VOLUME I

Technology Reinvestment Project
Manufacturing Education and Training

Undergraduate Manufacturing Teaching/Learning Laboratory

Lead Institutions:

University of Alabama in Huntsville
Alabama A&M University

Project Directors:

Bernard J. Schroer
University of Alabama in Huntsville
Huntsville, AL 35899

Arthur J. Bond
Alabama A&M University
P.O. Box 1148
Normal, AL 35762

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I. PROJECT SUMMARY

The manufacturing education program is a joint program between the University of Alabama in Huntsville's (UAH) College of Engineering and Alabama A&M University's (AAMU) School of Engineering and Technology. The objective of the program is to provide more hands-on experiences to undergraduate engineering and engineering technology students.

The scope of work consisted of:

Year 1

- Task 1 - Review courses at Alabama Industrial Development Training (AIDT)
- Task 2 - Review courses at UAH and AAMU
- Task 3 - Develop new lab manuals
- Task 4 - Field test manuals
- Task 5 - Prepare annual report

Year 2

- Task 1 - Incorporate feedback into lab manuals
- Task 2 - Introduce lab manuals into classes
- Task 3 - Field test manuals
- Task 4 - Prepare annual report

Year 3

- Task 1 - Incorporate feedback into lab manuals
- Task 2 - Introduce lab manuals into remaining classes
- Task 3 - Conduct evaluation with assistance of industry
- Task 4 - Prepare final report

This report only summarizes the activities of the University of Alabama in Huntsville. The activities of Alabama A&M University are contained in a separate report.

I.A Significant Accomplishments

The significant UAH accomplishments have been:

- The 1995 curriculum review conducted by the Industrial and Systems Engineering Department has resulted in a revised curriculum and the incorporation of the TRP lab materials and exercises into many of the ISE courses.

- NASA Marshall Space Flight Center (MSFC) has agreed to provide access to its Productivity Enhancement Complex for tours and the use of its advanced manufacturing equipment such as a composite winding machine and measurement equipment.

- Since 1971 Alabama Industrial Development Training (AIDT) has provided employment and upgrade training for over 1000 companies in Alabama. The AIDT Huntsville Center's resources are available to support the labs and include state-of-the-art manufacturing equipment, such as a stereolithography apparatus, CNC machining centers, coordinate measurement machine, CAD/CAM, and industrial robots.

- An agreement was signed with Drake State Technical School to teach a machining fundamentals lab. Drake State is less than one mile from AAMU. AAMU is using Drake State for the lab.

- Chrysler Electronics in Huntsville has agreed to provide the instructors and facilities for an electronics manufacturing lab. This lab is taught in the Chrysler electronics manufacturing prototyping facility.

- MagneTek in Huntsville has agreed to provide access to its manufacturing facility for tours and for an electronics ballast assembly lab.

The 1994 State of Alabama House of Representatives passed Resolution HJR214 commending the University of Alabama in Huntsville and Alabama A&M University for the undergraduate engineering education program.

I.B Lab Materials

The following lab materials were developed during the project which have been incorporated into the UAH Industrial and Systems Engineering Department courses:

- Internet skills
- Time study
- ErgoEASER
- Foam manufacturing
- Composite structure manufacturing

- Design of experiments
- GPSS/PC simulation system
- Design and analysis of manufacturing modules
- Nondestructive testing
- Penville plant

- Job shop scheduler
- Material resource planning
- Manufacturing processes
- Rhino robotics
- Helga off-line programming

- CAD/CAM and stereolithography
- Electronic ballast assembly
- Electronics manufacturing simulator
- Statistical quality control and applied statistics
- Ergonomics

Each lab is described in more detail in Section II. It should be noted that other agencies including the NASA Marshall Space Flight Center and Alabama Industrial Development Training also provided funding for the development of a number of the above labs.

I.C Industrial Participation

The following companies and organizations provided input to the program and reviewed the lab manuals:

- Boeing, Huntsville AL
- Chrysler Electronics, Huntsville AL
- Hughes Aircraft, El Segunda CA
- MagneTek, Huntsville AL
- Motorola, Huntsville AL
- Alabama Board of Registration for Professional Engineers and Land Surveyors
- Alabama Society for Professional Engineers
- Alabama Department of Economic and Community Affairs

The Huntsville Chapters of the Institute of Industrial Engineers (IIE) and the Technology Transfer Society (TTS) have established awards for outstanding senior design projects in ISE429. In the Spring 96 the two organizations awarded four IE Handbooks which were presented to the students at the Engineers Week banquet. The two societies made similar awards in 1997. The awards have become an annual event.

II. FULFILLMENT OF THE SCOPE OF WORK

II.A Expenditures

Table II.1 contains a summary of the tasks and expenditures during the project.

II.B Development of Lab Materials

A total of twenty lab and exercises have been developed under the TRP initiative. Table II.2 indicates the use of these labs in the revised UAH Industrial and Systems Engineering Department (ISE) curriculum. Each lab is briefly described in the following sections.

II.B.1 Internet Skills

This lab introduces students to the Internet and focuses on developing the basic skills necessary to access and retrieve information.

II.B.2 Time Study

This lab introduces students to basic time study skills. The lab uses Mr. Engineer Company's The Rate Trainer software which was developed at UAH. The Rate Trainer can be used to teach the concepts of normal time and rating. Using a specially designed key pad and software, the student can experience a 100% rate. The student receives instant feedback on the efficiency for each operation which is compared to the 100% rate. As a result, The Rate Trainer helps train a student reach a 100% rate. The user inputs a normal time. Then as the student presses the key pad at the start and end of the operation, The Rate Trainer computes the efficiency of the operation and displays the student's efficiency against the normal time. Mr. Engineer Company is now marketing the software with UAH receiving royalties. Students receive a copy of the software and the users manual.

II.B.3 ErgoEASER

This lab introduces students to ergonomic analysis of lifting and moving tasks. The lab uses the ErgoEASER software developed by the U.S. Department of Energy's Pacific Northwest Laboratory. ErgoEASER consists of a set of software tools for evaluating computer workstations and lifting task design. The software tools help identify ergonomic hazards and offers suggestions on eliminating these hazards.

II.B.4 Foam Manufacturing

This lab introduces students to the formulation and manufacture of rigid polyurethane foams. The lab uses the foam as a medium to introduce students to materials properties and statistically designed experiments. The steps in a typical lab are:

- Select a foam formulation
- Select parameters to vary in formulation (the design of experiment)
- Select response variables
- Make appropriate number of foam samples
- Interface with MSFC to make measurements
- Perform statistical analysis (ANOVA) and write report

The design of experiment software in Section II.B.6 is used to perform the ANOVAs.

II.B.5 Composite Structure Manufacturing

This lab introduces students to a wide variety of composite materials in use today as well as their advantages and disadvantages. The lab includes the preparation of a prepreg composite panel and performing a tensile test on the panel.

Table II.1. Tasks and expenditures

Project title: Technology Reinvestment Project Manufacturing Education and Training Undergraduate Manufacturing Teaching/Learning Laboratory

Accomplishment/ Deliverable	TRP UAH cash (x $1000)	Cost sharing UAH cash (x $1000)	Cost sharing in-kind (x $1000) Note 1	Total (x $1000)
Task: Review of AIDT courses	10	10	10	30
Task: Review of UAH courses	30	30	0	60
Task: Develop lab manuals				
UAH developed manuals	133	110	56	299
AIDT developed manuals	0	0	25	25
Purchased manuals	2	4	0	6
Lab facilities upgrade	4	30	98 16 (UAH)	148
Task: Field test labs	30	30	50	110
Task: Incorporate labs into curriculum	40	60	15	115
Total (UAH)	243	274	270	787
Total (AAMU) Note	137	75	155	367
Total both universities	380	349	425	1154

Notes:

1. Only one-half of the AIDT and ADECA cost sharing in-kind is given in Table II.1. The remaining one-half in-kind match is contained in the AAMU Table II.1.

