

IT support for cooperative work in manufacturing

Notes on software development strategy

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1.

All work is material activity but manufacturing is essentially and massively material. It's about changing the physical form of things – by changing the geometry of objects and by putting parts together in more or less complex configurations. Manufacturing work is thus not only materially embedded or situated, like all human behavior, and it is not merely materially constrained, like all work. Manufacturing work is fundamentally, inexorably, and continually faced with and dealing with an infinite array of physical, chemical, mechanical, thermodynamic, electrical, biological, etc. objects, processes, constraints, contingencies, inferences, breakdowns, etc.

Manufacturing work is therefore extremely variegated, not only from one industrial sector to the other, but also within the same enterprise, from one department to another, from one workstation to another, from situation to another. Due to the different character of the materials, processes, parts, tools, and other equipment, actors are locally faced with problems, challenges, issues, urgencies etc. that are often particular and unique to that particular setting or situation.

2.

Issues of space utilization may for example take precedent over other issues, such as delivery date, economy of scale, lead time, etc. Finished products may for instance take up so much space, that the issue of keeping order in the shipping room may require a rescheduling of the production plan. Similarly, in a cable factory the same drum may house multiple pieces of cable and it may be more efficient to reschedule production than to unwind and rewind the drums.

Current production planning and control systems (based on MRP technology) cannot express such issues.

3.

The inexhaustible material variety of manufacturing work also means that production planning and control activities cannot be conceived of in abstraction from the very transformation processes that are their target. Production planning

and control and process control are both conceptually and practically in an ‘internal relationship’, that is, production control activities are not external to but rather inexorably conceived of and expressed in term of the material transformation processes. Thus, if production planning and control systems and process control systems are designed in isolation of one another, radical and potentially disruptive impediments to production work are introduced.

Production planning and control systems must thus, at the very least, interface to a vast and open-ended array of other kinds of software systems: process control systems for different kinds of processes, CAD/CAM systems, accounting systems, payroll systems, etc.

4.

Finally, the inexhaustible material variety of manufacturing work implies that a manufacturing process involves a variety — typically an enormous variety — of qualitatively different processes such as pressing, extruding, casting, grinding, drilling, cutting, polishing, washing, welding, soldering, gluing, polishing, painting, fitting, screwing, assembling, etc., that typically are distributed over a large collection of more or less specialized workstations which in turn often will be specialized to deal with different ranges of dimension, different materials, different quality requirements, etc.

Due to the infinite variety of processes, the total process is radically distributed over specialized workstations, and, moreover, because manufacturing work is radically distributed, manufacturing work is facing very complex interdependencies. Any local contingency may have repercussions up- or downstream, which, to the local decision makers, may be intractable. A system supporting the local planning and management in the different groups might thus be running in different instances in different, but still interdependent working groups. The repercussions up- or downstream will affect interaction across these instances of the local planning and management system.

5.

The radical and inexhaustible variety of manufacturing work takes manufacturing apart from typical application domains for IT.

Accounting, for example, is essentially manipulation of symbolic representations of economic activities. The contingencies of the material world is of minor concern (except when invoices are lost, archives burnt or flooded etc.). More than that, accounting practices are regulated by law and accounting thus offers a large, practically homogeneous market for standardized accounting software products.

The same applies, more or less, to so-called ‘office work’, that is, the construction and manipulation of documents, which also has been amenable to

computerization by means of a limited suite of generic applications (e.g., word processing, spreadsheets, organizers).

By contrast to such domains, in which IT perhaps can be said to have experienced easy triumphs, manufacturing is not an appropriate domain for (more or less complex) monolithic applications or application systems (such as accounting work) or for integrated suites of generic applications (such as ‘office work’ or desktop publishing).

That is, manufacturing seems to require another, radically different software development strategy than that of the traditional areas of IT deployment. A monolithic application system will invariably create all sorts of problem on the shop floor, as workers strive to make the system fit. The dismal record of the existing monolithic MRP-based production planning and control systems in contemporary manufacturing seems to confirm that. Instead, an open-ended approach seems required.

6.

An open-ended approach must provide a framework (architecture, platform) in which specialized software modules designed to deal with specific tasks of management, coordination, communication, process control, etc. can be incorporated and interact in an orderly fashion.

However, it is unlikely that a conceptual model of manufacturing can be defined once and for all. The now obvious limitations of MRP systems are not the result of its inventors stupidity but of the infinite variety of manufacturing. New issues or processes will invariably emerge that need to be included as parameters or resources in the model.

It therefore seems as if the framework, as its foundation, must provide an abstract notation for defining functionalities, planning and control parameters, interfaces, protocols, etc. The essential requirement of this notation is that it can express a range of conceptual models of manufacturing.

On this basis, an ‘open software’ approach to the development of IT-support for local production planning and control would be feasible:

- (a) Development of abstract notation for defining functionalities, planning and control parameters, interfaces, protocols, etc.
- (b) Description of a (reasonably general and robust) conceptual model of manufacturing.
- (c) Definition of a (reasonably general and robust) general architecture of IT-support for production planning and control in manufacturing, that defines a set of functionalities (‘software modules’), their interfaces, protocols for communication between them, etc.
- (d) Development of key modules to test and demonstrate this architecture.

In this approach, all parts of the framework should be in the public domain, whereas modules can be either commercial or public domain. In this way, the role of the framework is to define the rule of a market.