The market as a driving force : the role of user groups

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Introduction

This article draws on experience gained in two major development projects with significant trade union involvement. The case studies described centre on developments in safety and health in the Swedish metal manufacturing industry.

With support from government funding for the now-defunct Swedish Working Life Fund, companies, tool manufacturers, unions, end-users, designers and researchers pooled their efforts to develop new products and practises relating to the use of hand tools. The projects were major undertakings in which the best-available national expertise was recruited and firm industrial commitment was achieved. There was a participatory aspect to both projects, involving end-users as well as union representatives.

The projects differed sharply in focus and design, reflecting the particular conditions met in the product areas addressed. The basic philosophy could be summarised as follows :

- A large share of the work-related injuries and diseases in manufacturing industry may be attributable to the use of hand tools.
- If major Swedish companies were to present united demands for better hand tools to be available, this would be an incentive to manufacturers and dealers.
- Benchmarking between companies with respect to choice, problem-solving, and use of hand tools could be much more efficient.
- Participation of end-users in the project would help to articulate demands in user terms, and facilitate the development of more efficient and user-friendly tools, as well as acceptance of new, improved tools as they become available.

It could be said that the participatory approach taken in the projects implied recognition of the operator as the expert on his or her work.

Case Study 1 : The Swedish Hand Tool Project

Background

The focus of the first case study project was "to turn the ten most frequent problem tools in Swedish manufacturing industry into new products, ergonomically well-designed and commercially available". Six major companies united in an orchestrated effort : ABB, Saab Automobile, Samhall, Scania, Volvo Trucks and Volvo Cars.

As noted by Kardborn (1998), there were three fundamental ideas forming the basis of the Swedish Hand Tool Project :

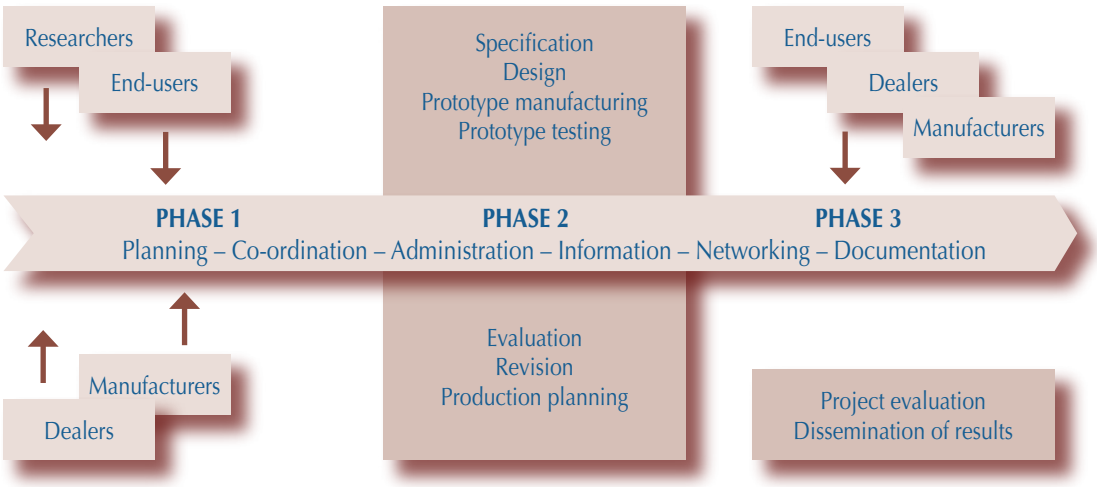
- There was a user-centred approach, facilitating inputs from end-users of hand tools.
- Increasing the knowledge base within the companies was essential in order to create acceptance and understanding of the qualities of the new products.
- It was necessary to create a project organisation that supported simultaneous activities in and information flow between the different groups.

Project design

A steering group was formed for the project, consisting of :

- the working group chairs ;
- representatives of the participating companies (the project owners) ;
- a representative of the financing agency ;
- a representative of the Swedish Metal Workers Union ;

Figure 1 : The Swedish Hand Tool Project (adapted from Kardborn, 1998)
Marketing, information and training activities were carried out throughout the project.



- a representative of the Swedish Association of Engineering Industries.