2. The detailed tasks and expenditures for AAMU are given in Table II.1 in the AAMU final report.

Table II.2. Use of lab materials in ISE courses

Lab material	ISE Course													
	224	340	378	390	391	423	424	426	427	428	430	433	437	447
Internet skills	X													
Time study	X						X							
ErgoEASER							X							
Foam manufacturing	X		X							X				
Composite structures			X											
Design of experiments								X		X				
GPSS/PC simulation system										X				
Design/analysis of mfg modules										X	X			
Nondestructive testing			X								X			
Penville plant											X			
Job shop scheduler												X		
MRP												X		
Manufacturing processes			X											
Rhino robotics											X			
Helga off-line programming											X			
CAD/CAM and SLA											X			
Electronic ballast assy								X						
Electronics mfg simulator													X	
SQC and statistics				X	X	X								
Ergonomics							X							
Total labs	3	0	4	1	1	1	3	2	0	4	6	2	1	0

ISE224	Introduction to Industrial and Systems Engineering
ISE340	Operations Research
ISE378	Materials and Manufacturing Processes
ISE390	Probability and Engineering Statistics I
ISE391	Probability and Engineering Statistics II
ISE423	Statistical Quality Control
ISE424	Ergonomics and Methods Analysis
ISE426	Design and Analysis of Experiments
ISE427	Management Systems Analysis
ISE428	Systems Analysis and Design I
ISE429	Systems Analysis and Design II
ISE430	Manufacturing Systems and Facilities Design
ISE433	Production and Inventory Control Systems
ISE447	Introduction to Digital Simulation

II.B.6 Design of Experiments

This lab augments the theoretical and computational aspects of the design of experiments. Software has been developed for analyzing a variety of experimental designs, such as one-way, two-way, two and three factorials, Latin Square, and two level six factor maximum Yates. Students receive a copy of the software and the users manual.

II.B.7 GPSS/PC Simulation System

This lab introduces students to the GPSS/PC simulation system. A number of lab exercises have been developed based on real world problems. Students are given a student version of GPSS/PC and a users manual.

II.B.8 Design and Analysis of Manufacturing Modules

This lab uses the modular manufacturing simulator developed by UAH which is being distributed by the NASA MSFC Technology Transfer Program. Over 800 firms have requested the simulator. Students use the simulator to design and analyze proposed manufacturing modules. Since a model can be built in less than ten minutes using the simulator, the primary focus of the lab in on developing student skills in systems design and analysis. Students receive a copy of the simulator and the users manual.

II.B.9 Nondestructive Testing

This lab teaches students the following nondestructive testing (NDT) techniques are introduced: ultrasonic testing, acoustic emission, and eddy current testing. Each technique is introduced by allowing the students hands-on exercises.

II.B.10 Penville Plant

This lab introduces students to the workings of the push, Kanban and team methods of manufacturing. Students are organized into teams to assemble ball point pens using the Penville Plant game developed by (TC)2, Inc.

II.B.11 Job Shop Scheduler

This lab introduces students to the basic concepts of shop floor scheduling with emphasis on finite scheduling. The job shop scheduler software was developed by UAH. The students receive copies of the software and the users manual.

II.B.12 Material Resource Planning

This lab introduces students to material resource planning (MRP). The exercises are built around the MRP module in STORM, an operations management software system. Teams of students are given information on a product to be manufactured and must develop a bill of material and a production schedule.

II.B.13 Manufacturing Processes

This lab introduces students to metal turning and milling processes. The lab is a twelve hour hands-on lab teaching students how to use a lathe and mill. The lab uses the facilities at the UAH engineering machine shop and the AIDT Huntsville Center.

II.B.14 Rhino Robotics

This lab introduces students to robot programming using the Rhino Education Robots. Students are taught the fundamentals of robot operation and programming and then apply this knowledge by programming the Rhino to do a defined task.

II.B.15 Helga Off-Line Programming

This lab introduces students to robot cell design and layout using the Helga off-line programming system. The system simulates the IBM7545 SCARA robot. Helga's animation capabilities allow a student to develop and debug a simple program for the IBM7545. Students receive copies of the software and users manual.

II.B.16 CAD/CAM and Stereolithography

This lab has been developed in conjunction with the Alabama Industrial Development Training. This day long lab introduces students to AutoCAD and SmartCAM and to rapid prototyping using the SLA250 stereolithography apparatus.

II.B.17 Electronic Ballast Assembly

This lab presents students with the problem of developing a manufacturing line layout for assembling electronic ballasts. The problem consists of determining standard times for component insertion, staffing, balancing, and laying-out the line to satisfy a desired production. MagneTek Corp. in Huntsville has provided the components for the ballast. After the teams have completed their designs, the students present their results on-site to MagneTek engineers and are taken on a plant tour to see the actual assembly of the ballasts.

II.B.18 Electronics Manufacturing Simulator

This lab focuses on the design and analysis of high volume electronics manufacturing systems. The Electronics Manufacturing Simulator (EMS) was developed in conjunction with Chrysler in Huntsville and consists of a line analyzer, static analyzer, and code generator (currently not completed). The line definer is used to develop the initial definition of an assembly line through a graphical user interface. Line elements are defined by selecting the appropriate icon from a master template of machines. The static analyzer uses the station processing times to generate an estimate of the maximum throughput for each station on the line. Students also tour the lines at Chrysler and Chrysler's electronics manufacturing prototyping facility. Students are given copies of the EMS simulator and the users manual.

II.B.19 Statistical Quality Control and Applied Statistics

This lab introduces students to a variety of statistical topics through the use of hands-on exercises and experiments. The lab provides students with a better sense of the basic concepts such as the central limit theorem, sampling and control charts. Software has been developed linking a digital caliper to a pc for taking measurements and generating control charts.

II.B.20 Ergonomics

This lab consists of having students use a variety of traditional and ergonomically designed tools under realistic conditions and evaluate the positive and negative impacts of both styles of tools.

II.C Use of Labs in Selected Topics Courses

The lab materials are also being used in the ISE439 and MAE459 selected topics courses in the College of Engineering. The selected topics vary based on student interest. Two examples of the use of the lab materials in these courses follow.

During the Spring 95 term, a student in ISE439 used the foam lab to evaluate the use of various fillers in rigid polyurethane foam. The fillers included cellulose fibers, sawdust, and fly ash. The MSFC Productivity Enhancement Complex was used to analyze the foam samples.

Beginning the Spring 94 term, students in MAE459 began the design and fabrication of a human powered submarine for the international human powered submarine design competition sponsored by the Perry Foundation. At the end of the term, the students had completed the design. A four foot section of the submarine was fabricated. First, a two foot diameter by four foot cylinder foam mold was made in the foam lab. NASA/MSFC then turned the foam mold to the desired contour. All the voids were filled and composites wrapped over the mold using MSFC equipment. The part was cured at MSFC and the foam mold removed leaving the completed four foot composite section of the submarine.

During the Spring 95 term, additional experiments were conducted by a new group of students in MAE459 to determine the desired polyurethane foam formulation. During the Summer 95 term, a new group of UAH and AAMU students constructed a wooden frame and poured polyurethane foam around the frame. The two foot diameter by ten foot foam cylinder was then transported to the MSFC Productivity Enhancement Complex.

During the Spring 96 term, MSFC machined the foam to the desired contour, wrapped the composites around the foam and cured the structure. Students assisted in filling the voids. During the Spring 97 term, the students will complete the propulsion and guidance and control systems. The submarine should be completed by Summer 97. Appendix C contains one of the student reports that summarizes the progress of the human powered submarine project.

