COMPUTER AIDED DESIGN AND DRAFTING/ INDUSTRIAL/AUTOMOTIVE MODELLING OPTION NEEDS ASSESSMENT

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COMPUTER AIDED DESIGN AND DRAFTING/ INDUSTRIAL/AUTOMOTIVE MODELLING OPTION NEEDS ASSESSMENT

EXECUTIVE SUMMARY

- This needs assessment was undertaken in order to assess the need for an Automotive/Industrial Modelling Option for the Computer Aided Design and Drafting program at OCC.

- Information for the assessment was obtained from a sample survey of employers in the field, a literature search, data from state and federal government sources, information from professional organizations, and a survey of existing training programs.

- The automotive industry is under increasing competitive pressure to move faster towards technological change in computer aided design and manufacturing systems. The proposed option is an attempt to keep pace with these developments by providing an integrated approach to industrial modelling.

- Employment prospects for those qualified in CAD/industrial modelling skills appear favorable. Demand nationally is expected to grow as fast as average up to the year 2005. There are expected to be strong employment opportunities for individuals with CAD skills.

- Employers contacted in the OCC survey and experts in the field responded favorably to the combination of skills suggested by the proposed OCC program. It would appear that the "Big Three" are moving faster than the smaller companies towards developing broader skills for their employees.

- Currently most individuals enter the field with high school education and additional training from a trade school or community college. Employers demand high levels of skill and favor industrial experience but seem less concerned with formal academic qualifications.

- There are a number of institutions in South-East Michigan, including the nationally recognized Center for Creative Studies, offering programs in Industrial Design, Computer Aided Design and Drafting. However, none of these programs offer the integrated approach proposed at OCC.

OAKLAND COMMUNITY COLLEGE
COMPUTER AIDED DESIGN
INDUSTRIAL/AUTOMOTIVE MODELLING OPTION
NEEDS ASSESSMENT

INTRODUCTION

Initiation of Proposed Program

This proposal was developed in February 1993 by Tahir Khan and Thomas Sawasky of the Technology Department at Auburn Hills, and Raymond Katz, faculty member in the Humanities/Art Department. The impetus for the proposal stemmed from an attempt to keep pace with technological changes in computer aided design and manufacturing systems. This proposed new program option would bring together the manual and computer aided design/modelling techniques. Manufacturing companies in the Southeast Michigan area, including the major automotive companies such as Chrysler Corporation, have shown interest in the program, designed to prepare students for entry level employment in automotive/industrial modelling.

Description of Proposed Program

The program would be an option in the CAD Associate in Applied Science degree program. As indicated in the Ten Year Enrollment Trends report prepared by the Office of Institutional Planning and Analysis (Appendix C), this program has experienced strong growth in both student headcount and credit hours over the last ten years.

The proposed option would represent an interdisciplinary approach to Industrial Product Modelling by combining the Auto Body option within the CAD program, with the Industrial Product Design program. The proposed program would allow students preparing for the industrial modelling/sculpting and prototyping industries to fully understand the concepts of the disciplines involved and the technical background to apply the latest technologies. Students would be prepared for careers in: clay, wood, cardboard and metal model making, as well as working in a proto-type situation or in the generation of solid modelling using sophisticated tools such as stereolithography.

Description of Occupation

It proved extremely difficult to obtain a satisfactory description of this occupation because of the nature of the advanced technology skills being proposed. Possible job titles suggested by the faculty include "proto-type parts fabricator" or "stereolithography technician". The available literature does not recognize these titles, however, the Dictionary of Occupational Titles defines "Clay Modelers," "Computer-Aided Designers," and "Industrial Designers." The title "industrial designer" embraces

much of the type of work involved. The Occupational Outlook Handbook, 1992-93, describes the nature of this occupation (industrial designer) as follows:

> "Industrial designers usually specialize in one particular area of design... Designers in some specialties are increasingly using computer-aided design to create and better visualize a final product. Industrial designers use computer-aided industrial design to not only create a design but to communicate the design to automated industrial tools.
>
> Most industrial designers work for consulting firms or large manufacturing companies. Industrial design requires a bachelor's degree. Graduates of two year programs generally qualify as assistants to designers."

Consultation with the staff of the Michigan Employment Security Commission confirmed that there is no existing data base which identifies the group of those who work in the CAD/CAM field. The occupation still tends to be located within the more general design or drafting group. Researchers at Wayne State University, Center for Urban Studies, undertaking research for the 1989 "Study of New and Emerging Occupations in Michigan" encountered the same problems of identifying data related to "new" occupations such as those in the CAD field. They were unable to identify "new" occupations in the Standard Occupational Classification Manual and were forced to develop new codes for the purposes of their survey.

The situation becomes more complex with the proposed addition of industrial/clay modelling skills, since so few individuals currently working in the field have this combination of skills. In addition, industrial/clay modelers are regarded within the automotive industry as having essentially artistic talents and skills.

