

Implementing a Computer Laboratory

Dianne Dorland and L. Alden Kendall
University of Minnesota Duluth

Chemical and Industrial Engineering at the University of Minnesota, Duluth (UMD) developed an Engineering Computer Laboratory to enhance the quality of undergraduate instruction. The campus-wide computer laboratories at UMD are operated by Information Services, providing computers and software to support the general computer needs of undergraduates in all of the academic programs at a University. This support is targeted at word-processing, spreadsheet analysis, data base needs, general programming languages, and communication needs. Engineering has special computational needs that were not provided by a single computer laboratory facility.

Previously, the Chemical and Industrial Engineering Departments provided limited computer support for undergraduate students by purchasing personal computers and installing special purpose software. The ratio of students to computers was 16/1. In many instances, single user licenses applied and limited computers were used for a specific type of design or analysis task. These computers were not networked to provide an environment where students learn how they may integrate their design and analysis activities in order to perform concurrent engineering for a facility or process design project.

The Departments of Chemical and Industrial Engineering received an NSF Instructional and Laboratory Improvement grant that was implemented between July 1995 and December 1997. The hardware and software provide engineering course support for engineering science as well as design applications for both engineering disciplines. The departmental faculty considered continued maintenance and operation of the computer lab, and chose to work with Information Services (campus level oversight) in the development of this lab. Information Services is responsible for the operation and maintenance of the lab. In addition, Information Services provided part of the match money for the grant proposal.

Laboratory Development

The laboratory was planned and developed through team effort. The team members were technical staff from Information Services and faculty from chemical engineering and industrial engineering. The team met regularly, planned the layout, considered available resources, and projected future needs for the laboratory. Approximately 2100 square feet of space was available for the project. The space was subdivided, utilizing 1800 square feet with 300 square feet in reserve for future development.

Purchasing and installation of the hardware and software was managed by the Information Services staff in consultation with the team members. Hardware installed in the lab includes 31 Pentium computers with CD-ROM and ZIP drives, a scanner, two laser printers, and a data/video projector. Software purchased for use includes Stat-Ease, Kaleidagraph, Promodel Professional Package, TOPDown, HYSYS, AutoCad, EASE, Factory Flow Plan Opt CAD, MS Project and Windows 95.

Program Implementation

Significant course development within chemical engineering occurred at two general levels, introductory and applications/design. At the introductory level, students developed basic use skills in technical computation, graphical presentation, and data analysis. Use of the components in HYSYS and demonstrations of the full process simulation lead into the applications/design level where process simulation integrates engineering science (transport phenomenon, heat transfer, mass transfer, kinetics, unit operations and process control) with design, culminating in the capstone design course, a 10 credit senior design laboratory course.

The major area of improvement is the way we teach the use of the programs. In the past we used a computer and LED panel in the classroom to show how to use software, with students developing program use skills on their own using the Department's computers. Departmental computers were limited in both number and current technology. Programs are now on a networked system, providing a better environment to manage software in terms of updates. Networked computers use a Window operating environment. It also possible to have students integrate material from multiple applications and to share information for concurrent engineering situations.

An industrial engineer frequently collects data, conducts appropriate analysis, and designs a system that delivers a product or a service. The product is generally discrete and the service often is related to human activities. The system exists in a physical setting consisting of equipment, utility services, storage areas, office services, employee services, customer services, and vender services. The system must be described physically, using relationships, by flow processes, by resource capabilities, and by control functions. The NSF grant provided the computer hardware and software needed to for these tasks.

The computer resources in the laboratory have been selected and configured to provide our students with a environment that makes it possible for their learning experience to emulate the professional activities of a graduate industrial engineer. Learning experiences in the computer laboratory develop this competence in the specific courses shown in Figure 1. The software used is also identified.

Physical Description

Physical description techniques are learned using Autocad in Introduction to Engineering Design. FactoryCAD runs as an add on module to Autocad and provides some drawing aids that make it very easy to prepare plant layouts with equipment and utility resources properly defined and positioned. The Autocad/Factorycad file is used by a number of other programs that are essential in the analysis and design process.

Relationship and Flow Descriptions

Relationships between locations and activities need to be described. AutoPLAN runs as an add on module to Autocad and is used to locate resources to meet design criteria. Activities define operations and a sequence of operations define a process. TOPDown is used to prepare descriptions of process flow. More detailed process flow analysis can be done using FactoryFLOW and Promodel. Both of these programs can use the physical layout developed in FactoryCAD. FactoryFLOW runs as an add on module to Autocad and uses material flow path

lengths and flow quantities as a quantitative criteria to locate resources. Promodel uses a simulation model to evaluate relationships between resources in terms of the flow of entities through the system.

