OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

RESTRICTED

DP/ID/SER.A/1437
8 February 1991
ORIGINAL: ENGLISH

18804

CONSULTANCY SERVICES REGARDING COMPUTER APPLICATIONS IN OFFICE AND INDUSTRY

SI/LIB/89/801

LIBYA

Technical report: Industrial mechanization and automation, particularly in the area of CAD/CAM applications*

Prepared for the Government of
the Socialist People's Libyan Arab Jamahiriya
by the United Nations Industrial Development Organization,
acting as executive agency for the United Nations Development Programme

Based on the work of Stanislaw Zietarski,
CAD/CAM expert

Backstopping officer: E. Kok, Engineering Industries Branch

United Nations Industrial Development Organization
Vienna

* This document has not been edited.

V.91 21310

Abstract

The report covers the scope of activities carried out by Stanislaw Zietarski,CAD/CAM expert,within the frames of the project: CONSULTANCY SERVICES REGARDING COMPUTER APPLICATIONS IN OFFICE AND INDUSTRY, SI/LIB/89/801/11-02, at the Secretariat for Strategic Industries in Misurata,Libya, from 3 August to 7 October 1990.

The purpose of the project:

- to enable the Secretariat for Strategic Industries to introduce CAD/CAM technology onto industrial level,particularly in engineering industries.

The duties defined for the post are to:

- identify suitable engineering industry plants,where CAD/CAM systems should be fully utilized as an integrated part of its manufacturing and/or design operations;
- assist the Secretariat in the setting up of a pilot CAD/CAM system which could be utilized for training purposes of mechanical and industrial engineers from the selected plants;
- advise the Secretariat on the reguirements of hardware,software,and peripheral equipment necessary for the proper functioning of the pilot CAD/CAM system;
- recommend a plan of action for implementing CAD/CAM system at selected industrial enterprises,training programmes for CAD/CAM users as well as future technical assistance required.

After first days discussions within the Secretariat the workplan has been established (Annex 1) and additional tasks have been added :

- to prepare the program for the intensive training course on CAD/CAM technology for selected engineers from the plants concerned (Annex 2);
- to lecture,carry out workshops,and consult on the program topics.

Taking into account the scope of products manufactured in the plants concerned and production plans for the comparatively near future,the pilot CAD/CAM project has been devised,which is divided in two interrelated phases (Annex 4, Annex 5).

Table of contents

Introduction

In the decade of 1980s,the CAD/CAM technology was economically justified only in design and manufacture of highly sophisticated,complex products like spaceships,airplanes,computers, vehicles,ships,color TV sets,etc.;therefore it could be viable in developed countries.

At the present stage of the CAD/CAM development,there is deep conviction about the ubiquitous impact of computers on all industry sectors.In whatever industry sector,it is understood that entreprises are unlikely to survive in an increasingly competitive market,unless they understand how the computers can aid their product design and manufacturing. So it is little wonder that developing countries,among them Libya,want to exploit the full potential of this technology.

The question is no longer "should" the Libyan industry become involved in advancement of computer applications in domestic plants,but rather "how" to best utilize available resources (such as manpower,capital,and equipment),to most effectively enter the field of CAD/CAM and then FMS or CIM technologies.

As a rule,the main point of interest for developing countries and for the Libyan industry as well are microcomputer-based components of CAD/CAM systems.But it is often misunderstood,that it means PC class computers only. So far there is no professional CAD/CAM system available for IBM PC class microcomputers.

In Libyan industry,the efforts are being made to accomodate advances in computer applications with national development programmes,which is particularly visible in the Strategic Industries sectors.

In order to establish a framework and propose necessary steps related to the development of CAD/CAM technology within the Strategic Industries,the working visits to 15 plants have been arranged.After that it has been possible to evaluate the advancement of manufacturing methods used in the plants and to evaluate the diffusion of computers and computer controlled production equipments.

The important distinquished fact arising from the working visits is that there is not any fully implemented NC machine tool in the plants visited. It has to be pointed out,that numerically controlled machine tools (NC,CNC) must be seen as a starting point and substantial element of CAM in the industrial environment,therefore,the Strategic Industries should install and to put into operation some CNC machines in the selected plants.This has been elaborated in the report. The successful completion of two phases of the pilot CAD/CAM project (Annex 4,Annex 5) is a prerequisite for the next step toward factory automation (FMS,CIM).

An absolute prerequisite for the success of any strategy for CAD/CAM development will be the creation of an awareness at the highest levels,of the value of CAD/CAM as an essential factor in industrial development.

