within the project "*The Operator of the Future*" (Fig. 1) and resulted in plenty of positive feedback from participants, who felt that the input was relevant, well-structured, easy to agree with due to the consensus categorizing, and also that the event as a whole was a good opportunity to mingle with and learn from a variety of representatives from different industries.

The name “Keyword Mingling” comes from the gathering of input in the form of keywords on sticky notes, generated at first in smaller sub-groups in the room and later in a plenary form. The ‘mingling’ happens when participants listen to each other's input and then assemble related keyword notes into combined functional categories, which they themselves write a suitable heading for. Then, each represented company at the workshop is asked to award points to the most important categories for continued focus and

efforts. Finally, the points given are summed up, resulting in a ranking of the identified categories from most to least prioritized.
Another treatment of this study is described in Andersson and Osvalder [11] who used the workshop outcomes to map the data onto a cognitive systems engineering model, but their paper is based on different data (only one of the workshops described here, combined with a workshop not described here).
To summarize, the aim of this paper is to present an open-forum method for gathering input and achieving a ranked consensus of which technologies to focus future research efforts upon. The method is intentionally geared towards open, non-anonymous workshops with a double purpose of strengthening partnership and dialogue between partners, rather than keeping them separate and anonymous to each other.

2. METHOD AND EXECUTION

The general format of the workshop was to invite representatives from many different industrial sectors to a one-day workshop (approximately 6 hours in length, including breaks and meals) to give their views on what their own industrial sector would look like in the future (on a perspective of 5, 10 and 20 years ahead) and to reach a consensus within the group of which technological developments would be of greatest benefit to Swedish industry as a whole. The authors functioned as a research team who chaired, moderated and recorded the workshop results. One author acted as moderator for the session, alerting participants to the times allotted to each activity. The other authors were tasked with taking observation notes or collecting the data from the different activities (see section 2.5).

2.1. Formulating main questions

For the greater purpose of the workshop to be fulfilled (i.e. achieve a consensus of which future technological developments should be concentrated upon for the benefit of Swedish industry), it was considered important to formulate a limited number of main questions to guide the workshop. In order to not presuppose and thereby skew the results, it is important that these main questions remain fairly broad and needs-oriented rather than conceptual (i.e., depending too much on a particular concern). In the observed case, the two following questions were used to guide the consensus building:

- Which tasks must the operator of the future carry out?
- What does the operator of the future require to achieve those tasks?

In this case, there was a clear connection between the two guiding questions, as the answers to the second one depended on the results of the first one. This connection provided continuity in the discussions.

2.2 Recruiting participants

The aim of the workshop(s) was to provide a wide and diverse representation of Swedish industry and to establish what kind of technology development could serve their most common, cross-sector needs. In the case of the two observed workshops, participants were chiefly recruited from companies that would be potential *users* of technology to solve future operator challenges.

Each company was represented by between 1 to 5 people on a voluntary basis. 25 industrial representatives from 15 different Swedish companies participated, representing the mining, automotive, metals manufacturing, nuclear power, defence, packaging and medical equipment sectors. Participants were also from a variety of job types, including research and development, purchasing, sales and shop-floor workers. Table 1 shows the sector and number of participants for each workshop.

Table 1: Sectors and participants

	Sector	No. of participants
Workshop 1	Process industry Mining, steel manufacturing, metals, nuclear power	9
Workshop 2	Workshop industry Automotive, packaging, medical products, manufacturing, defence	16

2.3 Location and materials

The workshops were held in two different conference locations in Sweden. In order to facilitate the collection and structuring of the workshop, some basic requirements on the locations and supplied materials were established.

Location amenities
A room large enough for about 20-25 participants is most suitable for this type of workshop. The room should allow participants to sit together for plenary activities (e.g. along the sides of a long table) and to separate into smaller groups of about 3-5 people (additional standing tables may be suitable for this). It is necessary to have large empty wall spaces that can be written upon, such as a whiteboard (preferably more than one). A projector for showing introductory slides is optional but recommended.

Materials
The participants were provided with the following materials:

- A schedule/agenda for the day
- Note-taking materials
- Pens
- Coloured sticky notes (one specific colour was assigned to each participating company, in order to trace feedback to that company)

- Separate, smaller sticky notes (1/2 width of the regular notes) with the numbers 1, 2, 3, 4 and 5 – one set for each company
- Whiteboard pens for the group exercises

2.4 The workshop process

Preliminaries
Each workshop was commenced with a round of introductions (during which different colours of sticky notes were assigned to each company) and a short run-through of the day's objectives and schedule, chaired by the session moderator. For the purposes of this particular workshop theme, there was also an initial "inspirational lecture" about emerging technologies that had been imagined in science-fiction movies and years later been realized and commercialized in the form of existing modern technology such as smartphones, video conferencing, motion capture etc. The purpose was to set a tone for the workshop that allowed the participants to imagine freely what kinds of technology did not exist today but might become a reality in the distant future.