Relation of Proposed Program to College Mission

This proposal meets the objectives of Goal 1 of the OCC Mission Statement in offering "learning opportunities and experiences which respond to the vocational needs of the communities OCC serves." The proposal also addresses Part C of this Goal in that it will help to provide "a curriculum responsive to the changing educational needs of the residents of the district."

METHODOLOGY

Methods of Data Collection

A modified version of the OCC needs assessment process was adopted for this report. A literature search was performed for background information on the field. In addition, employment information was obtained from a variety of professional, industry, public and regulatory bodies. A phone survey of sixteen employers was carried out in order to validate employment opportunities in the area and to elicit employer educational and certification requirements. This sample of employers,

although smaller than that normally used in the needs assessment process, was considered appropriate given the nature of the assessment.

A review of existing automotive/industrial modelling programs in higher educational institutions in Michigan was conducted. Comparisons of enrollment and graduation information were made, and an examination of program content was conducted.

Methods of Data Analysis

Qualitative analysis of employer survey data was conducted and the verbal responses were analyzed for content.

ANALYSIS

Industry Outlook

Motor vehicle manufacturing is under increasing competitive pressure to make major changes in its design, development and production processes. Current trends within the industry are towards Computer Integrated Manufacturing (CIM) systems, consisting of a number of design, engineering, and manufacturing functions combined with computer hardware and software, control systems, and machine tools designed to produce high quality products at low cost.

The main technologies that make up CIM are computer-aided engineering (CAE), computer-aided design (CAD), computer-aided manufacturing (CAM), and the management information systems (MIS) which include networking between the functions. At the current level of technology, CAE software is used for engineering analysis, such as finite element structural analysis. CAD is the representation of surface using geometry, while CAM applies manufacturing processes such as tool path analysis and die design.

These systems are closely linked with the movement by the automobile companies away from sequential engineering and towards a concurrent engineering philosophy. This latter concept involves all phases of product design and development working together, concurrently, as a team, to shorten the time to market, reduce cost and redundancies, and improve quality in order to compete in the international marketplace.

In the search for shorter product development cycles there are new opportunities for CAD/CAM applications. Currently automotive exterior and interior surfaces are styled using clay models, which allow for the development of several concepts quickly before one is chosen for refinement. The clay model is then converted into a CAD/CAM model for programming numerically controlled mills. Surface points are taken using a laser or coordinate measuring machine, creating a data file of points, which is then fitted into geometric surfaces by a CAD/CAM operator. This process of generating a new body look is known as reverse engineering.

Future applications of CAD/CAM will still require the use of clay models, but only as conceptual guides. Increasingly sophisticated CAD systems will give designers more surface control and could also allow them to use previous designs, stored in common data bases, for new applications.

These developments within the automobile industry are taking place within the context of continued downsizing and greater teamwork; workers are now expected to have higher and more comprehensive skill levels to function effectively. In addition, due to the movement towards rapid proto-typing, more of the product engineering function is taking place at the supplier level, thus extending the need for more sophisticated skills to a wider group of workers.

Employment Opportunities

Current Employment

The Michigan Occupational Information System (MOIS) groups CAD/CAM engineers and technicians within the classification of drafters. According to MOIS, about 318,700 drafters were employed, nationally, in 1988. Employment of drafters is expected to grow as fast as the average for all occupations through the year 2000, particularly with the extensive use of CAD systems. Individuals with associate degrees in drafting and those trained in computer-aided equipment will find the best opportunities.

There were about 22,950 drafters employed in Michigan in 1988. Most worked in urban areas. The majority worked for manufacturing companies or provided drafting services for a variety of businesses. Over 60% of those employed in manufacturing worked for companies that manufacture cars, trucks, and related equipment.

The "Study of New and Emerging Occupations in Michigan" (WSU Center For Urban Studies) reported that there are strong employment opportunities for those with CAD/CAM skills. Employers surveyed identified 8.5% of their current workforce as being in the new and emerging category. Of this category, almost 86% are associated with the introduction of computers, robotics, CAD/CAM and quality control. The following table (Table 1) identifies the distribution of different employment groups within the CAD/CAM technology classification:

Table 1
Current Employment in New and Emerging Occupations
in Michigan, by Technology

	White Collar				Blue Collar				
Technology	Admin.	Engineer	Tech.	Clerical	Precision	Production	Fabricator	Total	% of Total
CAD/CAM	219	4,189	2,121	68	1,984	3,277	354	12,212	11.2

Source: Study of New and Emerging Occupations in Michigan

Information from the OCC employer survey confirmed this employment data. All of the employers contacted confirmed their interest in hiring employees in the CAD field. Only two companies, both Ford and Chrysler, also indicated that they had recently or were currently considering clay modelers. Within the smaller, supplier companies and job shops there was less perceived need for those with solely clay modelling skills. All groups of employers, with one exception only, believed that combination of skills suggested by the proposed OCC program would be beneficial. Typical comments were directed to a perceived lack of understanding on both sides of the modelling and CAD requirements or skills. Other comments were as follows:

"More knowledge always helps an employee"
"Crossover backgrounds are always useful"
"Wider background knowledge is always beneficial"

Ray Campau, Supervisor of Clay Modelling at Ford, reported that the company is actively "trying to get modelers to work in 3 dimensional CAD."