I. ANALYSIS OF THE CURRENT AND PROJECTED PRODUCTION

The Libyan industry is divided into three main groups: oil industry, light industry, and strategic industry. The oil industry plays a dominant role in the Libyan economy (92 percent of total export income in 1987). The light industry has the largest employment (appr. 33000 employees), and appr. 16000 employees have been employed in the Strategic Industries plants. The Strategic Industries are subdivided into 17 companies, grouped in four sectors. These industry sectors are: metallurgical industry, chemical industry, engineering industry, and construction materials industry.

In order to propose ways and means to develop technical capabilities in regard to applications of the CAD/CAM technology it was necessary to gather suitable information on job shop and small batch manufacturing. To do it, fifteen largest plants within the Strategic Industries have been visited. The plant data have been gathered according to the specific questionnaire (Annex 3). Detailed discussions with managers and enginneers on the spot and having seen shop floors have helped enormously in establishing the limits to feasibility of CAD/CAM applications. Such data as machine tool types, production equipment, production volumen, number of different parts, repeatability of batches, complexity of parts, projected change of products have been utilized for the pilot CAD/CAM project.

Engineers involved in any computer-based activity in the plants visited have been encouraged to participate in the intensive training course on CAD/CAM, organized by the Secretariat for Strategic Industries in Misurata (Annex 2). Fourteen engineers took part in the course (two weeks, lectures - 36 hours, computer workshop - 72 hours). Eight of them passed the final examination.

The visited plants:

- Iron and Steel Complex, Misurata;
- Chemical Complex, Abu Kammash;
- TV Set Factory, Zawia;
- PC Board Plant, El Maya;
- Spare Parts General Company, Tripoli;
- General Company for Wire and Electricity, Benghazi;
- General Company for Pipes, Benghazi;
- Central Workshop, Benghazi;
- Libyan Cement Company, Benghazi;
- Tire and Battery Plant, Tajura;
- Truck and Bus Company, Tajura;
- Libyan Tractor Company, Tajura;
- General Company for Computers, Tripoli;
- Filter Factory, Tajura;
- Construction and Metalwork Company, Tripoli.

There are considerable variations among the companies as to the advancement of manufacturing methods, availability of a modern production equipment, manpower shortage, and other factors which influence productivity of the company. In most companies, at least in some departments, the complexity of products and the number of manufactured parts justifies using the CAD/CAM technology, particularly numerically controlled machine tools (NC).

Some plans for projected new products,for example, mold and dies for TV tubes,for buses and trucks,and spare parts manufacture downright necessitate wide and advanced use of a CAD/CAM technology. For complex shapes of products,the high quality cannot be achieved unless the CAD/CAM will be fully applied. There were some approaches in the past to implement CNC machine tools on shop floors,but it was unsuccessful. Lack of skilled manpower and qualified engineers staff precluded and still precludes successful implementation of CNC machine tools.

This is the most important indication as to what goals should be set for the pilot CAD/CAM project.

Genarally speaking,there is a full understanding for computer-aided drafting among engineers from companies,and many companies are preparing to install PC-based or IBM PS/2-based drafting systems (eg.AutoCAD).In many companies,Computer-Aided Drafting systems are regarded as synonymous with Computer-Aided Design and the success of overall CAD facility depends to a large extend upon the effectiveness of the drafting system. It must pointed out,that professional CAD systems include additionally 3D geometric modeling,engineering analysis (stress-strain analysis,finite-element methods,kinematics and animation,analysis of mass properties,etc.),and design evaluation. Such a system is required for the pilot CAD/CAM project.

II. THE PILOT CAD/CAM PROJECT FOR STRATEGIC INDUSTRIES

Comprehensive,fully integrated CAD/CAM systems are seen to be still at the stage,where the cost of hardware and software as well as requirements for skilled personnel precludes using it in the Strategic Industries. These systems are usually specialized for a final,complex product.

Key objectives for the proposed pilot CAD/CAM project are to:
- establish a CAD/CAM system framework capable of orientation to an individual company;
  provide a means whereby users may evolve at their own pace into CAD/CAM facilities;
  implement a 2D and 3D geometric modeling for the manufactured products and to apply it for engineering analysis, drafting,and design evaluation;
- implement NC/CNC programming for machine tools and other production equipment and to simulate a tool path;
- implement interface between a host computer and NC/CNC machines;
  expand applications to embrace such areas as production control,process planning,inspections,and materials handling.

To i m p l e m e n t the CAD/CAM system and to e d u c a t e engineers on CAD/CAM systems should be two inseparable goals of the project.