Keyword Mingling based on questions
Two question sessions were held during the course of one workshop, one for each question determined in section 2.1 and lasting about 75 minutes each. At the beginning of each, participants were split up into small discussion groups of 3 – 5 people (based on similarity of industrial sector) and then shown the question for the first time (see 2.1). The time was then spent as follows (times are approximate):

- 10 minutes writing keyword answers individually on the sticky notes
- 10 minutes discussing these together with other participants in the small groups
- 5 minutes arranging the notes on a common space (whiteboard) alongside those of other groups.
- 15 minutes where each group presented their ideas via one selected member
- 15 minutes of "Keyword Mingling", where all participants were asked to rearrange sticky notes on the group area into functional categories that reflected similar concerns, and to write headings for each of these groups in consensus
- 5 - 10 minutes discussion of the different groups, splitting of or consolidation of similar categories
- 5 - 10 minutes of each company awarding the most interesting categories points using the smaller sticky notes – the most interesting categories earned 5 points, the second most interesting 4, etc. (Fig 2)

Fig. 2: Rearranged functional groups of keywords (large sticky notes) with headings written by participants and ranking points (small sticky notes). The different colours allow tracing of ideas back to a specific company.

2.5 Summing up and collecting the feedback

Two questions (2.1) were addressed according to the procedure described in 2.4. The functional groups, headings created by participants and the points awarded were photographed, then the points were added and recorded, and finally all the sticky notes were collected group-wise on separate sheets of paper with the heading written out. This maintained the integrity of all the collected data, and the colour codes made it easy to establish which ideas and concerns stemmed from which company. Also, the points allowed the researchers to quickly sum up the group consensus about which areas were the most important by ranking the groups by the number of points they had received in total.

The workshop was wrapped up with a discussion of how well the participants agreed with the resulting ranking, which allowed all parties to weigh in with any corroborating or differing opinions or reservations. At the end, the participants were thanked and were informed that the results of their particular session would be distributed to them shortly after the workshops.

3. EXPERIENCES OF USE

Since most of the method use has been described in section 2, this section will mainly summarize the way that the results from the two workshops were presented as a consequence of the Keyword Mingling format.

Consolidating the workshop results
The way that the participant input was generated and grouped allowed each session's results to be easily "harvested" by the research team, as described in 2.5. The workshops generated 19 categories of concern for Question 1 (tasks) and 14 for Question 2 (requirements). It was possible to decide whether similar categories brought up in each separate workshop could be consolidated into one, thanks to the retention of the original keywords and the 'tracking

colours' of each company. This allowed the authors to determine whether concerns brought up independently of each other in different workshops had been addressed to similar challenges.

Ranking simplifies prioritization of concerns
Thanks to the summing up of the points for each named category, it was easy for the authors to identify which concerns were considered the most interesting across the industrial sectors. Table 2 and Figure 3 illustrate the results of the ranking (and where the 'cutoff' level for the top 6 concerns lies) for the Task and Requirement questions respectively.

Table 2: Task ranking (Top 6)

Workshop	Category	No. of points (out of total: 235)
1, 2	Communication	46
1	Interpretation (of what is happening)	42
2	Increased control over systems	32
2	Analysis	25
1, 2	Competence	22
1	Adjustments	22
	TOTAL TOP 6	**189 (80.4%)**

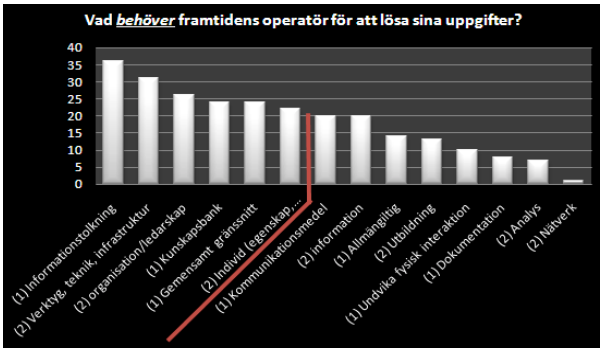

Fig. 3: The 'cutoff' principle is illustrated for the Requirements session, using the point ranking from the workshops to determine the 'top 6' concerns to address in future research endeavours.

Contents of the categories
The categories were easily elaborated upon thanks to the collecting of keywords in category groupings, allowing the analyst to rearrange the collected keywords in a format that allowed for structured reporting. Also, the colour code provided the possibility to note any trends or similar concerns among companies. This added to the strength of any claims that certain concerns might be of interest across sector boundaries, or chiefly the concern of a specific industry.