II.D Copies of Lab Manuals

Appendix B contains copies of the following lab manuals:

- Internet skills
- Time study - Includes The Rate Trainer manual and software
- ErgoEASER - This manual and the software are copyrighted by U.S. Department of Energy Pacific Northwest Laboratory and therefore not included in Appendix B.
- Foam manufacturing
- Composite structure manufacturing
- Design of experiments - The manual includes software.
- GPSS/PC simulation system - The manual includes a copy of the student version of GPSS/PC from Minuteman Software, Stowe MA. The GPSS/PC software is copyrighted and therefore not included in Appendix B.
- Design and analysis of manufacturing modules - The manual includes a copy of the Modular Manufacturing Simulator software.
- Nondestructive testing
- Penville plant - The manual and plant simulation kit is copyrighted by (TC)2, Inc. and not included in Appendix B.
- Job shop scheduler - The manual includes a copy of the job shop scheduler software.
- Material resource planning - Production planning and control manual
- Manufacturing processes
- Rhino robotics
- Helga off-line programming - The manual includes a copy of the off-line programming software.
- CAD/CAM and stereolithography
- Electronic ballast assembly
- Electronics manufacturing simulator - The manual includes a copy of the Electronics Manufacturing Simulator software.
- Statistical quality control and applied statistics
- Ergonomics

III. CURRICULUM REFORM

III.A Impact on Systemic Curriculum Reform

Table III.1 gives the required courses for all UAH engineering students. UAH awards the BS in Engineering with an option in the following specialties:

- Industrial and Systems Engineering (ISE)
- Mechanical and Aerospace (MAE)
- Electrical and Computer (ECE)
- Chemical and Materials (CME)
- Civil and Environmental (CEE)

Table III.1. Required courses for all students

Course	Hours
• Engineering core	
• MAE271 Statics	3
• MAE294 Nature and Properties of Materials	4
• EE300 Electrical Circuits I	3
• EE311 Electronic Instrumentation	3
• EE301 Electronics Instrumentation Lab	1
• ISE321 Engineering Economy	3
• MAE362 Dynamics	3
• English EH101 and EH301	6
• Humanities and Social Sciences electives	18
• Mathematics	
• Calculus MA171, 172, and 201	12
• MA244 Linear Algebra	3
• MA324 Differential Equations	3
• Basic Sciences	
• General Physics PH111, 114, 112, 115	8
• Chemistry CH121, 125	4
• ISE option	61
Total semester hours	135

III.A.1 ISE Curriculum Before TRP Award

Table III.2 outlines the courses in the Industrial and Systems Engineering option of the BSE degree. This option provides a strong analytical and theoretical grounding in the basics of industrial and systems engineering. Note that only four of the courses had labs or hands-on exercises.

III.A.2 Revised Curriculum

In 1995 the ISE faculty approved an extensive revision of the ISE option in part as a result of the TRP initiative. Table III.3 outlines the new ISE option of the BSE degree.

The most notable changes to the curriculum have been:

- New sophomore course ISE224 Introduction to Industrial and Systems Engineering
- New course ISE340 Operations Research which replaced ISE326 Production and Operations I
- Modification of ISE424 Ergonomics and Methods Analysis to include ergonomics as well as time study and methods analysis
- Modification of ISE430 Manufacturing Systems and Facilities Design to include topics on material handling and facilities location and layout
- New course ISE433 Production and Inventory Control Systems which replaced ISE327 Production and Operations II
- ISE426 Design of Experiments now a required course rather than an elective
- New elective course ISE437 Electronics Manufacturing Processes

With the exception of ISE340 and ISE427, all of the courses that have been added or modified in the curriculum utilize lab material and exercises developed under the TRP initiative. In addition, lab materials developed under the TRP initiative have been integrated into many of the ISE courses. As a result, the ISE option stresses the use of a system approach to problem solving and develops student skills through the extensive use of hands-on, real world oriented lab exercises.

Brief catalog descriptions of the courses in the revised ISE option to the BSE degree are:

- ISE224 Introduction to Industrial and Systems Engineering

An overview of industrial engineering concepts. Includes the history and development of classical industrial engineering; documentation and computational methods; basic work methods and measurements; manufacturing systems; and economic decision analysis. Prerequisite: MA172.

- ISE340 Operations Research

Fundamentals methods, models, and computational techniques of operations research. Linear programming including transportation, assignment, and simplex algorithms. Queuing theory. Prerequisite or parallel: ISE390.

- ISE378 Materials and Manufacturing Processes

Engineering properties of materials, sources of information for properties of materials, cost considerations for material selection, manufacturing processes, casting, forming, machining, cost considerations for machining operations. One or more field trips and shop laboratory included. Prerequisite: MAE 370.

Table III.2. Pre TRP Industrial and Systems Engineering Option

Course		Hours	Lab
EE197	Computer Methods in Engineering	3	
MAE198	Engineering Graphics	2	
MAE370	Mechanics of Materials	4	
ISE378	Materials and Manufacturing Processes	3	
ISE326	Production and Operations I	3	
ISE327	Production and Operations II	3	Yes
ISE390	Probability and Statistics I	3	
ISE423	Statistical Quality Control	3	
ISE424	Ergonomics and Methods Analysis	3	Yes
ISE427	Management Systems Analysis	3	
ISE428	Systems Analysis and Design I	3	
ISE429	Systems Analysis and Design II	3	
ISE430	Manufacturing Systems and Facilities Design	3	Yes
ISE447	Introduction to Digital Simulation	3	Yes
ISE490	Probability and Engineering Statistics II	3	
AC211/221	Principles of Accounting with Laboratory	3	
Technical Electives		8	
Science Elective		4	
Total		60	

Table III.3. Revised Industrial and Systems Engineering Option

Course		Hours	Lab
EE197	Computer Methods in Engineering	3	
MAE198	Engineering Graphics	2	
MAE370	Mechanics of Materials	4	
ISE224	Introduction to Industrial and Systems Engrg	3	Yes
ISE340	Operations Research	3	
ISE378	Materials and Manufacturing Processes	3	Yes
ISE390	Probability and Engineering Statistics I	3	Yes
ISE391	Probability and Engineering Statistics II	3	Yes
ISE423	Statistical Quality Control	3	Yes
ISE424	Ergonomics and Methods Analysis	3	Yes
ISE426	Design and Analysis of Experiments	3	Yes
ISE427	Management Systems Analysis	3	
ISE428	Systems Analysis and Design I	3	Yes
ISE429	Systems Analysis and Design II	3	Yes
ISE430	Manufacturing Systems and Facilities Design	3	Yes
ISE433	Production and Inventory Control Systems	3	Yes
ISE447	Introduction to Digital Simulation	3	Yes
AC211/221	Principles of Accounting with Laboratory	3	
ISE Elective		3	
Science Elective		4	
Total		61	

- ISE390 Probability and Engineering Statistics I

Engineering uses of probability theory, discrete and continuous probability distributions including binomial, Poisson, hypergeometric, normal, uniform, gamma, beta, lognormal, exponential, and Weibull. Statistical sampling, distribution of means, variances, and proportions. Prerequisite or parallel: MA201.

- ISE391 Probability and Engineering Statistics II

Continuation of ISE390 with regression analysis, analysis of variance, and nonparametric statistics. Design of engineering experiments and computer based solution of large scale problems. Prerequisite: ISE390.

- ISE423 Statistical Quality Control

Statistical theory and techniques to assess the quality of manufactured products. Includes laboratory exercises. Prerequisite or parallel: ISE391.

- ISE424 Ergonomics and Methods Analysis

Introduces students to basic principles of methods analysis and ergonomics. Methods analysis topics include: work measurement, work measurement tools, work sampling, job analysis, job evaluation, and the development and use of flow and activity charts for methods improvement. Ergonomics topics include: anthropometric data, workplace design, design of the physical environment, work organization, and display and control design. Includes term project. Prerequisite: ISE391.

- ISE426 Design and Analysis of Experiments

Advanced topics in statistical experiments with emphasis on the design aspect. Confounding, fractional replication, factorial and nested design. . Prerequisite: ISE391.

- ISE427 Management Systems Analysis

Formal organization structures and functions. Analysis of informal organization function within formal organizations. Techniques for making decisions within formal organizations, together with ethical constraints. Prerequisite: ISE390.

- ISE428 Systems Analysis and Design I

Philosophy and methods of industrial and non industrial systems analysis and design. Methods of systems definition, analysis, simplification, evaluation, and optimization. Design project required. Prerequisites: ISE340, ISE391 and senior standing.