To rationalize steps,the pilot CAD/CAM project has been divided in two phases:

PHASE 1. Design,drafting,CNC programming,simulation (Annex 4)
PHASE 2. CNC programming (with machining simulation),measurements,maanufacturing,inspections,DNC networking (Annex 5).

There are many considerations to judge when purchasing computer hardware for a new CAD/CAM system. The vital issues for the Libyan industry are: price,adequate computetional power, software availability,reliability in industrial environment, and minimal requirements for technical service. All over the world,industry is dominated by computer hardware for CAD/CAMs from IBM,DEC,CDC,PRIME,UNIVAC,HEWLETT-PACKARD,APOLLO,SUN, TEKTRONIX,MEGATEK,VERSATEC,etc. According to available estimations and to my experience,the pilot CAD/CAM project in Libyan conditions should be made up of DEC computers and DEC CAD/CAM workstations.The VAX DUAL-HOST configuration suits the best for Strategic Industries plants.It is one of the most reliable configurations for industrial environment.

The PHASE 1 (Annex 4) may be located ,at first,in the Secretariat for Strategic Industries in Misurata,and after the phase has been successfully implemented to move it or double it in the Iron and Steel Complex in Misurata.

The PHASE 2 (Annex 5) may be located in the Iron and Steel Complex in Misurata.

The computer hardware and peripheral equipment for the PHASE 1 are listed in Annex C.

CAD/CAM systems rely mainly upon software.To describe a CAD/CAM system in detail is,in large measure,to describe software. According to present-day estimates,the top manufacturer of related CAD and CAM systems are: IBM,Computervision,Intergraph,Calma,Applicon,McAuto,Control Data,Auto-Trol,Gerber,etc. (all in USA),Matra Datavision,Dassault,Batelle,IKOSS,Fides, etc.(all in Europe).The most known CAD/CAM systems are CADAM, CAEDS,CD,ANVIL,EUCLID,CATIA,MEDUSA,SUN,APOLLO,etc.

APT system,APT-like systems and specialized manufacturing systems are used as a standalone CAM modules.

For the Libyan industry,an European supplier has many advantages. So this is the proposed software for the PHASE 1 (and mostly for PHASE 2 as well) of the pilot CAD/CAM project:

1. EUCLID-IS	3D Solid modeling (2D modeling as well), engineering analysis and design evaluation, Finite-Element Method, NC programming for machine tools,SURF-APT for machine tools, Material Requirements Planning (MRP),other CIM packages. Applied to mechanical,electrical,and civil engineering. Supplier: Matra Datavision S.A.,France
2.APT-IV (with Sculptured Surfaces)	NC/CNC programming system used to 2-,2.5 3-,4-,5-axis machine tools and other CNC machines.It can work as a standalone CAM modul. Supplier: Computer-Aided Manufacturing International,Texas,USA or German version of APT from Waldrich Coburg,Germany.
3.IGES,VDA,SET	Interface software between EUCLID and other CAD systems,between EUCLID and APT IV. Supplied with EUCLID.
4.CASPA	Simulation of machining (cutter path in 3D presentation). Supplier: the same as in p.2.

This is the necessary software for the pilot CAD/CAM project.To fully implement this software,it requires 2.5-3 years. A CIM software from other vendors may be and should be implemented separately and independently on PC and IBM PS/2 class microcomputers.It helps immensely to prepare computer infrastructure for next steps toward CAD/CAM or even FMS,CIM systems.

The PHASE 2 of the project has been expected to start eight to twelve months after PHASE 1 has been initiated.The necessary equipment for the starting point of PHASE 2 are at least two CNC machine tools: one lathe and one milling machine or machining center. Machine tools,wire-cut EDM,coordinate measuring machines has been selected in order to cover the current and projected production within Strategic Industries and to expand applications of CAD/CAM systems.

The additional computer hardware,CNC machine tools,CNC wire-cut EDM,and coordinate measuring machines for the PHASE 2 of the project are listed in Annex 7.

For each purchased CNC machine tool or any other production equipment,an adequate software must be supplied,which is to some extent compatible with the CAD/CAM software.For example, CMM manufacturers usually supply very sophisticated software, which can be run as a standalone system.

To implement and run the PHASE 1 of the project is at least ten engineers to be engaged:

(a) hardware maintenance and service,networking . 1 person
(b) VMS operating system,system management..... 1 person
(c) EUCLID,application programs (eg.FEM) ..... 3 persons
(d) EUCLID,APT ..... 3 persons
(e) APT,postprocessors,CNC software ..... 2 persons.

One engineer for duty (a) is to be trained at supplier training center for at least six weeks.Prerequisites for the training: electronics engineer, 2 year experience in microcomputer or electronic devices maintenance.