The project design is illustrated in Figure 1. Four different working groups were formed :
- end-users (the participating companies) ;
- Swedish tool manufacturers ;
- tool dealers (wholesale companies and representatives of foreign tool manufacturers) ;
- researchers (engineers, ergonomists, designers, physiologists).

A main responsibility of the **User group** was to identify the problem tools. It would also support evaluation of prototypes and participate in educational and information activities.

The **Tool manufacturer group** would consider the list of problem tools, identify suitable actors and contact designers. It would support the development of prototypes, and make them available for testing against the requirements and for comparison with existing standard tools. Finally, the new tools would be made available to users and marketed.

The **Dealer group** would scan the market for existing good products that may not have achieved general acceptance. They would also participate in educational activities. When new project tools were developed by manufacturers, this group would give support to making the ergonomically improved products available to end-users.

The role of the **Research group** was to :
- make scientific knowledge relevant to hand tool design available to the project consortium ;
- develop methods for inventorizing and prioritising problem tools, and collecting user demands ;
- develop ergonomic specifications for the project tools ;
- apply science-based methods for the evaluation of tools and prototypes ;
- document the project results and report to the scientific community.

Material, methods and results

Identification of problem tools

In order to obtain a list of problem tools, a report form was distributed to end-users from within the six participating companies. About 400 reports were received back to the project management group. In prioritising project tools, a number of aspects were considered.

In order to evaluate these reports against the project intentions, a list with weighting factors was developed, assigning different levels of importance to different types of problems reported.

Tools were required to :
- be assigned a high problem weighting ;
- feature in more than one report ;
- be of concern to many end-users ;
- feature in official statistics of causes of reported occupational accidents and injuries ;
- be strategically chosen (represent a range of tools) ;
- be a standard item in an ordinary tool-box ;
- not have been the focus of recent ergonomic development projects ;
- be able to be reasonably developed within the project framework ;
- have the potential to be manufactured in Sweden (not mandatory).

The complicated process of project tool selection resulted at the end of Project Phase 1 in ten project tools, for each of which a development project was launched.

Specifications

Once the project tools had been identified, the specification project started, applying a consumer technology approach. The "yellow sticker method" was applied as a validated way to arrive at identification and articulation of user demands. This method was applied in local groups in the participating companies. A group would ideally consist of 3-6 end-users, a supervisor, an expert from the health care services (an ergonomist, a nurse, a safety engineer or a doctor), an engineer from the technical support services, and a member of the purchasing department. Each participant was given a set of yellow self-adhesive stickers, and was asked to write down any type of demands that a tool of the category should fulfil, one demand on each sticker. After a few minutes, the stickers were collected in by the local convenor and a session followed where they were posted on a whiteboard, in groups of stickers addressing related types of demands. Each demand group was then discussed by the participants, and the views noted by the convenor.

The yellow sticker method served essential purposes in the tool specification process. In the identification of demands, operators were given the same opportunities as the supervisor or the expert to express views – irrespective of hierarchies. The session also contributed to a common understanding of the problems associated with an existing tool. The end-users were given a clear role in the process, and their experience was acknowledged.

Following the inventory of user demands, the research group developed an ergonomic requirements dossier containing specifications for each project tool in the form of :
- a definition of the tool ;
- a list of user-specified demands ;
- a list of ergonomic demands ;
- a list of technical demands ;
- a checklist relevant to all kinds of hand-held tools and machines ;
- references to existing standards and authoritative publications.

These specifications were used subsequently as a starting point for the testing of tool prototypes developed in the project.

■ The tool development projects

Tool manufacturers joined with designers appointed by the project to develop functional prototypes. Tests were carried out by experienced users called in for the purpose. The tests included (a) comparison checking of prototype tool characteristics with the tool specifications, and (b) comparative testing using a standard tool as reference.

The choice of methods for testing was based on previous research on evaluation of hand tools (e.g., Kilbom *et al.*, 1993). Users were interviewed about the tool characteristics with reference to the user demands articulated in the tool specification.

To facilitate evaluation of new tools and prototypes, and the choice between existing tools, a guide, *A Good Hand Tool – Check yourself !* was applied. The guide was essentially a checklist which users could use to assess tool performance against a number of properties considered important in terms of ergonomics and productivity.