- ISE429 Systems Analysis and Design II

Continuation of design project begun in ISE428. Prerequisite: ISE428.

- ISE430 Manufacturing Systems and Facilities Design

Overview of modern manufacturing systems design with emphasis on facility location and plant layout. Includes classical systems, just-in-time systems, basic principles of integrated manufacturing systems design, as well as analysis of process flow, process productivity, and available space to determine facility layout. Prerequisite: senior standing.

- ISE433 Production and Inventory Control Systems

Inventory models including classical optimal economic order quantity models, manufacturing resource planning systems, master production scheduling, material requirements planning, capacity planning, and purchase order control. Prerequisite: ISE390.

- ISE447 Introduction to Digital Simulation

Philosophy and elements of digital, discrete event simulation. Emphasis on the modeling and analysis of stochastic systems, including probabilistic models, output analysis, and the use of simulation software. Prerequisites: EE197 and ISE391.

The following courses can be used for the ISE elective:

- ISE437 Electronics Manufacturing Processes

Current concepts, facilities, and technology utilized in the manufacture of electronic components and products. Includes printed wiring board fabrication and component mounting methods. Automation, quality and reliability, product testing and economic issues. Prerequisite: senior standing.

- ISE439 Selected Topics in ISE

III.B Impact on Recruitment and Retention of Students

Almost all of the lab materials were introduced into the courses in the Department of Industrial and Systems Engineering. Although no correlation can be made, the enrollment in the ISE428 and ISE429 senior design courses may provide an indication of the impact of student retention since most of the labs were initially introduced in these two courses. The enrollment in these courses has been:

FY92-93	15	(quarter terms)
FY93-94	10	
FY94-95	4	(switched to semester terms)
FY95-96	13	
FY96-97	16	

After a gradual decline in enrollment from FY93 through FY95, enrollment in ISE428 and ISE429 is now on the increase.

III.C Programs with K-14 Institutions and Students

Not applicable

IV. PARTICIPATION OF ACTIVE AND DISPLACED DEFENSE WORKERS

Not applicable

V. PROJECT EVALUATION

Table V.1 provides assessment information on each project/deliverable presented in Table II.1.

During the summer 1994 many of the labs were field tested in the AIDT Summer Engineering Residency Program. A total of sixteen first and second year college students participated in the program. Of the sixteen students, eleven students were from the NASA Marshall Space Flight Center (MSFC) summer student program, three students from the U.S. Army Missile Command summer student program, and two students that were incoming engineering students to UAH.

Table V.1. Evaluation and assessment

Project title: Technology Reinvestment Project Manufacturing Education and Training
Undergraduate Manufacturing Teaching/Learning Laboratory

Accomplishment/ Deliverable	Institution where tested	Personnel involved	What assessed	Instrument	Location Tested	Date
Task: Field test lab manuals						
Summer 94	AIDT/UAH	Students	Lab manuals	Student feedback	AIDT	6/94
Summer 95	AIDT/UAH	Students	Lab manuals	Student feedback	AIDT	6/95

UAH hosted a two week Adventures in Engineering program for thirty high school students during the summer 1995. The program was funded in part by the National Science Foundation. A number of the labs were used to introduce the students to engineering.

One of the student projects in the Adventures in Engineering involved the fabrication of a four foot wing for a remotely controlled airplane. Dr. B. Landrum in the Mechanical and Aerospace Engineering Department designed a new wing for the airplane. The AIDT Huntsville Center used the CAD file to grow a stereolithography (SLA) mold of the wing. Polyurethane foam was poured into the SLA mold to make the wing sections using the Foam Lab. The students then glued the two sections together and wrapped the wing with a composite in the Composites Lab. The wing was fastened to the airplane and the airplane flown at the U.S. Space and Rocket Center. A total of five different wings were fabricated with the composites.

VI. DISSEMINATION

Copies of the lab materials are provided to the students enrolled in the classes. However, the lab materials are not disseminated to other groups or individuals.

VII. LEADERSHIP AND MANAGEMENT SYSTEMS

An organization chart for the project is given in Figure VII.1. At the start of the project Bernard J. Schroer was the ISE chair and Director of the Center for Automation and Robotics (CAR). During the second year of the project Dr. Schroer became Associate VP for Research. He maintained his ISE faculty appointment and Director of the Center for Automation and Robotics. As Director of the Center for Automation and Robotics he had available both staff and facilities to support the project. For example, the Foam Fabrication and Composites labs are located in CAR.

Faculty from the Department of Industrial and Systems Engineering and the Department of Mechanical and Aerospace Engineering were solicited to participate in the project. The Dean of the College of Engineering and the two department chairs were brought in early to assure faculty participation. The ISE chair was instrumental in the curriculum review.

Faculty that participated in the lab development were:

- Donald B. Wallace, PhD
  Professor, MAE

- Phillip A. Farrington, PhD
  Associate Professor, ISE

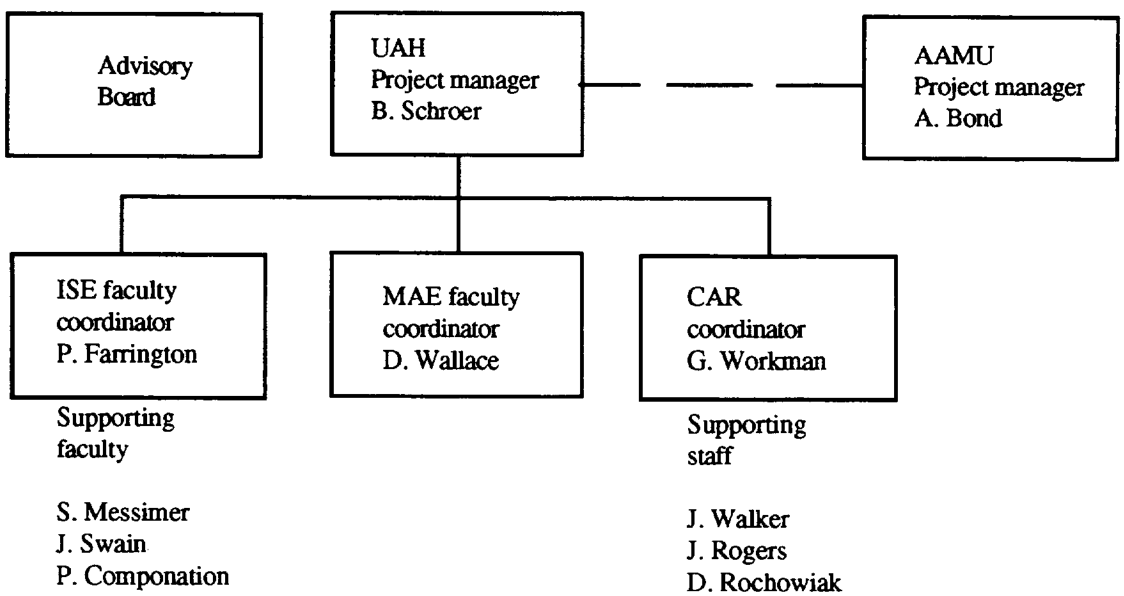

Figure VII.1. Project organization

- Sherri L. Messimer, PhD
  Associate Professor, ISE

- James J. Swain, PhD
  Associate Professor, ISE

- Paul J. Componation, PhD
  Assistant Professor, ISE

Adjunct faculty that assisted in the lab development were:

- Patrick Lawler
  Adjunct Assistant Professor, ISE
  Help develop the design of experiment lab

- John Evans, PhD
  Adjunct Associate Professor, ISE
  Help develop the interface with Chrysler

The following staff in the Center for Automation and Robotics participated:

- Gary L. Workman, PhD
  Sr. Research Scientist
  Developed foam, composites and non-destructive inspection labs
  Teaches these labs

- James Walker PhD candidate
  Assisted in developing composite lab and teaches composites lab

- Daniel Rochowiak, PhD
  Associate Professor, Computer Science
  Teaches internet lab

- John Rogers, PhD candidate
  Developed job shop scheduler and electronics manufacturing simulator labs and teaches these labs

Industrial personnel participating in the project were:

- Pat Gill
  Rhonda Kunkel
  MagneTek
  Assisted in electronics ballast assembly lab and tour of facilities

The plan was to actively involve the industrial partners in providing program input and in reviewing the lab manuals. However, the industrial participation was minimal. The exceptions were Boeing and MagneTek which made significant donations of materials to support the new labs and Chrysler which opened it electronics manufacturing prototyping facility for tours and labs.

