

Autonomous working groups in manufacturing:

Core activities and requirements for IT support

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Introduction

This paper briefly describes core findings from a number of field studies of autonomous working groups. The studies were conducted by members of the IDAK project in the spring of 2001 at five different manufacturing enterprises. The report is primarily a summary of a much more elaborate report (in Danish). The purpose of the present report is to provide input to a discussion of the requirements that IT support for autonomous working groups in manufacturing must meet.

The work of the different groups differed with respect the organization of the work, the degree of autonomy, etc., but there were also quite many similarities with respect to the problems these groups were facing in their daily struggle with planning their activities, monitoring progress, rescheduling, etc. etc.

Focus in the field studies were ‘overhead’ activities like administrative, planning, and coordinative activities, as opposed to how the actual production work was conducted. A lot of effort was spent on establishing staffing plans for the next periods, establishing work plans, making changes in accordance with the constantly changing requirements and possibilities, coordinating with other groups, etc.

The background for our studies — and the motive for considering IT support for these ‘overhead’ activities — is three-folded:

- There has been a strong desire for delegating increased responsibilities and competencies to employees who do the actual production work and who thus have first-hand knowledge of the production process.
- Earlier experiments with autonomous working groups indicated that the groups did not have the required background knowledge or the support required for actually performing the necessary the planning and control tasks.
- The existing IT systems for manufacturing settings have no, or very poor, support of the administrative, planning, and coordinative tasks that the groups have to undertake. The central ERP-systems used for planning and managing the processes today are not designed for being used by groups on the shop floor. They are developed for centralized control.

The aim of our studies have been to discuss possibilities for IT support departing from an understanding of the challenges, problems, and needs faced by the groups.

Administrative tasks to be undertaken

We have studied autonomous working groups in five different factories. These were:

- A group at a large shipyard (Lindø),
- Groups in cable production (NKT),
- Two groups producing metal shelves and baskets (Blika),
- Groups in parts production and assembly in ship engine production (Man B&W),
- A group assembling small amplifiers for sound measuring equipment (B&K).

From these studies we have identified three general groups of tasks that, to a large extent, can be found in all autonomous working groups. These are (a) Division of labor and staffing planning, (b) Production planning and control, and (c) Coordination information and experience exchange.

Division of labor and staffing planning

These activities primarily have the purpose of establishing a staffing plan indicating who will operate which work station (or place) at what time. The plan must reflect competencies of the individual workers (e.g., ‘is he certified for driving that truck?’ or ‘is she trained for running the canting center?’), the production tasks to be undertaken, shifts, holidays, etc. The plans must furthermore be updated in accordance with the changes that arise due to workers calling in ill or workers absent for training purpose, meetings, etc. In some situations the groups will also have to handle ‘loans of members’ to or from other groups.

The division of labor is in some situations defined in terms of work stations or places, whereas it in other situations is defined in terms of tasks (depending on the nature of the production).

The group also take decisions concerning job rotation, training plans, holiday plans, etc.

Production planning and management

Production planning and management is a core task and a challenge for many autonomous working groups. The first planning is typically done based on input (production orders) from the central planning department in the factory. Production orders to the groups can be at a very general level (‘we need 500 BMR1798 produced by the end of week 27’), or as very detailed task lists produced by the central MRP systems. Many constraints and parameters have to be considered when establishing the plans. Some of these are:

- deadlines (importance of conflicting deadlines)
- set-up times
- flow of materials
- required raw materials or components
- required sequence (routing)
- flexibility in choice of sub-processes

- affects of decisions down-stream in the production
etc.

In most of the groups we have studied a new version of the production plan is established either on a daily basis or on a weekly basis.

A second aspect of the production planning has to do with production management, i.e., controlling the processes and rescheduling the plan in accordance with all the (at the original planning time) unforeseen events and changes. Production management has thus to do with establishing the required overview of the production processes and of the actual progress compared to planned. In bullets, the core activities have to do with:

- Ensuring coherence between the plan and the actual work.
This includes monitoring progress. There often are major differences between what is foreseen in the plans (e.g. with respect to initial set-up time for a process) and reality. Hence, it is necessary to monitor to the extent to which plans are being fulfilled or can be fulfilled. Another aspect that current planning systems do not support is accounting for space requirements.
- Handling unforeseen events.
Take action when deadlines cannot be meet, etc. For example re-route a production flow if a work station fails. Disturbances can occur both due to production problems, lack of or defective materials and parts, human errors, changes in demands and priorities from the rest of the enterprise, etc.
- Monitoring the flow of materials.
This includes contacting other groups up-stream in the production or suppliers of component or materials. This kind of monitoring activities is also essential internally in the group. Some actors in the group are usually suppliers to others (actors on the route that work in progress follows within the group).
- Managing the local storage of materials and sub-components.
Ensuring that the required components and materials are available when needed, and keeping track of the consumption so that spare parts or raw materials can be requested or purchased in time.
- Quality assurance
Many autonomous working groups are responsible for quality assurance of their own products. These processes have to be managed and documented and the experiences collected and distributed to relevant actors.
- Requesting assistance.
In many situations, a group may need support in their work from people outside the group (e.g., order a crane for moving very heavy components).