Future Employment

On the national scale, according to the Occupational Outlook Handbook 1992-93, employment in design related occupations is expected to grow faster than the

average for all occupations through the year 2005. The Bureau of Labor Statistics projects that employment in the drafting area, which includes CAD/CAM operators, should increase by 13% from the 1990 level of 326,000 to 370,000 in 2005. The largest growth, projected at 46%, will be in the area of engineering and architectural services.

Within Michigan, MOIS reports that employment of drafters, is expected to increase as fast as the average for all occupations, through the year 2000. An average of 660 job openings annually is expected with 180 due to growth and 480 due to replacement.

These predictions are consistent with the findings of the "Study of New and Emerging Occupations in Michigan" which reported that, currently, more than a third of the new and emerging jobs in firms with less than 500 employees have been filled by "new hires". The new hire proportion is expected to increase to 50% of the new and emerging jobs to be added in the near future. In addition, five year projections indicate these new and emerging technology groups growing rapidly.

Experts in the field agree that there is a considerable need for well trained individuals with high level skills in the CAD/CAM field, especially in Michigan. Del Coates, consultant to the Industrial Designers Society of America and a previous Head of Design at the Center for Creative Studies commented, that in his view, training in these areas can "only become more important."

Table 2
Growth in New and Emerging Occupations
in Michigan, by Technology

	White Collar				Blue Collar				
Technology	Admin.	Engineer	Tech.	Clerical	Precision	Production	Fabricator	Total	% of Total
CAD/CAM	56	5,208	1,662	154	1,197	1,672	209	10,158	12.1

Source: Study of New and Emerging Occupations in Michigan

Information from the OCC employer survey confirmed that employers foresaw strong employment opportunities for the future, particularly for the "well qualified". Specific needs mentioned included digital scanners and clay milling machine operators.

Demand for Retraining of Current Employees

Within the largest firms of the automobile industry there is a growing trend toward requiring employees to master multiple skills. This coupled with the fact that technology tends to be implemented more quickly within the larger firms creates a potential demand for retraining in the new technologies and upgrading of existing skills (Cyert and Mowery, 1987). Smaller companies are more likely to hire a new employee to meet their needs, while the larger firms have the capacity to retrain their existing staff. Consistent with this, the "Study of New and Emerging Occupations in Michigan" identified the greatest impact of new technology on the modification of existing jobs rather than in the creation of totally new occupations.

Approximately half of those employers interviewed in the OCC sample indicated an interest in retraining their employees. This tended to be strongest in the CAD area although some companies indicated that training was already available to them from software vendors.

Employee Benefits

Wage and Salary

In 1990, according to the Occupational Outlook Handbook 1992-93, the average entry level salary in design related occupations was $25,700. Computer-Assisted Drafters earned salaries ranging from $22,000 to $32,600. The highest earnings of all drafters' wages are found in urban areas and for drafters working in manufacturing companies. Experienced drafters operating computer-aided-design equipment generally have higher salaries than other drafters.

Table 3 summarizes annual salaries, in early 1991, of various categories of industrial designers.

Table 3
Salaries of Industrial Designers

Title	Average	Average Salary Range
Designer	$33,900	$27,500-$41,200
Designer Drafter	$29,000	$24,200-$35,900
Tool Design Engineer (Beginning)	$28,600	$24,100-$35,800
Tool Design Engineer (Experienced)	$42,000	$33,600-$50,800

Source: MOIS

In Michigan, the average annual earnings of Industrial Designers working for private employers in the Detroit area in early 1991 ranged from $27,696 to $49,764. In the Michigan automobile industry, annual base salaries for most product engineering designers ranged from $27,348 to $59,940 in 1991. However, most of these designers would be required to have a bachelor's degree.

Information from interviews with employers indicated that salaries currently range from $17,000 per year, for entry level CAD Detailers, to $62,00 per year at the top level for a Master Modeler.

According to MOIS, most industrial designers receive paid vacations and holidays; life, accident, disability, and hospitalization insurance; retirement plans and sick pay. In addition, some employers offer stock purchase or savings plans.

Advancement Opportunities

MOIS cites possible steps in a career ladder as including industrial design assistant, industrial designer, design project leader, and design manager or consultant. Advancement depends on the talents and abilities of the individual. However, several of the employers contacted indicated, that a flattening of organizational structures is changing this type of career progression. Talented individuals working within team structures may receive recognition in terms of salary increase rather changes of title.

Occupational Desirability

The Occupational Outlook Handbook 1992-93 describes working conditions in this occupation as follows:

> "When designing and developing products, industrial designers work with engineers, research and marketing personnel, top-level managers, production experts and machine operators."

Work areas are generally clean, well lighted and air conditioned. Much of the designer's time may be spent at a CAD workstation but they may also be involved in production processes.