The most supportive partner was Alabama Industrial Development Training (AIDT) and especially the AIDT Huntsville Center. AIDT assigned staff to support the project, opened its facilities to support lab development, and provided lab instructors. The AIDT in-kind match was significant. A key to the AIDT success was the participation by the AIDT management, especially Mr. Dusty Brown, Assistant Director in Montgomery, AL. In addition, UAH had a relationship with the AIDT Huntsville Center dating back to the opening of the Center in 1989. Since 1989 UAH has had numerous students use the AIDT facilities for graduate research and undergraduate student projects.

AIDT staff participating in the project were:

- Steve Pollock
  Joe Paxton
  Ron Hollis
  Lab instructors for CAD/CAM/SLA and machining fundamentals labs.

The industrial partners met on the average twice a year. These meetings were held at the AIDT Huntsville Center and UAH. At these meetings faculty and staff updated the industrial partners on the labs. The partners were given specific tasks to review and to provide feedback on the labs.

VIII. RESOURCES

Table VIII.2 summarizes the facilities and equipment used on the project and sources of funding. The following donations were made to UAH by local industry to support the labs:

- Variety of composite materials
  Boeing
  Value: $97,500

- Approximately fifty sets of unassembled electronics ballasts
  MagneTek, Huntsville
  Value: $1,200

IX. LESSONS LEARNED

The following lessons were learned during the program:

- The development of the lab manuals provided the momentum for the Industrial and Systems Engineering Department to conduct a curriculum review to and incorporate the labs into courses.

- The new faculty in the Industrial and Systems Engineering Department were a primary factor the for success of the program, especially in leading the curriculum review and in adopting the new labs.

- Industries in the area were quite willing to provide access to their facilities for tours, to donate lab materials, and to provide employees for instructors.

- Access to a nearby state training center reduced the duplication of very expensive manufacturing equipment, such as CNC machining centers and a stereolithography unit. UAH need of this type of equipment was minimal and would be difficult to justify economically.

X. OTHER INFORMATION

The following conference papers were prepared:

- "Impact of the Technology Reinvestment Project on Teaching Manufacturing Education," ***AIAA 1994 Space Programs and Technologies Conference***, AIAA Paper 94-4505, Huntsville, AL, October 1994, Bernard J. Schroer, Phillip A. Farrington, Sherri L. Messimer, Donald B. Wallace, and Gary L. Workman.

- "Simulation and Undergraduate Engineering Education: The Technology Reinvestment Project," ***Proceedings of Winter Simulation Conference***, Orlando FL, December 1994, pp. 1387-1393, Phillip A. Farrington, Sherri L. Messimer, and Bernard J. Schroer.

Table VIII.2. Facilities and equipment use and expenditures

Project title: Technology Reinvestment Project Manufacturing Education and Training
Undergraduate Manufacturing Teaching/Learning Laboratory

Accomplishment	Description of facility/equip	How used	TRP cash ($1000)	Match cash ($1000)	In-Kind match ($1,000)	Total ($1000)
Task: Develop lab manuals						
UAH developed manuals						
	UAH/CAR foam lab	Support lab	0	20	0	20
	UAH/CAR Composite materials	Support lab	0	10	98	108
	Electronics ballast components	Support lab	0	0	2	2
	GPSS/PC software	Support lab	1	0	0	1
	SQC and statistics	Support lab	1	0	0	1
	Ergonomics	Support lab	3	4	0	7
AIDT developed manuals						
	AIDT Huntsville Center labs with lathes and mills, CAD, CAM and SLA	Support lab	0	0	25	25
Purchased manuals						
	(TC)2 software and manual	Support lab	1	0	0	1
Task: Field test labs	AIDT/UAH facilities		0	0	50	50
Task: Incorporate into curriculum	AIDT/UAH facilities	Support labs	0	0	15	15

Notes:

1. The detailed facilities and equipment use and expenditures for AAMU are given in Table VIII.2 in the AAMU final report.

- "Polyurethane Foams for Engineering Education and Technology Transfer," ***Proceedings 26th International SAMPE Technical Conference,*** Atlanta GA, October 1994, pp. 669-674, Gary L. Workman and Bernard J. Schroer.

- "Transferring Technology to Manufacturing Education Using the Technology Reinvestment Project," ***Proceedings of Technology Transfer Society***, Washington, DC, July 1995, pages 277-283, Bernard J. Schroer, Gary L. Workman, and Arthur J. Bond.

- "Applying Federal Technology to Hands-on Undergraduate Engineering Education," ***AIAA 1995 Space Programs and Technologies Conference***, Huntsville, AL, AIAA 95-3752, September 1995, Bernard J. Schroer, Gary L. Workman, and Arthur J. Bond.

- "The Polyurethane Foam Project for Engineering Education," ***AIAA 1995 Space Programs and Technology Conference***, Huntsville, AL, AIAA 95-3753, September 1995, Gary L. Workman, Sherri L. Messimer, and Bradley J. Schroer.

- "Improving 'Hands-on' Engineering Technology Laboratories through the Technology Reinvestment Project," ***Proceedings of the ASEE Southeastern Regional Conference***, Biloxi, MS, May 1995, E. L. Bernstein, Arthur J. Bond, and A. R. Terrill.

The following presentations were made:

- "The Technology Reinvestment Project as a Mechanism for Improving Education Quality," Industrial Engineering Research Conference, Nashville, TN, May 1995, Phillip A. Farrington, Sherri L. Messimer, James J. Swain, and Bernard J. Schroer.

- "Undergraduate Teaching/Learning Laboratory," TABES, Huntsville, AL, May 1995, Arthur J. Bond.

APPENDIX A

TRP/MET DATA BASE OF INDICATORS TABLES

Table 1
Background Information

University of Alabama in Huntsville
Manufacturing Education Teaching/Learning Laboratory

YEAR 3

Function	Name	Phone	Fax	E-Mail
Principal Investigator	Bernard J. Schroer	205-890-6100	205-890-6783	schroerb@email.uah.edu
Technical Leader (if not PI)	Arthur J. Bond (Co-PI)	205-851-5560	205-851-5561	
Database Contact				

Name	Manufacturing Education Teaching/Learning Laboratory	Updated 3/20/97
Home Institution	University of Alabama in Huntsville	State
		Data Collected From 3/18/96 Through 9/17/97

Headquarters' Address University of Alabama in Huntsville
Huntsville, AL 35899

HQ Phone 205-890-6100 **HQ Fax** 205-890-6783

Table 2
Project Activity Summaries

University of Alabama in Huntsville
Manufacturing Education Teaching/Learning Laboratory

Project Title	Lev.	Investigator	Site	Test	Impl.	Del	Description
Undergraduate Mfg. Education Teaching/Learning Laboratory	☐ T ☐ L ☒ U ☐ A ☐ G ☐ P ☐ O	B. J. Schroer	University ofAlabama in Huntsville	◉ Yes ○ No	◉ Yes ○ No ○ Cont.	◉ M ○ C ○ W ○ Y ○ D ○ S ○ I ○ T ○ O	Lab Manuals
Undergraduate Mfg. Education Teaching/Learning Laboratory	☐ T ☐ L ☒ U ☐ A ☐ G ☐ P ☐ O	Arthur J. Bond	Alabama A&M University	◉ Yes ○ No	◉ Yes ○ No ○ Cont.	◉ M ○ C ○ W ○ Y ○ D ○ S ○ I ○ T ○ O	Lab Manuals

Quit Print Previous Next New Done Help

Record 2

Table 3: Personnel

University of Alabama in Huntsville
Manufacturing Education Teaching/Learning Laboratory