What were the project outcomes ? The development of new tools for the market is summarised in the table below, which shows that new versions of most project tools were made available in the project.

Project tool status

Tool	Status
Engineer's hammer	Marketed
Knife	Marketed
Crimping tool	Marketed
Ratchet	Marketed
Hex key	Marketed
Wire brush	Marketed
Plate shears	In process
Cable stripper	In process
Band cutter	Not adopted
Spanner	Not adopted

Source : Sperling *et al.*, 1997 ; Kardborn 1998

Concluding remarks

It was concluded by Sperling *et al.* (1997) that, "The Swedish Hand Tool Project became an arena of a network of actors. The large scale project drew attention in industry and made the importance of ergonomic hand tools obvious. Interaction between research and practice, on basis of user requirements, was found to be a fruitful model in product development. Ergonomically improved non-powered hand tools were developed, and improved work with powered hand tools was made the goal of a subsequent project. Methods for comparative evaluation of hand tools were tried and improved in subsequent projects."

Kardborn (1998) in his project evaluation, concluded : "The user-centred approach was basic to the Swedish Hand Tool Project. User participation of two kinds, representatives for end-users as well as actual end-users, was an effective method that provided important information for the specification, design and evaluation of improved hand tools. As shown by the Swedish Hand Tool Project, the mixed strategy of design *for* users, *with* users, is successful."

Case Study 2 : The Powered Hand Tool Project

Background

A group of major Swedish manufacturing companies decided to launch a joint project based on needs and experiences with respect to the use of powered hand tools, and on the results of Case Study 1. It was realised that the problems concerning powered hand tools differed from those encountered in the use of non-powered hand tools :

- the tools are generally heavier ;
- precision grips are less common ;
- actuators need to be operated ;
- cords (electric or pneumatic) or batteries add to the handling strain ;
- shocks and vibrations are common ;
- powered tools are generally more expensive and often system-dependent (i.e., pneumatic tools require compressed air supply).

It was realised that the risks involved in the use of powered hand tools could only be addressed to a limited extent by modified tool designs, and that other factors, like workplace design and work organisation, might be equally important. It was also thought that there were administrative obstacles to acquisition of the best possible tool on the market for a certain application, involving economic constraints, conservatism, and hidden agreements between purchasers and suppliers.

The project aims were formulated as follows : "The main intention was to reduce injuries caused by hand held powered tools, by demonstrating how to be able to decrease exposure to work with such tools, and to show how machines can be improved in order to make possible safe use for all of operators."

Operative goals included :

- To influence powered tool manufacturers in order to bring about development and marketing of ergonomically optimised tools. So-called "concept machines" would be developed within the project in order to demonstrate ergonomic solutions and increase awareness among manufacturers, end-users, and purchasers of tools.

- To show how the production situation could be changed in order to reduce the risk in working with hand-held powered tools.
- To demonstrate how better product design could reduce the use of powered tools in production, and to explore how production experience may be fed back more efficiently to product designers.
- To disseminate within the project companies information on successful interventions where medical, technical and organisational measures had resulted in good working conditions for employees sick-listed due to working with hand held powered tools.

Another stated goal was to inform other companies and actors about the project outcomes.

Project design

A consortium of seven major tool user companies - Asea Brown Bovery (ABB Support), Electrolux, Saab Automobile, Saab Scania, Samhall, Volvo Cars, Volvo Trucks (associated), VME Excavators - was formed to formulate and run the project. Figure 2 illustrates the organisational structure of the project.

A steering group was formed to oversee the project and to facilitate the dissemination of results. It comprised representatives of :

- the seven project-owning companies ;
- the Association of Swedish Engineering Industries ;
- the Swedish Metal Workers Union ;
- the Swedish Institute of Production Engineering Research ;
- the Swedish Working Life Foundation (financing body).

The project was subdivided into the following activities :

1. Identification of problem tools.
2. Development of prototypes showing the potential for alternative, ergonomic tool design.
3. Documentation of technical and organisational solutions developed in industry, and dissemination in a benchmarking effort.
4. Development of reference workplaces in industry.
5. Development of models for ergonomic feedback from users and production engineers to product designers.
6. Development of educational material.
7. Development of a checklist to be used in tool acquisition and a model for ergonomic evaluation of work with powered hand tools.
8. Documentation of good practices in rehabilitation of users of powered tools.