Occupation

Level of Training Needed

The "Study of New and Emerging Technologies in Michigan" identified a high level of skill as a prerequisite for employment in the CAD/CAM field. Generally four years of college or other technical and apprenticeship training were required. Engineers and engineering technicians were rated among the hardest-to-fill occupations as a result of the high skill levels required.

However, from employers contacted by OCC it would seem that there was less interest in formal academic qualifications than in appropriate training and experience. Only one company indicated that they usually required a bachelor's degree; the most frequently required educational qualification was high school graduation with additional training. This training could be in the form of an associate degree or trade school training combined with industrial experience. As frequently happens in the automotive industry, there tends to be movement from Original Equipment Manufacturers (OEM) companies, job shops and other suppliers to the "Big Three".

Adequacy of Currently Available Training

Within the state of Michigan, MOIS lists nine community college programs in the field of Industrial Design, 34 colleges offering programs in Computer Aided Design and 45 offering Drafting programs.

Several programs in Industrial Design offer instruction in both clay modeling and computer aided design. However, these programs do not necessarily focus on the automotive industry; instead, they concentrate on design. None of these programs offer the integrated approach proposed in the OCC program.

> **Ferris State University:** Ferris offers a baccalaureate degree in Product Design which is part of their Industrial Design program. Requirements for this degree include a modelling course which has a unit on clay modeling; there are other mediums used in the course including wood and styrofoam. Computer design is not taught in the modelling course, but the students use the modelling skills in their design courses. The focus of their program is on

design, there is no automotive concentration. They enroll 25--30 students each year at all levels, and their placement has been "100% to date."

Center for Creative Studies--College of Art and Design: CCS also offers a program in Industrial Design, which is nationally recognized. They have a course in clay modeling which is integral to their program as students are required to make clay models of all their designs. However, the course itself consists of only clay modeling; there is no computer design component. Students at CCS can focus on automotive design with the likelihood of working for General Motors, Chrysler, or Ford. The Industrial Design program enrolls 70 students each year at all levels, and approximately half of the matriculants graduate from the program. Their placement has been "above 75%" since the program's inception in the early 1960's. However, they did encounter problems placing graduates in 1992 when the recession hit the "Big Three," causing hiring freezes. The tuition for two full time semesters at CCS is $7,250.

University of Michigan (Ann Arbor): At the UM, the Industrial Design program is housed within the school of Art & Architecture. Students in the program learn to model in various mediums including clay, plastics and wood. They do not emphasize an automotive application, but they stress that their placement within the Big Three is quite high. There are 50 students in this program at all levels, and 5-6 students graduate each year. A spokesperson from the program believes that although the use of clay modeling has been greatly reduced, it will never be completely phased out. Computer-aided-design, on the other hand, will "grow and grow and grow." He also stressed that the hardest part for the U of M has been affording the software and hardware programs needed to teach the courses. They used to use "Autocad" and are now using "Powerdraw."

Walpro Technical Inc. - Clay Modelling School: Walpro has graduated over 100 people since its inception in 1988; 90% of these graduates are now employed. Walpro's instruction centers on the automotive industry. They do not offer any computer-aided-design courses; only clay modelling. Out of all the students they have placed, "No one has ever complained that they did not have CAD skills."

Macomb Community College: Macomb offers a program in Auto Body Design which incorporates interactive computer graphics with manual drafting. They contract with outside businesses and industries for use of their computer systems. Half of their students are "traditional" and half are there for retraining. Graduates are placed with the "Big Three;" with job shops; and with suppliers.

Wayne County Community College: Wayne offers a program in Drafting/Computer Aided Design. However, this program only enrolls 30--35 students and will likely be revised in the near future. They do not offer any clay modelling.

Schoolcraft College: Schoolcraft offers two programs under the umbrella of Computer Aided Design: Mechanical Design and Tool Design. They do not offer clay modelling within this program, but one of the instructors did see the benefit of clay modelling within a CAD program "especially in conjunction with the advanced versions of Autocad."

Preliminary Cost Estimate

It is estimated by faculty members that the proposed option would involve no additional costs as it would utilize existing equipment, hardware, software and resources within the college.

SUMMARY

Employment prospects for graduates of the proposed option would appear to be favorable with most experts expecting all CAD related occupations to grow. The concept of integrating industrial modelling and CAD skills was generally favorably received by both experts and employers in the field. It would seem that this type of integration is in harmony with both the technological and organizational changes taking place within the automobile industry. Within South-East Michigan this type of integrated option is not currently being offered at any of the other institutions.