Resource Capabilities

The capabilities of resources for processes and projects need to be established. Microsoft Project is used to assign, monitor, and report on project resource utilization. Process capabilities are dependent on the operations and activities that make up the process. EASE and ErgoEASE are used to design process activities, determine standard times for these activities, and develop operation cycle times. The activities of the worker can be modeled and an ergonomically correct work station can be designed. Simulation models using Promodel are also used to study process

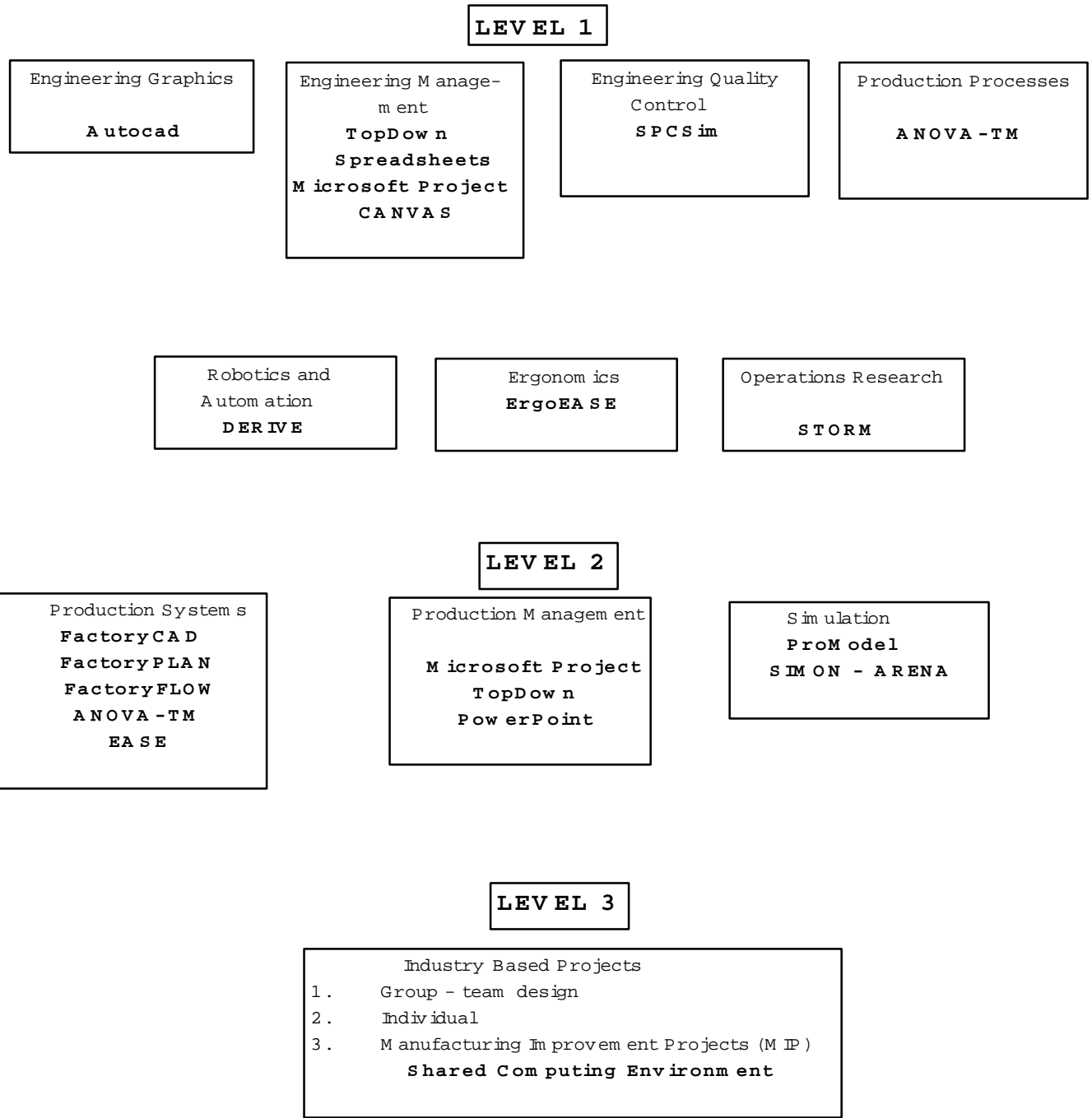


FIGURE 1

capabilities. Process characteristics can be systematically altered in Promodel to optimize these capabilities.

Control Functions

DERIVE is used to plan control actions for robots. SPCSim is used for quality control studies. Promodel is also used to simulate the behavior of a system using a particular process control strategy.

The two levels identified in Figure 1 represent the use of computer resources at Level 1 to analyze and design system components and the use of computer resources at Level 2 to investigate various kinds of systems. A third level exists and represents the use of computer resources in industry based design projects. These projects provide a capstone design experience for the student and require that the student be proficient in using computers at Level 1 and Level 2 in order to be effective at Level 3. At Level 3, experience is gained in the selection and use of the computer resource to aid in analysis and design. Also, experience is gained in electronic communication to share files with other students, faculty, and companies.

All of the software has been installed except for STORM. We are waiting for a Windows version to be released. We are already in our second year of operation and are starting to upgrade some of the software.

Conclusion

The incorporation of a computer laboratory designed specifically to meet the needs of engineering students has appreciably improved the quality of our educational resources. Operation as a campus lab with engineering priority addresses engineering curriculum needs, promotes capacity usage, and provides a cost effective platform for maintenance and operation.

Biographies

DIANNE DORLAND is professor and head of chemical engineering at the University of Minnesota Duluth. She worked for Union Carbide and DuPont in Charleston, West Virginia after receiving her BS and MS from the South Dakota School of Mines and Technology. She completed her PhD at West Virginia University before joining the UMD in 1986. She teaches Hazardous Waste Processing Engineering and Material and Energy Balances.

L. ALDEN KENDALL is professor and head of industrial engineering at the University of Minnesota Duluth. He has 28 years of academic experience as a teacher, researcher, and administrator. Fields of interest are design education, process models, simulation, and computer integrated manufacturing. He has a BMinE from the University of Minnesota, MSIE from the University of Iowa, and a PhD in IE from the Ohio State University.