

A Panel Discussion
on the
NSF Workshop on Manufacturing Systems Integration

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The University of Michigan

1. Introduction

Systems integration is an activity which until now has been largely handled on an ad hoc basis, often with disastrous effects and almost always with more work than was originally anticipated. The difficulties appear to compound rapidly with increasing complexity of the interconnections among subcomponents, and appear at several different levels, e.g. algorithmic, mechanical interconnections, electrical interconnections, communication protocols, software and data. Moreover, a broad spectrum of people is involved, and communication of common problems and solutions is often lacking. To investigate the causes underlying systems integration problems a workshop involving a broad range of experts was sponsored by the National Science Foundation. The workshop was organized by the Robotics Laboratory of The University of Michigan, and held at St. Clair, Michigan in November, 1983.

The underlying premises were

- Further and wider integration of manufacturing automation will be broadly beneficial.
- In spite of its benefits integration of manufacturing automation is taking place at an unacceptably slow pace.
- A basic research program in systems integration methodologies is needed to support and foster acceleration of integration of manufacturing.

The goals of the workshop were twofold. First, the extent to which the above three premises are true was to be determined. In particular, workshop participants were asked to answer the following questions

- What does systems integration mean in your area?
- How much systems integration is desirable? Will it be a major aid to manufacturing, or has it been overvalued?
- Is systems integration taking place at an unacceptably slow pace?
- What research areas would it be appropriate for NSF to fund under the heading of systems integration?
- Is the necessary work in systems integration primarily standards work, or is it research?

The views of industry were to be particularly important in making these determinations.

Second, the workshop would bring together and establish communication among researchers from industry and the academic world who are working on various aspects of the

integration of manufacturing automation. This was considered particularly important given the broad range of people concerned with the various aspects of integration.

The results of the workshop will be disseminated in several ways. This panel discussion is one of them. In addition, a written report is being prepared (completion is expected in May, 1986). An audio recording was made of the entire workshop, and a complete transcription of it has been prepared. A videotape of the final reporting session is being prepared.

2. The Technological Area

The integration of manufacturing automation at the cell and factory floor levels was the technological area of interest. The workshop started with the following tentative characterizations.

The cell level is characterized by a modest number of machines and devices in close proximity, having a great deal of interaction. Significant time intervals are short: microseconds up to minutes. Geometric coordinates, shape, high level sensor based motion control and contact constraints are important. Variables are often real valued. The cell level involves such activities as adaptive control of machines, closely coordinated control of multiple robots and machines, task level planning of robot and machine operations, trajectory planning and the building of tools to support these activities.

The factory floor level is a collection of cells, each with its own cell level description. Here, concerns are with the flow of materials, tools, parts, and information throughout the manufacturing facility. Elements are somewhat more loosely coupled, than at the cell level. Significant times are typically measured in seconds and minutes (e.g., the time required to load a machine with a part, to create a part program, to move a part from one machine to another, to bring together two pieces for assembly). It is sufficient to identify a location by name, not coordinates; to characterize a cell by its capabilities or simply "execute" programs for, say, NC machines and robots. Typical constraints are of the form "At most one pallet can be at machine #4." Variables are usually logical integers or names.

It is not only systems' integration at the cell and factory floor levels individually that is of interest, but integration of activities across these levels as well. The interconnections between the cell and factory floor levels are often in the form of commands to the cell level and status reports to the factory

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a quantity of one larger product variety production on demand with low lead times with the ability to be agile This is in stark
contrast to conventional manufacturing which has relied on economies of scale and where change is viewed as a disruption
and is therefore detrimental to production Computer integrated manufacturing CIM and flexible manufacturing practices are
a key component in the transition from conventional manufacturing to the new manufacturing environment While the use of
computers in manufacturing from controlling individual machines NC Robots AGVs etc to controlling flexible manufacturing
systems FMS has advanced the flexibility of manufacturing environments it is still far from reaching its full potential in the
environment of the future Great strides have been made in individual technologies and control of FMS has been the subject
of considerable research but computerized shop floor control is not nearly as flexible or integrated as hyped in industrial and
academic literature In fact the integrated systems have lagged far behind what could be achieved with existing technology

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