APPENDIX A
NEW PROGRAM OPTION

NEW PROGRAM OPTION

COMPUTER AIDED DESIGN AND DRAFTING
TECHNOLOGY
Auburn Hills

Option - Automotive / Industrial modeling

This is an option in the CAD Associate in Applied Science degree program. This program represents an interdisciplinary approach to INDUSTRIAL PRODUCT MODELING. It is a combination of the AUTO BODY option within the CAD program , and the INDUSTRIAL PRODUCT DESIGN program.
This program allows students preparing for the industrial modeling / sculpting and proto-typing industries to fully understand the concepts of the disciplines involved and the technical background to apply the latest technologies. Students will be prepared for careers in; clay, wood, cardboard and metal model making, as well working in a proto-type situation or generation of solid modeling using sophisticated tools such as stereolithography.

Major Requirements

ADT 110	Introduction to Body Drafting	3 credits
ADT 230	Body Layout II - Surfacing	3 credits
APD 838	Template and Fixture Layout	3 credits
CAD 145	CO-OP	3 credits
CAD 245	CO-OP	3 credits
CAD 120	Computer Aided Design Applications I	3 credits
CAD 110	Introduction to Computer Aided Design	3 credits
CAD 130	Computer Aided Design Applications II	3 credits
CAD 213	Techniques and Applications for Design and Manufacturing	4 credit
CAD 215	Advanced Surfaces	4 credits
CAD 210	3-D Wire Frame and Surfacing	4 credits
DDT 105	Product Drafting	3 credits
DDT 115	Descriptive Geometry	3 credits
IPD 252	Industrial Sculpture I	3 credits
IPD 151	Model Making Techniques	3 credits
IPD 253	Industrial Sculpture II	3 credits
MAT 114	Plane Geometry	3 credits
MEC 101	Introduction to Manufacturing Processes	3 credits

Suggested Electives

ADT 210	Body Layout I - Detailing	3 credits
CAD 220	Product Detailing	3 credits
DDT 125	Advanced Descriptive Geometry	3 credits
IPD 101	Industrial Design Drawing	3 credits

General education Requirements
See graduation requirements for an Associate in Applied Science Degree on page 39.

NOTE:

1. Students are responsible for checking to ensure that all prerequisites have been met.

2. A student may substitute suggested electives for co-op classes with departmental approval.

6 PROGRAM NEED STATEMENT

Modelling is done extensively in industrial as well as in automotive fields. With changes in technology, the computer aided design and manufacturing systems are playing critical roles in modelling techniques. This new program option will bring together the manual and the computer aided design and modelling techniques. Area industry, especially Chrysler, has shown keen interest in this new Computer Aided Design and Drafting Option. This program option is designed to prepare graduates for entry level employment in automotive/industrial modelling.

No additional staff will be needed. No capital outlays are anticipated as existing labs will be used. A lab fee of $90 will be required for CAD classes, as recommended by campus.

7. PROGRAM GOALS AND OBJECTIVES

1. GOAL: The student will examine the materials and methods by which products are shaped in the preliminary model and prototype stages.

   OBJECTIVE: By the use of quizzes and project assignments the student will demonstrate the knowledge in concept model making through the use of various materials such as clay, wood, styrofoam, plaster, cardboard and plastic.

2. GOAL: The student will be exposed to modelling and fabrication of full size scaled models.

   OBJECTIVE: Student will demonstrate skills by performing procedures from rough stages of development through refinement using bucks, armature, section and grid lines, compound empathics, sweeps and splines.

3. GOAL: Student will examine advanced problems of modelling and fabrication, including surface development, construction of flat, concave, and complete planes and surfaces.

   OBJECTIVE: The student will demonstrate the skills by developing models dealing with advanced problems mentioned above.

4. GOAL: Students will learn the basic operation of the CAD system.

   OBJECTIVE: Through lectures, demonstrations and hands-on experience on a CAD system, students will demonstrate the skills of using a CAD system for basic applications.

5. GOAL: Students will design automotive/industrial components applying solid modelling techniques.

   OBJECTIVE: Students will demonstrate their understanding of the principles of solids design by completing design projects, performance tests, and quizzes.

6. GOAL: Students will learn the principles of detailing.

   OBJECTIVE: Students will demonstrate their understanding of the principles of detailing of parts by development of orthographic views, auxiliary views, and dimensioning and tolerancing.

7. GOAL: Students will learn the principles and techniques of three dimensional wireframe design and surfacing.

   OBJECTIVE: Through lecture, demonstrations, and hands-on sessions on a CAD system, the students will perform several tasks which will demonstrate their understanding of these principles.

8. GOAL: Students will study the relationships of points, lines, planes, views and their placement on body parts.

OBJECTIVE: Through quizzes and projects the students will display competence in the above mentioned topics.

9. GOAL: Students will learn the techniques of sheet metal development, true sections and projections of curved surfaces.

OBJECTIVE: Through test and assignments/projects the student will demonstrate the understanding of the above mentioned concepts.

10. GOAL: The students will learn the advanced concepts of curve and surface development, and the concepts of reverse engineering.

OBJECTIVE: Students will do projects that relate to advanced curve and surface development.