For each project tool, a task force group of industrial designers was established and instructed to work with "the problem owners" among the companies to develop and test out prototype tools. The design process was user-oriented. For instance, end-users in the participating companies were asked to keep diaries of the use of the particular tool and provide a commentary to the designers.

Material, methods and results

The project tools

Problem tools were identified through questionnaires filled in by users, scientific evidence, and the informed opinion of responsible company personnel.

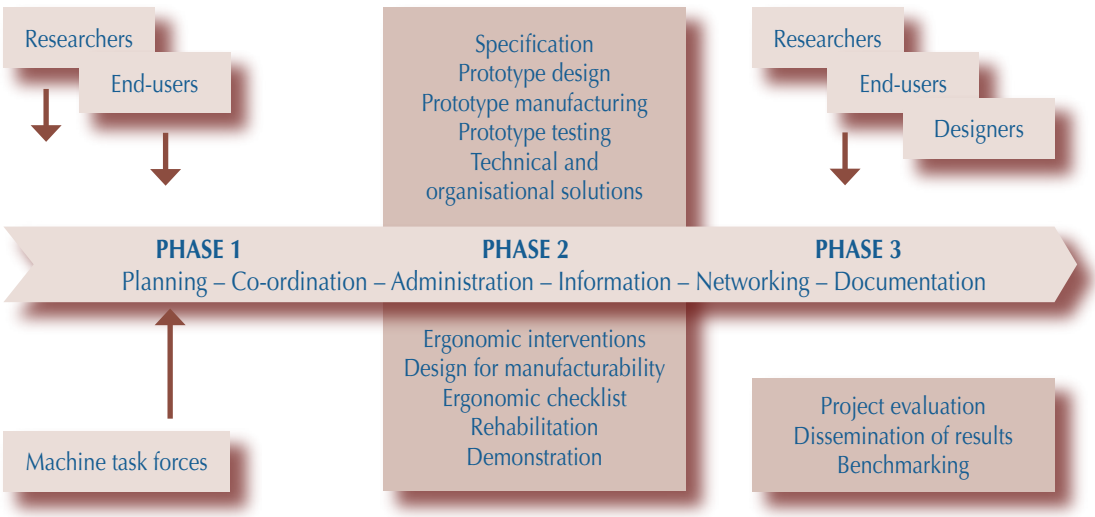
The following types of tools were prioritised :

- battery-powered screwdriver ;
- stapler ;
- pop riveter ;
- cutting device for electronic assembly ;
- angle grinder.

Reaching out to the end user : the hand ergonomics training kit

One of the major endeavours in the Powered Hand Tool Project was to find ways to make end-users aware of ergonomics factors of importance in the selection and purchasing of tools. In accordance with

Figure 2 : The Powered Hand Tool Project
Marketing, information and training activities were carried out throughout the project.



the consumer-oriented approach, it was decided to develop a "hands on" training kit for practitioners "to support awareness and critical thinking" (Garmer *et al.*, 2002).

The training kit was housed in a wooden box, designed for easy transport. It contained a booklet introducing the essential hand ergonomics issues and a laboratory manual, as well as overhead originals that could be used to introduce a session with practitioners.

The box contained the following ingredients :
- a slide-rule for measuring hand size ;
- a grip cone for measuring grip diameter ;
- a hand-grip force measuring device ;
- a device for measuring screwdriver torque ;
- a bolt for trying out wrenches ;
- a structure for trying out hammers ;
- a number of tools of different makes (screwdrivers, pliers, hammers, wrenches).

The training kit was intended for use on the company shop floor, where end-users together with supervisors, purchasers and technical support would unite in a discussion of the pros and cons of different tools.

- Project results

It should be emphasised that the development of tool prototypes was only one of several subprojects carried out in the Powered Hand Tool Project. The following list shows that the stated operative goals were reached :
- five functional prototype tools were developed ;
- technical and organisational solutions were documented, including 120 good solutions from the participating companies, and the Powered Tool Centre as a facility to support quality and ergonomics in car assembly ;
- six reference workplaces were developed ;
- models were developed for ergonomic feedback from users and production engineers to product designers, particularly with respect to manual welding ;
- educational materials were developed, including a training kit for increasing awareness among end-users ;
- a checklist was developed to be used in tool acquisition and a model for ergonomic evaluation of work with powered hand tools ;
- good practices in rehabilitation of powered tool users were documented.