4. RESULTS

The results of the two workshops on the 'Top 6' level were as follows:

Tasks of the Operator of the Future
The question of which tasks the operator of the future must complete were elaborated as follows in the workshops.

- *Communication* – this was considered the most important task in both workshops. The category covered aspects ranging from operator roles, mandates, technology access, support systems, capturing of quality issues in production, levels of communication (departments, hierarchy, team change-overs) and the importance of a common taxonomy or language.
- *Interpretation (of what is happening)* – being able to recognize and correctly interpret different operative stages was considered important in Workshop 1. This concerns recognizing "clues" and being able to identify their role in complex processes, continuously interpreting situations and taking correct action.
- *System control* – the participants of Workshop 2 emphasized that future operators must be able to measure, follow up and interpret ongoing processes and conditions. This includes an ability to predict chains of events, and adaptively optimize processes, control errors, alarm protocol and keeping instructions updated.
- *Analysis* – participants in Workshop 2 found it important to analyze data to identify cause-and-effect relations in order to improve processes, products and allocation of resources. A prerequisite for correct analysis is the ability to specify and identify main tasks in a system.
- *Competence* – both workshops addressed the importance of competence. Competence was sub-categorized by the participants as being of two types in operators (deep specialist competence and flexibility) and another one in leaders (coaching abilities and being able to handle the characteristics of different age groups, e.g. IT competence).
- *Adjustments* – in Workshop 1, two types of amending tasks were identified – one is an operative competence, i.e. being able to judge a situation and act accordingly to identify and eliminate sources of error, while the other involves more long-term planning and working in a problem-solver mode, including reporting, repairing and following up.

Requirements of the Operator of the Future
The question of what the operator of the future needs (e.g. in terms of support, infrastructure and technology) in order to fulfil the tasks described in the previous session was described as follows:

- *Information interpretation* – the operator of the future must be able to correctly interpret their working surroundings in order to act as a part of it. This category detailed the visualization needs of

operators, sorting functions, testing/simulation possibilities, being able to search for information, prognostic tools and personalized, portable information carriers.

- *Technology* – this category was a multifaceted point of discussion in both workshops. Most input from participants appeared along a continuum with two extremes: on one hand, simplicity, overviews and usability were considered a main concern, while on the other end the need for companies to "dare" to let new, innovative and advanced technologies into their workplaces was discussed. A large part of the discussion was about how such new technologies could facilitate person-to-person communication. The need for technological infrastructures was also discussed, e.g. platforms, networks and consolidation of control systems into the same user interface. Better ergonomics and HMI (human-machine-interaction) were themes that reappeared several times in these discussions.
- *Organization* – participants' views on this subject concerned the need of more coaching and supporting abilities in the leadership of the future. Other aspects were corporate culture, incentive systems, career paths in the organization, mandates, knowledge support and strategies to address high as well as low engagement levels among operators.
- *Body of knowledge* – in workshop 1, participants brought up the importance of having a good "bank of knowledge" to turn to in order to perform a variety of cross-disciplinary tasks and in order to facilitate knowledge transfer and training.
- *Common user interfaces* – this category, brought up in Workshop 1, concerns issues of being able to provide a good user interface that unites solutions for interpreting data, getting an overview of complexity and controlling systems and machinery.
- *Individual capacity and competence* –this category was one that was consolidated from two originally separate categories (both from workshop 2). Competence chiefly concerned the duality mentioned before, i.e. the specialist knowledge and the breadth, flexibility and adaptability. Participants described the characteristic operator of the future as an analytical team player with technical prowess who is willing and motivated to learn, to improve and take responsibility for his/her work tasks.

5. CONCLUSION

The authors find that the Keyword Mingling method provides great possibilities to reach a clear consensus among a diverse group of industrial technology users. The method is particularly suitable for situations where a parallel goal to collecting feedback and achieving consensus is to create a collaboration forum where the participants are intentionally introduced to each other and encouraged to engage in future collaboration within the project. Another reason for this time-limited non-anonymous format could be to shorten the time frame until consensus is reached (compared to the time it takes among Delphi study participants). The structure of the method provides a good "backbone" to a short one-day workshop format, keeps the participants continually aware of the progression of the consensus-building, allows the 'tracing' of specific answers and concerns back to a certain company (via the colour coding) and provides a semi-quantitative measure of the strength of the consensus (using the colour-coded points ranking system). All of these factors were observed to simplify the process for the research team to carry out post-workshop analysis with confidence. The results are brought back to participants in a ranked format that they recognize, and the participants also acknowledged on-site that the workshop setup was a good learning experience and forum to meet and discuss common future issues with a wealth of expertise from Swedish industry.

6. ACKNOWLEDGEMENTS

The authors thank all participating company representatives that supported and gave input to this study. The work was financially supported by Vinnova. We would also like to thank the anonymous reviewer who suggested amendments,

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