COURSE DESCRIPTIONS

CAD 110 Introduction to Computer Aided Design and Drafting 3 Credits
Prerequisite or corequisite: DRT 111 or equivalent or consent of instructor.
This course is an introduction to the field of computer aided design and drafting. It will provide students with an overview of the applications and development of computers as applied to the field of engineering drafting and design. The students will learn and apply computer aided design techniques and principles to create drawings and will learn the software capability of the system by generating, moving and editing the basic geometric elements. Students will become familiar with system hardware such as, but not limited to, CRT, keyboard, tablet/menu, etc. In addition to formal classroom lecture and demonstrations, students will use equipment such as a CAD system and other related hardware to complete a series of assignments.

CAD 120 Product Detailing 3 Credits
Prerequisite: CAD 110.
The student will learn the techniques and principles of creating orthographic and auxiliary views on a CAD system. The student will create working detail drawings by adding the necessary sections, dimensions, tolerances, notes and specifications to multiviews. Given a work description or isometric view of a simple object, the student will be able to completely describe its shape in orthographic multiview projection. The student will also develop skills in the use and selection of standard parts from the CAD Data Base.1.

CAD 130 Descriptive Geometry/Assembly Drawings 3 Credits
Prerequisite: CAD 120.
Students will learn the principles and techniques of dealing with advanced concepts of computer aided design and drafting drawings. The student will apply the principles of descriptive geometry to create views such as, but not limited to, isometric and true views. Students will perform analysis, such as section analysis and calculate weight and volume of the part. Emphasis is also placed on creating working details and assembly techniques to create assembly drawings.

CAD 145 Design and Drafting Co-op Internship 3 Credits
Prerequisite: CAD 210
This course provides the student with practical training in the field of Drafting/Design and CAE (Computer Aided Engineering Applications). The student will be employed in a supervised situation under the guidance of a qualified coordinator. During the Co-op Internship period the student will identify and describe, through reports, technical problems encountered on the job.

CAD 210.1 Three Dimensional Wireframe Design and Surfacing Credits
Prerequisite or corequisite: CAD 130 or consent of instructor.
The student will learn the principles and techniques of creating parts in three dimensions. Emphasis is also placed on basic surface generation techniques for design and manufacturing. Some of the topics include three dimensional part design, various types of surfaces, analysis, layers and filter, use of sets,

volume creation, etc. The student will use computer hardware and software to solve three dimensional engineering and drafting problems using computer aided engineering (CAE) techniques.

CAD 213 Techniques and Applications of Solid Modelling for Design and Manufacturing 3 Credits

Prerequisite: CAD 210 or consent of instructor.
Using a Computer Aided Design and Engineering (CAD/CAE) software package, the student will learn the principles and techniques of solid modelling for design and manufacturing. Practical applications of solid modelling are incorporated into this product oriented class. The student will use a CAD/CAE system to complete the solid modelling projects dealing with and not limited to metals, plastics and composites. The course also includes the basic analysis of solids, an overview of desktop manufacturing such as, sterolithography (technique of making plastic objects directly from Computer Aided Design data), and shading techniques of solid models.

ADT110 3 CREDITS

INTRODUCTION TO BODY DRAFTING
PREREQUISITES: DDT100 (FORMERLY DRT111) or advance placement through Tech Prep.

This course is an introduction to the Body Drafting / Design field. The student will study the relationship of points, lines, planes, and views as they relate to body drafts. The students will become familiar with the terms and projection techniques used in the body drafting field. Occupational awareness will be enhanced through group and individual projects.

Course fee.

ADT 230 3 CREDITS

BODY LAYOUT II- SURFACING

PREREQUISITES: ADT110, DDT115 (FORMERLY DRT116)
DDT105 (FORMERLY DRT112)

The students will develop skills in advanced body surfacing through the application of proportional surfacing techniques. Problems will include design clearance considerations, surfacing and developing several major vehicle panels as well as studying the impact of federal regulations on vehicle design.

Course fee.

IPD 151 .....3 Credits
Model Making Techniques
Prerequisistes: IPD 101.
This course examines the materials and methods by which products are shaped in the preliminary model and prototype stages of development. The student is introduced to the materials and techniques that the professional modeler normally encounters in the automotive and product industry. Projects are assigned to enable the student to acquire first-hand experience in concept model making through the use of various materials such as clay, wood, styrofoam, plaster, paper, cardboard, and plastic. Course fee.

IPD 252 .....3 Credits
Industrial Sculpture I
Prerequisite: IPD 151.
This course is focused on modeling and fabrication of full-sized and scale models of manufactured products through the development of mechanical and creative aptitudes of three dimensional interpretation from designer sketches and verbal description. Procedures from rough stages of development through refinement, using bucks, armature, section and grid lines, compound empathics, sweeps, and splines will be applied. Course fee.

IPD 253 .....3 Credits
Industrial Sculpture II
Prerequisite: IPD 252.
This course examines advanced problems of modeling and fabrication, including surface development, construction of flat, concave, and complex planes and surfaces. Use and design of templated, and shop machinery to create unique appearances and the application of materials to simulate finished production surfaces are studied. Course fee.