Coordination information and experience exchange.

In many groups a lot of effort is used on informing each other of changes in plans, material flows, etc. It has been a general observation that actors in the groups are heavily interdependent in their activities, and that they, as a consequence, spend much time on coordinating and negotiating their activities. This is also the case with respect to their relations with other working groups or parties (e.g., other groups down-stream the

production, central planners, purchase department, process support technicians, etc.). In many of the situations we have followed, the actors in the groups had no efficient means (medium) for undertaking this interaction with each other or with people outside their own group.

Many of the groups are also confronted with requirements regarding accounting for, or documentation of, the production process.

Exchange of experience and knowledge is a major challenge to many autonomous groups. There is a strong need for collecting and express experiences (e.g., ‘how long time does it take to produce 200 of the BMR1798?’ or ‘what is the alternative production process when the canting work station breaks down?’). It is important to share these kinds of experience with the others in the group, but currently no efficient means support this. We have observed a number of ‘private’ log books or photo collections, but very little is based on well-defined procedures and supported by tools. The most common means for exchanging experiences are ‘war stories’ told during breaks and in similar situations.

Much production work is widely spread in space and time or conducted in shifts. The problems with experience and knowledge exchange then becomes even bigger.

Requirements for IT support

As illustrated above, workers in autonomous groups are facing a many problems in performing the administrative and managerial tasks required for planning and managing their work. It seems obvious to consider how IT could support planning, managing, collaboration, and coordination activities. It is, however, important to emphasize that IT is no panacea. There are a number of areas in which IT cannot support the members of production groups, but we believe that IT can, combined with other initiatives, provide a useful tool for the groups.

A number of overall principles for the design of the systems has been identified:

- Plans are ‘resources for situated action’, that is, allow deviation from plans!
- Planning and managing systems should not aim at or pretend to ‘having a complete picture of the situation’
- Provide an overview of status - ‘open ended’.
- Actors should be in control of systems. No automation (beyond well defined, insular processes).
- Allow all kinds of experimentation with the plans. Let the system present the (likely) *consequences* of the plan.
- Level of detail and perspective should be selectable

In the above, usability of the user interface is presumed. HCI issues are not addressed by our project. Similarly, it is obvious that education and training of shop floor workers in the basic concepts and models of ERP are essential preconditions of any IT support of this kind.

In the following, the requirements are organized in accordance with the three main categories of tasks mentioned above. They will only be very briefly listed:

Division of labor and staffing planning

Staffing planning:

- The groups should have access to specify rules for work periods, holidays, etc. individually (e.g., the number of working hours in a day)
 - Support for specifying the staffing plan including indications of the potential conflicts, problems etc. (show the consequences)
 - Provide an overview of the plan and of the current situation.
- etc.

Education, training and rotation planning:

- The groups should have access to specifying categories of competencies, roles, etc. individually.
- Support for specifying the training and rotation plans including indications of the potential conflicts, problems etc.

etc.

Production planning and management

- Support for specifying the production plan including indications of the potential conflicts, problems etc. An obvious way of illustrating the consequences is by providing an overview of the resulting production load on the individual places, work stations or roles.
- The level of ‘organizational depth’ of the consequences should be selectable.
- Allow to request a ‘suggested best plan’. Allow experimentation.
- Provide an overview of alternative processes, work stations, roles etc. for each component in the plan.
- Provide background information for each task in the plan (e.g., drawings, information on which order it is part of). An important aspect of background information could be to provide access to previous experiences with a similar production order.
- User specified constraints on, for example, routing, process sequence, etc.
- User-specified grouping of production activities.
- Provide an overview of status on previous processes (up-stream) and parallel and following processes (down-stream).
- Provide an overview of flow of materials including access to ordering components and materials.
- Provide an overview of the plan, and of the current situation. Overview of the progress compared with the plan.
- Interfaces to the production systems, for example automatic transfer of information (data, a CNC program, etc.) from the planning system to the work station.
- Support ordering assistance.
- Support of collection of quality assurance information.

Coordination information and experience exchange.

- Support documentation of the actual production processes.
 - Support annotations of documents, drawings, etc.
 - Provide facilities for collecting statistical information about the production.
 - Provide facilities for registering and distributing information of relevance for others in the group.
 - Provide channels for communication and negotiating with other actors outside the group.
 - Support exchanges of information and experiences within the group.
 - Provide access to the general information systems used in the company.
- etc.