Personnel Classification	Total	Sex			Race/Ethnicity						Foreign	Disabled
		F	M	US	NA	AA	C	H	PI	A		
Stud. in Experimental Upper Division UG (Undergraduate)	183	83	100	183								
Students in Experimental Master's Degree Program	0	0	0	0								
Graduate TAs	0	0	0	0								
Undergraduate TAs	0	0	0	0								
Students Doing Internships in Industry	0	0	0	0								
Active Defense Workers	0	0	0	0								
Displaced Defense Workers	0	0	0	0								

Table 3: Personnel

University of Alabama in Huntsville
Manufacturing Education Teaching/Learning Laboratory

Personnel Classification	Total	Sex		US	Race/Ethnicity						Foreign	Disabled
		F	M		NA	AA	C	H	P I	A		
Faculty UAH & AAMU	11	2	9	11								
Management Staff UAH & AAMU	6	0	6	6								
Experts in the Classroom	0	0	0	0								
Other Educational Personnel	4	0	4	4								
Visiting Faculty	0	0	0	0								
Stud. in Short-term Technician Training	0	0	0	0								
Stud. in Short-term Professional Training	0	0	0	0								
Stud. in Experimental Lower Division UG (Undergraduate)	0	0	0	0								

TABLE 4: FUNCTIONAL EXPENDITURES

The University of Alabama in Huntsville
"Manufacturing Education Teaching/Learning"
NAG8-1029 Jul-97

FUNCTIONAL CATEGORY	Project Year 1994-97	Current Year 3/96 - 9/97
Faculty Salaries	88,913	12,465
Student Salaries	834	0
Research Staff Slaries (Full-time (non teaching) research scientists and technical support)	15,811	1,648
Post-Doc Salaries	0	0
Adminstration Management Salaries (clerical support, contracts officer, etc.)	18,407	1,272
Fringe benefits	21,947	3,106
General Operating Expenses (includes subcontracts)	160,377	43,094
Facilities	0	0
Travel	1,914	1,510
Equipment	805	0
University Overhead-Indirect Costs	71,176	12,538
Total	380,184	75,633

Table 5: Matching Funds by Source of Support

University of Alabama in Huntsville
Manufacturing Education Teaching/Learning Laboratory

Type	TRP/MET Award	Industry	Univ.	Other Federal Agencies	State	Other Support	Total
Cash-Unrestricted							
Cash-Restricted			49,932				
In-Kind Equipment, Materials and Supplies		17,000					
In-Kind Personnel		13,500					
In-Kind Software							
Other Operations		30,000					
Total		60,500	49,932				110,432

Information taken from attached memos dated April 16, 1997.

Table 6: Industrial Participation

University of Alabama in Huntsville
Manufacturing Education Teaching/Learning Laboratory

Company	Type of Support	Type of Part.	Size	Foreign	Representative(s)	Hire or Supervise	Engineering Production
Chrysler Electronics	☐ CA ☐ SE ☒ IP ☐ OS ☒ IE ☐ NA ☐ IS	☒ A ☐ F ☒ L	○ S ○ M ● L	○ Yes ● No	J. Evans	● H ○ S ○ N	● Yes ○ No ○ Unkn
Remarks							
Boeing	☐ CA ☐ SE ☒ IP ☐ OS ☐ IE ☐ NA ☐ IS	☒ A ☐ F ☐ L	○ S ○ M ● L	○ Yes ● No	C.Bateman	● H ○ S ○ N	● Yes ○ No ○ Unkn
Remarks							
Hughes	☐ CA ☐ SE ☒ IP ☐ OS ☐ IE ☐ NA ☐ IS	☒ A ☐ F ☐ L	○ S ○ M ● L	○ Yes ● No	A. Avrick	● H ○ S ○ N	● Yes ○ No ○ Unkn
Remarks							
MagneTek	☐ CA ☐ SE ☒ IP ☐ OS ☐ IE ☐ NA ☐ IS	☒ A ☐ F ☐ L	○ S ● M ○ L	○ Yes ● No	P. Gill	● H ○ S ○ N	● Yes ○ No ○ Unkn
Remarks							
Motorola	☐ CA ☐ SE ☒ IP ☐ OS ☐ IE ☐ NA ☐ IS	☒ A ☐ F ☐ L	○ S ○ M ● L	○ Yes ● No	A. Klugman	● H ○ S ○ N	● Yes ○ No ○ Unkn
Remarks							
UDS/Motoroal	☐ CA ☐ SE ☒ IP ☐ OS ☐ IE ☐ NA ☐ IS	☒ A ☐ F ☐ L	○ S ○ M ● L	○ Yes ● No	A. Perry	● H ○ S ○ N	● Yes ○ No ○ Unkn
Remarks							

Table 7: Non-Industrial Participation

University of Alabama in Huntsville
Manufacturing Education Teaching/Learning Laboratory

Organization	Type of Support		Type of Part.	Size	Foreign	Representative(s)	Hire or Supervise	Engineering Production
Alabama Industrial Development Training	☐ CA ☒ IP ☒ IE ☒ IS	☐ SE ☐ OS ☐ NA	☐ A ☒ F ☒ L	○ S ○ M ○ L	○ Yes ● No	E. Castile, D. Brown, R. Hollis, S.Pollock,	● H ○ S ○ N	○ Yes ● No ○ Unkn
Remarks								
Alabama Society of Professional Engineers	☐ CA ☒ IP ☐ IE ☐ IS	☐ SE ☐ OS ☐ NA	☒ A ☐ F ☐ L	○ S ○ M ○ L	○ Yes ● No	J. Yalowitz	○ H ○ S ● N	○ Yes ● No ○ Unkn
Remarks								

Table 1
Background Information

YEAR 2

Function	Name	Phone	Fax	E-Mail
Principal Investigator	Bernard J. Schroer	(205) 895-6100	(205) 895-6783	schroerb@email.uah.edu
Co-PI	Arthur J Bond	(205) 851-5560	(205) 851-5561	
Technical Leader (if not PI)				
Database Contact				

Name
Manufacturing Education Teaching/Learning Laboratory

Home Institution
University of Alabama in Huntsville, Huntsville. AL

Co-Institution:
Alabama A&M University. Huntsville, AL

State

Updated 2/17/95

Data Collected

From	
Through	

Headquarters' Address

University of Alabama in Huntsville
Huntsville, AL 35899

HQ Phone (205) 895-6100 HQ Fax (205) 895-6783

Table 2
Project Activity Summaries

Project Title	Lev.	Investigator	Site	Test	Impl.	Del	Description
Undergraduate Manufacturing Education Teaching/ Learning Laboratory	☐ T ☐ L ☒ U ☐ A ☐ G ☐ P ☐ O	Bernard J. Schroer	University of Alabama in Huntsville	⊗ Yes ○ No	⊗ Yes ○ No ○ Cont.	⊗ M ○ C ○ W ○ Y ○ D ○ S ○ I ○ T ○ O	Lab Manuals
Undergraduate Manufacturing Education Teaching/ Learning Laboratory	☐ T ☐ L ☒ U ☐ A ☐ G ☐ P ☐ O	Arthur J. Bond	Alabama A&M University	⊗ Yes ○ No	⊗ Yes ○ No ○ Cont.	⊗ M ○ C ○ W ○ Y ○ D ○ S ○ I ○ T ○ O	Lab Manuals
	☐ T ☐ L ☐ U ☐ A ☐ G ☐ P ☐ O			○ Yes ○ No	○ Yes ○ No ○ Cont.	○ M ○ C ○ W ○ Y ○ D ○ S ○ I ○ T ○ O	
	☐ T ☐ L ☐ U ☐ A ☐ G ☐ P ☐ O			○ Yes ○ No	○ Yes ○ No ○ Cont.	○ M ○ C ○ W ○ Y ○ D ○ S ○ I ○ T ○ O	