APPENDIX B
EMPLOYER LIST

Employer List

1. Chrysler Corp
   Michael Holmes
   12000 Chrysler Dr
   Detroit, MI 48288
   (313) 576-1202

2. General Motors
   Rick Stoey
   3044 W Grand Blvd
   Detroit, MI 48202
   (313) 986-4675

3. Auburn Engineering
   Rob Schweikhardt
   (313) 852-6250

4. CDI-Modern Engineering
   Ron Beach
   28000 Dequindre Rd
   Warren, MI 48092
   (313) 578-6000

5. CDI-Modern Engineering
   Jerry Fearn
   28000 Dequindre Rd
   Warren, MI 48092
   (313) 578-6000

6. CDI-Modern Engineering
   Ken Smiley
   28000 Dequindre Rd
   Warren, MI 48092
   (313) 578-6000

7. Hawtal Whiting
   John Voich
   800 Stevenson Hwy
   Troy, MI 48083
   (313) 597-7777

8. Hawtal Whiting
   George Smith
   800 Stevenson Hwy
   Troy, MI 48083
   (313) 597-7777

9. Hawtal Whiting
Don Harrison
800 Stevenson Hwy
Troy, MI 48083
(313) 597-7777

10. Ford Motor Co
Allen R. Kasper
American Rd P.O. Box 1899
Dearborn, MI 48121
(313) 322-3000

11. Ford Motor Co
Bill Sherman
American Rd P.O. Box 1899
Dearborn, MI 48121
(313) 322-3000

12. Ford Motor Co
Ray Campau
American Rd P.O. Box 1899
Dearborn, MI 48121
(313) 322-3000

13. ECS Roush Inc
Betty Zink
11916 Market
Livonia, MI 48150
(313) 591-4342

14. Pioneer Engineering
Russ Damphousse
32201 North Avis
Madison Heights, MI 48071
(313) 589-3411

15. Johnson Controls
Dave Harrison
375 Robbins Dr
Troy, MI 48083
(313) 585-6490

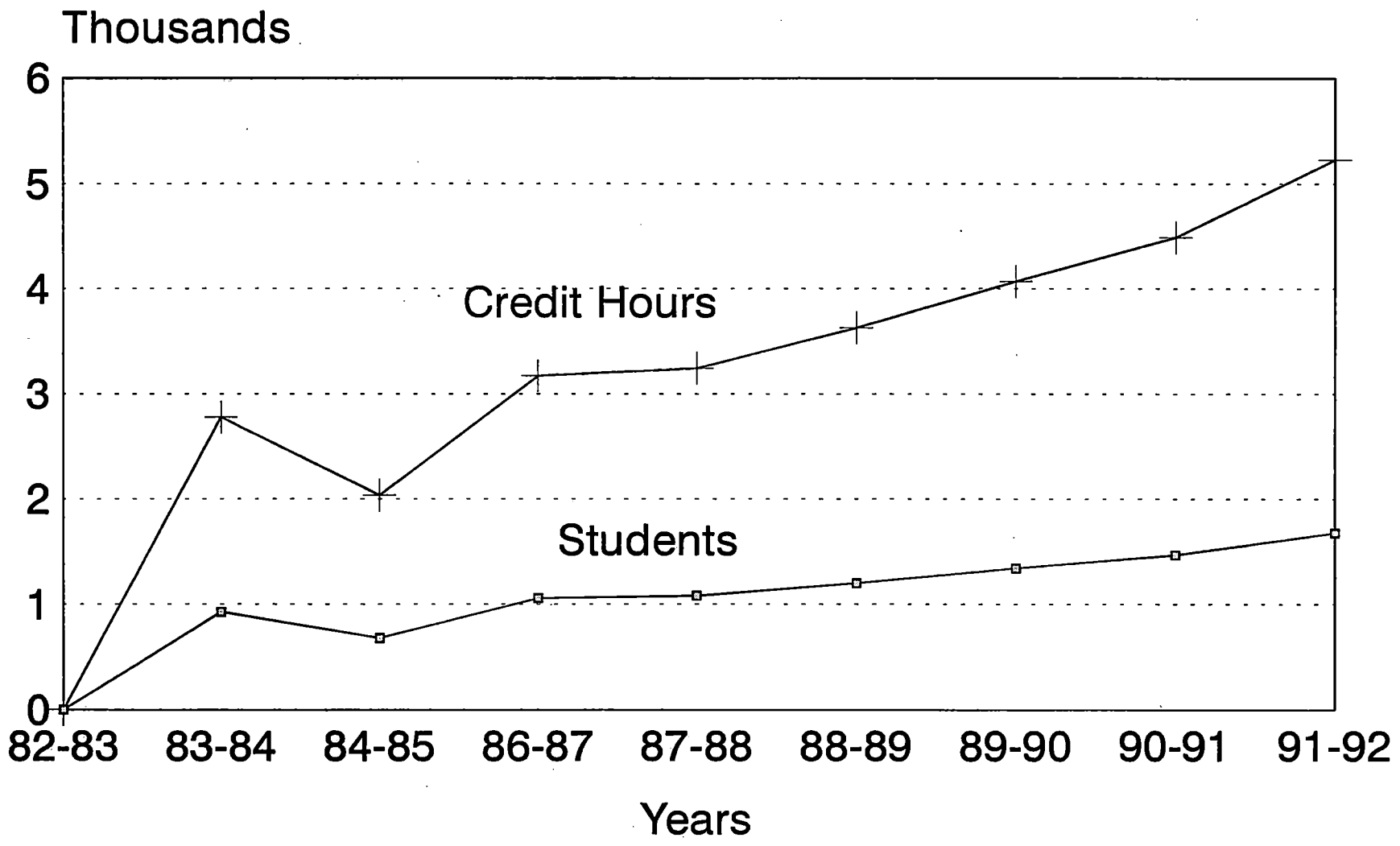
16. Tri-Co. Engineering
Larry Peters
616 Ajax Dr
Madison Heights, MI 48071
(313) 589-3505