The outcomes of this part of the project thus included five new functional prototypes of powered tools, all of which represented significant advances over currently available devices. However, due to the short timeline allotted to the Powered Hand Tool Project by the financing body, negotiations with tool manufacturers could only be initiated, and had to continue after completion of the main project. The responsibility for pursuing this work was given to the designers.

In an evaluation study of the effect of using the hand tool training kit in one of the participating companies, Garmer *et al.* (2002) found positive outcomes.

Concluding remarks

The Powered Hand Tool Project drew on the experiences of the Swedish Hand Tool Project. However, mainly due to extreme time constraints, there was a somewhat less clear end-user focus in the new project. Arguably, it was run much like an industrial project, carried out under severe time pressure and with heavy focus on operational goals. Nevertheless, the project was organised as a participatory effort, where workers' needs and experiences could be noted and acted upon, and where technical and organisational solutions could be worked out locally, as closely as possible with the end-users.

The project outcomes were considered relevant and in principle, highly useful, by the companies. However, our observations suggest that the project did not manage to significantly change broader attitudes or practice in the project companies. It may be said that the project aims to change basic values and ways in the company's approach to work with hand-held powered tools were unrealistic. Undoubtedly, changes did take place within the companies, but it was not possible to trace these back specifically to the Powered Hand Tool Project outcomes. It can be assumed that a one-year effort devoted solely to information at the end of the project, and engaging the researchers as well as company production staff, would have been most beneficial to the impact of the project.

Summary and conclusion

The Metal Workers Union was very active on the Steering Committee in both projects. The representatives were appointed at the national level. An important role in the project formulation stage was to approach individual companies and discuss the prospective project with local employers and unions.

The user-oriented approach in the projects was chosen for a number of reasons including :
- to increase the relevance of the project ;
- to ascertain that good ergonomic solutions were developed ; and
- to support acceptance of ergonomically sound tools as they become available.

End-users played an essential role in both projects, in particular in Case Study 1, in terms of a truly participatory process. Studies on the effectiveness of change strategies (Ingelgård and Norrgren, 1997) have demonstrated that programmatic change strategies, i.e., attempts to bring about change through predesigned, expert-designed and narrowly-focussed interventions, are generally less effective than a learning strategy, based on a broad, participatory working through of structure and technology, as well as the processes by which experience and new

information are transformed into action. Relating the present projects to these definitions, it appears that Case Study 2 was mostly of a programmatic nature. Thus, the relatively minor impact on learning that the results indicate, could have been anticipated.

There was no standardisation focus in these projects. However, in the formulation of technical and user demands, standardisation documents, including some under development, were referred to. For instance, for the ergonomic specification of the engineer's hammer, reference was made to the ISO standard document on hammers, and to relevant ergonomics documents forming part of the CEN standardisation process.

In conclusion, the two projects represented major undertakings by industry, research organisations and financing bodies. The cases demonstrate both the potential and the difficulties of trying to apply user-driven development of machinery for industry. It is evident that in order to have a substantial influence on machinery manufacturers, a group of user companies needs to be formed, representing a large number of prospective customers. End-users, if given the opportunity, may provide unique insight that is highly relevant in formulation of functional requirements to be included in the machinery specifications. An end user approach enhances the quality of the project, and manufacturers should see this as an asset. Articulations of user demands may also feed into the standardisation process leading to user-centred design.

It is interesting to note that Henriksson *et al.* (1996) in a study of attitudes among actors having a potential influence of the development of hand tools in the two projects, found that whereas all actors agree that it is the end-users who are the most knowledgeable with respect to characteristics of hand tools, there is a difference with respect to the appreciation of influence. The end-users themselves think that they have little power to bring about any changes, but all other actors believe that end-users have significant influence on the development.

Ultimately, manufacturers are profit-driven. Unions should ally with other forces to increase awareness of the importance of ergonomic issues, health and safety in the use of machinery, thereby creating a market for good products, which would give manufacturers of such products a competitive edge. This is a possible way forward for European trade unions. The case studies included in the present report point to project models that could be applied in such an extended context. ■

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