Table 3: Personnel

Personnel Classification	Total	Sex F	Sex M	US	Race/Ethnicity NA	AA	C	H	P I	A	Foreign	Disabled
Faculty												
UAH	5	2	3	5	--	--	--	--	--	--	--	--
AAMU	6	0	6	6	--	--	--	--	--	--	--	--
Management Staff												
UAH	4	0	4	4	--	--	--	--	--	--	--	--
AAMU	2	0	2	2	--	--	--	--	--	--	--	--
Experts in the Classroom	--											
Other Educational Personnel	4	0	4	4								
Visiting Faculty	--											
Stud. in Short-term Technician Training	12											
Stud. in Short-term Professional Training	--											
Stud. in Experimental Lower Division UG (Undergraduate)	--											
Stud. in Experimental Upper Division UG (Undergraduate)	327											
Students in Experimental Master's Degree Program												
Graduate TAs												
Undergraduate TAs												

Through December 31, 1995
NAG8-1029

Table 4: Functional [ ]enditures

Functional Category	Project Year 1994-96 Current Year	Fiscal Year 1995-1996
Faculty Salaries	64,643	9,415
Student Salaries	834	0
Research Staff Salaries (Full-time (non-teaching) research scientists and technical support)	4,658	4,658
Post-Doc Salaries	0	0
Administration Management Salaries (clerical support, contracts officer,etc.)	1,783	972
Other Salaries Fringe benefits	10,292	1,941
General Operating Expenses Includes subcontracts	77,685	23,281
Facilities	0	0
Travel	404	0
Equipment	0	0
University Overhead-Indirect Costs	36,716	7,388
Total	197,015	47,655

Information taken from December 31, 1995 account statement.

Through 9/30/95

NAG8-1029

Table 5: Matching Funds by Source of Support

Type	TRP/MET Award	Industry	UAH Univ	Other Federal Agencies	State	AAMU Other Support	Total
Cash-Unrestricted			109,511			46,164	155,675
Cash-Restricted							
In-Kind Equipment, Materials and Supplies		97,500	15,780				113,280
In-Kind Personnel		2,900 600 950			109,600 1,008		115,058
In-Kind Software							
Other							
Total		101,950	125,291		110,608	46,164	384,013

Information taken from October 16, 1995 match report
Dr. Schroer to Dr. Carlisle

Table 6: Industrial Participation

Company	Type of Support	Type of Part.	Size	Foreign	Representative(s)	Hire or Supervise	Engineering Production	Remarks
Chrysler Electro.	☐ CA ☐ SE ☒ IP ☐ OS ☒ IE ☐ NA ☐ IS	☒ A ☐ F ☒ L	○ S ○ M ⊗ L	○ Yes ⊗ No	J. Evans	⊗ H ○ S ○ N	⊗ Yes ○ No ○ Unkn	
Boeing	☐ CA ☐ SE ☒ IP ☐ OS ☐ IE ☐ NA ☐ IS	☒ A ☐ F ☐ L	○ S ○ M ⊗ L	○ Yes ⊗ No	C. Bateman	⊗ H ○ S ○ N	⊗ Yes ○ No ○ Unkn	
Hughes	☐ CA ☐ SE ☒ IP ☐ OS ☐ IE ☐ NA ☐ IS	☒ A ☐ F ☐ L	○ S ○ M ⊗ L	○ Yes ⊗ No	A. Avrick	⊗ H ○ S ○ N	⊗ Yes ○ No ○ Unkn	
MagneTek	☐ CA ☐ SE ☒ IP ☐ OS ☐ IE ☐ NA ☐ IS	☒ A ☐ F ☐ L	○ S ⊗ M ○ L	○ Yes ⊗ No	P. Gill	⊗ H ○ S ○ N	⊗ Yes ○ No ○ Unkn	
Motorola	☐ CA ☐ SE ☒ IP ☐ OS ☐ IE ☐ NA ☐ IS	☒ A ☐ F ☐ L	○ S ○ M ⊗ L	○ Yes ⊗ No	A. Klugman	⊗ H ○ S ○ N	⊗ Yes ○ No ○ Unkn	
UDS/Motoroal	☐ CA ☐ SE ☒ IP ☐ OS ☐ IE ☐ NA ☐ IS	☒ A ☐ F ☐ L	○ S ○ M ⊗ L	○ Yes ⊗ No	A. Perry	⊗ H ○ S ○ N	⊗ Yes ○ No ○ Unkn	
	☐ CA ☐ SE ☐ IP ☐ OS ☐ IE ☐ NA ☐ IS	☐ A ☐ F ☐ L	○ S ○ M ○ L	○ Yes ○ No		○ H ○ S ○ N	○ Yes ○ No ○ Unkn	

Table 7: Non-Industrial Participation

Organization	Type of Support	Type of Part.	Size	Foreign	Representative(s)	Hire or Supervise	Engineering Production	Remarks
AL Ind. Dev. Training	☐ CA ☐ SE ☒ IP ☐ OS ☒ IE ☐ NA ☒ IS	☐ A ☒ F ☒ L	○ S ○ M ○ L	○ Yes ⊗ No	E. Castile D. Brown R. Hollis S. Pollock J. Paxton	⊗ H ○ S ○ N	○ Yes ⊗ No ○ Unkn	
AL Society of Prof. Engineers "	☐ CA ☐ SE ☒ IP ☐ OS ☐ IE ☐ NA ☐ IS	☒ A ☐ F ☐ L	○ S ○ M ○ L	○ Yes ⊗ No	J. Yalowitz	○ H ○ S ⊗ N	○ Yes ⊗ No ○ Unkn	
AL Dept. Econ. & Comm. Affairs	IP	A		N	T. Holmes	H	N	
AL Board of Registration	IP	A		N	B. Smith	N	N	

Table 1
Background Information
Sample MET Project

YEAR 1

Function	Name	Key Personnel: Phone	Fax	E-Mail
Lead PI	Bernard J. Schroer	(205)895-6100	(205)895-6783	schroeb@email.uah.edu
Co-PIs	Arthur J. Bond	(205)851-5560	(205)851-5561	
Technical Leader (if not Lead PI)				
Data Base Contact				

Page 2 of 5

Sample MET Project

Name: Manufacturing Education Teaching/Learning Laboratory	Updated 8/8/94
Home Institution Sample University: University of Alabama in Huntsville — State: Huntsville, AL	Data Collected From: Through:
Partner Institution(s): Alabama A&M University — Huntsville, AL	
Headquarters' Address: University of Alabama in Huntsville, Huntsville, AL 35899	TRP Class
	Start Date 3/18/94
	TRP Proposal Number
	Agency COTR
HQ Phone (205)895-6100 HQ Fax (205)895-6783	Page 1 of 5

Quit | Print | Previous | Next | Done

Table 2
Project Activity Summaries

Project	Lev	Investigators (Name)	Instructional Sites	Test	Implement	Del	Deliverable Description
Undergraduate Manufacturing Education	U	Bernard J. Schroer	University of Alabama in Huntsville	Y	Y	M	Lab Manuals
Teaching/Learning Laboratory							
Undergraduate Manufacturing Education Teaching/Learning		Arthur J. Bond	Alabama A&M University	Y	Y	M	Lab Manuals
Laboratory							

Table 3
Personnel

[illegible]	Total	Gender M	Gender F	US or Perm Res.	Race - Ethnicity 1	2	3	4	5	6	Foreign	Disabled
Faculty UAH	4	3	1	4	0	0	0	0	0	4	0	0
Faculty A&M												
Management Staff	2	2	0	2	0	0	1	0	0	1	0	0
Other Educational Personnel												
Experts in the Classroom	0											
Visiting Faculy	0											
Students in Short-Term Technician Training Activities	0											
Students in Short-Term Professional Training Activities	16											
Students in Experimental Classes - Lower Division UG	0											
Students in Experimental Classes - Upper Division UG	165											
Students in Experimental Master's Degree Programs	0											
Displaced Defense Workers	0											
Graduate TAs	0											
Undergraduate TAs	0											
Students Doing Internships in Industry	0											