APPENDIX C
SCH AND ENROLLMENT TRENDS IN COMPUTER AIDED DESIGN

Oakland Community College

SCH and Enrollment in Computer Aided Design

(1982-83 through 1991-92)



Source of Data: ACS-6 Enrollment Report

APPENDIX D
INDUSTRIAL/AUTOMOTIVE MODELLING EMPLOYER SURVEY

Survey Number _____

INDUSTRIAL/AUTOMOTIVE MODELLING
NEEDS ASSESSMENT
EMPLOYER TELEPHONE SURVEY

Name of Business:_____

Type of Business: _____

City and Zip Code:_____

Telephone: _____

A. Once you reach the Director of Training, Personnel, Human Resources or other appropriate supervisor, be sure to record:

Name: _____

Title:_____

Phone:_____

Time Interview Begins:_____

SURVEY

B. Begin survey here:

We are in the process of considering implementing a new option within the Computer Aided Design and Drafting program. The new option would concentrate on industrial modelling; the student would be trained in both clay modelling and CAD.

1. a) Do you think the proposed new option of combining clay modelling with computer-aided design is a good idea?

_____ *Yes*

_____ *No*

_____ *Uncertain, please explain:*_____

b) Would a student trained in both be better qualified than someone trained in either CAD or clay modelling alone?

_____ *Yes*

_____ *No*

c) Is there a need for employees trained in both areas?

_____ *Yes*

_____ *No*

2. Do your employees do both clay modelling and computer aided design or are these areas handled by different employees?

_____

_____

_____

_____

3. Among your clay modelers and computer-aided designers, what are examples of salary ranges for **entry** level positions?

Entry Level Salary Range

_____ to _____ per hour

_____ to _____ per hour

_____ to _____ per hour

4. Are you now hiring in either area? Which one?

1 _____ Yes *(Please circle clay modelling or computer aided design)*

0 _____ No

7 _____ Uncertain, please explain: _____

5. How do you recruit clay modelers and computer-aided designers?

_____

_____

_____

6. What is the minimum **educational** qualification required by your organization for entry-level personnel in clay modelling and computer-aided design?

	Yes	*No*
a) No specific educational requirement	0	1
b) High School diploma or equivalent	1	0
c) Completion of Apprenticeship	1	0
d) Certificate	1	0
e) Associate degree	1	0
f) Bachelor degree	1	0

g) Other education or degree, not listed *(Please specify)* _____

7. As part of our assessment we are interested in understanding potential career paths for entry level clay modelers and computer aided designers. Could you explain what advancement opportunities are available, with examples of typical job titles?

_____

_____

_____

8. a) Can you tell us the name of the computer system you use in your design studios?

_____

b) If a student were trained using an alternative software program, would you consider hiring that student or would their training not be applicable to your company's needs?

_____

_____

_____

9. Would your organization consider sending current employees to OCC for retraining in an Industrial Modelling program which combined clay modelling with CAD?

1 _____ Yes
0 _____ No
7 _____ Uncertain, please explain:_____

10. Would your organization consider offering internships (either paid or non-paid) for students in an Industrial Modelling program?

PAID?
1 _____ Yes
0 _____ No
7 _____ Uncertain, please explain: _____

UNPAID?
1 _____ Yes
0 _____ No
7 _____ Uncertain, please explain: _____

Thank you for your time and assistance. We appreciate your help and believe that your responses will help to influence what happens in our community colleges in the future. If you have any further questions please contact OCC's Office of Planning and Analysis at (313) 471-7746.

Interviewer: _____

Date: _____

Time interview finished: _____

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Manufacturing Engineering, "Shake Down Years for Automakers," April 1993, vol. 110, p.16.

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Occupational Outlook Handbook 1992-93

Olling, Gus J. "CAE/CAD/CAM Perspective at Chrysler Corporation."

Vasilash, G. S. "Defining the unknown part (CAD/CAM using clay models). Production, vol. 101, no. 2, p.57-59.

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