Table 4

Functional Budget

Function	CURRENT YEAR	NEXT YEAR
PROJECT ACTIVITIES: New Curricula/Modules	206,449	210,434
Educational Tools		
Delivery Systems		
Improving the Teaching/Learning Culture		
Testing and Implementation	25,800	25,800
Instruction		
ADMINISTRATION: Shared Equipment	55,000	55,000
Management	45,293	48,932
Travel	2,800	2,800
Communications Infrastructure and Associated Expenses	5,000	5,000
Indirect Costs	75,027	77,089
TOTAL	415.369	425,055

Table 5
Matching Funds by Source of Support

TYPE	TRP/MET Award	University	Industry	Other Federal Agencies	State	Other Support	TOTAL
Cash - Unrestricted	131,523	143,076					274,599
Cash-Restricted							
In-kind: Equipment, Supplies, Materials					55,000		55,000
In-kind: Personnel			25,800		60,000		85,800
In-kind: Software							
Other							
TOTAL	131,523	143,076	25,800		115,000		415,369

Table 6
Industrial Partners

Company or Consortium	Type of Support	Type of Participation	Firm Size	Foreign	Representative(s)	Remarks
Chrysler Electro.	IP, IE	A, L	L	N	J. Evans	H Y
Boeing	IP	A	L	N	C. Bateman	H Y
Hughes	IP	A	L	N	A. Avrick	H Y
MagneTek	IP	A	M	N	P. Gill	H Y
Motorola	IP	A	L	N	A. Klugman	H Y
UDS/Motoroal	IP	A	L	N	A. Perry	H Y

Table 7
Non-Industrial Partners

Organization	Type of Support	Type of Participation	Foreign	Representative(s)	Remarks
AL Ind.Dev.Train.	IP, IE, IS	F, L	N	E. Castile	H N
AL Society of Prof. Engineers	IP	A	N	J. Yalowitz	N N
AL Dept. Econ. & Com. Affairs	IP	A	N	T. Holmes	H N
AL Board of Registration	IP	A	N	B. Smith	N N

VOLUME II

Technology Reinvestment Project
Manufacturing Education and Training

Undergraduate Manufacturing
Teaching/Learning Laboratory

Lead Institutions:

University of Alabama in Huntsville
Alabama A&M University

Project Directors:

Bernard J. Schroer
University of Alabama in Huntsville
Huntsville, AL 35899

Arthur J. Bond
Alabama A&M University
P.O. Box 1148
Normal, AL 35762

Grant: NAG8-1029
Marshall Space Flight Center
National Aeronautics and Space Administration

March 18, 1994 - September 17, 1997

September 1997

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APPENDIX B

PROJECT OUTPUT/DELIVERABLES

THE RATE TRAINER

Developed by:

Mr. Engineer Company
984 West Carroll St.
Dothan, AL 36301
(334)794-8440
Fax (334)792-2847

and

Center for Automation and Robotics
University of Alabama in Huntsville
Huntsville, AL 35899

1996

TABLE OF CONTENTS

1.0 INTRODUCTION

Every manufacturing firm is concerned with the cost of manufacturing. Furthermore, every manufacturing firm is concerned with determining the time to manufacture a part.

Time study is a technique for "establishing an allowed time standard for performing a given task, based on measurement of the work content of the prescribed method, with due allowance for fatigue and personal and unavoidable delays" (*Handbook of Industrial Engineering*, John Wiley & Sons, Salvendy, editor, 1992). The steps in conducting a time study are given in Figure 1.

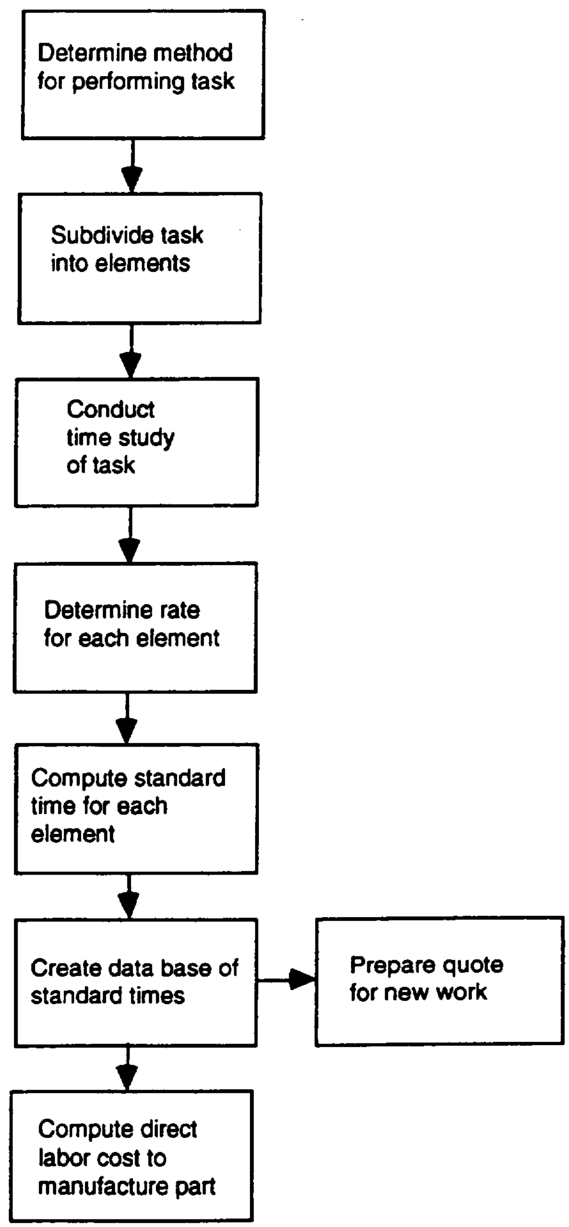

Figure 1. Steps in conducting a time study

Some of the problems encountered in performing a time study are:

- Need for a trained time study analyst, or industrial engineer, to perform the time study.
- The determination of the number of samples to be collected for each time study element to obtain confidence in the standard.

The Rate Trainer can be used to teach the concepts of normal time, or normal pace, and rating, or efficiency. The Rate Trainer is a tool which helps an operator develop a feel for a 100% rate and to compare the operator's rate with a 100% rate. The operator receives instant feedback on the efficiency for each cycle. This feedback can then be used by the industrial engineer to assist the operator reach the desired rate for the operation.

The Rate Trainer can also be used as a training tool. For example, the industrial engineer can observe an operator and compare the operator's rate with a 100% rate.

The Rate Trainer has evolved from Mr. Engineer Company's many years of working with manufacturing firms. Mr. Engineer Company has teamed with The University of Alabama in Huntsville to develop The Rate Trainer.

2.0 SYSTEM INSTALLATION

The minimum requirements for installing The Rate Trainer on a PC are:

- 386 PC with 8mb of memory
- Hard drive
- Windows 3.1

The steps to install The Rate Trainer are:

1. Exit Windows and enter DOS.
2. Place The Rate Trainer disk into disk drive.
3. Execute program SETUP.EXE. This program will automatically install The Rate Trainer software and create an icon in Windows.
4. To execute the software, return to Windows and click The Rate Trainer icon. Figure 2 shows the introductory screen for The Rate Trainer.

The Switch Box comes with a 25 ft cable attached to a RS232 connector. The RS232 connector should be inserted in serial port COM1 or COM2 of the PC.

3.0 OPERATION OF RATE TRAINER

The Rate Trainer can be used by selecting the Mouse Port option or the Space Bar option in the Configuration menu. The Rate Trainer can also be used with the Mr. Engineer switch box by selecting the appropriate COM port in the Configuration menu.

The steps to use The Rate Trainer are:

1. Input time for 100% rate in the Setup menu (See Figure 3).
2. Input Rate Display Parameters in Setup menu (See Figure 3).
3. Select mouse, keyboard or Mr. Engineer switch in Configuration menu.
4. Select Record Sample Rate in Run menu (See Figure 2).
5. Click mouse, space bar or Mr. Engineer switch to start clock.
6. Click mouse, space bar or Mr. Engineer switch to stop clock.