One engineer for duty (b) is to be trained at supplier training center for at least six weeks.Prerequisites for the training: engineer,2 year experience in DOS or any other operating system.

Engineers for duties (c),(d),(e) should be selected from a group trained at the Secretariat for Strategic Industries.The lecturers for such training courses can be provided by UNIDO.

A draft of programs for the intensive training courses (PHASE 1) has been presented in Annex 8.

Below has been given a general approach to training courses for industry (PHASE 2).

The CAD/CAM technology in itself is so all encompassing that the training program must of necessity reach a large percentage of a plant's personnel.Therefore,when the CAD/CAM technology is introduced into a plant,a complete training program is to be not only recommended but considered an absolut must. Generally speaking,if industry does not train or help to train personnel,the necessary skilled manpower will not be available.The shortage of skilled manpower in computer-based technologies is not temporary,and if a plant relies only on its recruiting ability,rather than arranging to train its own personnel,then the whole productivity of that plant is in danger.The first question arising in management's mind is to whom should be given CAD/CAM training,and the answer is:First to management itself-because without a knowledgeable managerial level,full utilization of the CAD/CAM technology is not possible.The special attention must also be given to the design enginnering staff and to the planning,tooling,production and quality control staff.

The programs of courses,seminars,and conferences should concentrate on application-oriented education and on applied research seeking practical ways in which CAD/CAM technology can be utilized most effectively in the industrial environment.

Generally speaking,there are three main goals for these educational and training programs:

- general training in the development of CAD/CAM technology (usually for a managerial level,according to Annex 2, but without computer workshops);
- retraining of qualified specialists from particular industrial sectors (experienced specialists are introduced and then trained in the concerned CAD/CAM software);
- general and advanced training of fully qualified CAD/CAM engineers and researchers in the concerned area of industry (for personnel of research & development centers,or CAD/CAM centers,within a specific industry sector).

III. CONCLUSIONS AND RECOMMENDATIONS

1. The basic engineering software is necessary for engineers in areas of applications within Strategic Industries, otherwise, the CAD/CAM introduction onto industry level will be unduly prolonged. General engineering software was made more than a decade ago and the software offered now is usually modified and/or reprogrammed versions of the known programs implemented on a new hardware and operating systems (except of interactive computer graphics which are still being developed). So there is no reason to wait for a new engineering software. While the hardware costs are going down, the cost of skilled manpower and software are increasing. Software proposed for the pilot CAD/CAM project represents general engineering software and is of basic importance for CAD and CAM modules.

2. To establish the pilot CAD/CAM project center in Strategic Industries with the following goals:
   - implementation of comprehensive, professional CAD/CAM systems;
   - modification and maintenance of the implemented CAD/CAM software;
   - training of the personnel in the area of CAD/CAM systems implemented in the specific sector.

   The CAD/CAM project needs not only persons with computer science knowledge, but in the first place persons with a deep knowledge of application area together with the requisite capability in systems analysis and programming.
   A successfull software center relies more on technical experts than any other enginnering organization, therefore, it is important to provide career path for technical experts so that they can achieve a high social standing without turning into management.
   The bulk of the productivity on CAD/CAM projects comes from a relatively small number of highly qualified participants (5-10 persons).

3. Wide-scale training programs on the CAD/CAM technology should be promoted by the Secretariat for Strategic Industries and other concerned institutions. The CAD/CAM introduction onto factory level can be jeopardized by the shortage of skilled manpower.
   In the frame of CAD/CAM project, special attention must be given to the numerical control manufacturing (NC, CNC).
   For full utilization of the CAD/cam technology the training process must reach a relatively large percentage of plant's staff. The following functional groups should be included: design engineering, planning, tooling, production, quality control, and, in the first place, the managerial level.

4. Significant efforts should be taken to include the subjects, interrelated with CAD/CAM technology, in university curricula in Libya. This can be the only long-term solution for higher computer education. Usually it is composed of: numerical methods in mathematics, high-level programming languages (FORTRAN for engineers), simulation and optimization methods, numerical geometry and computer graphics, finite element methods, production systems and computer-aided manufacturing. These subjects are already in university curricula of engineering departments in developed countries.

 Annex 1

Misurata, 7 August 1990

WORKPLAN for Mr.Stanislaw ZIETARSKI,
UNIDO-expert on CAD/CAM

From	Until	Activities
7 Aug.	9 Aug.	Meetings with staff members of the Information Centre of the Secretariat for Strategic Industries. Discussions on the subject of applicability and feasibility of CAD/CAM for Strategic Industries with Mr.Idris Sassi,Mr.Ahmed Magdoub,Mr.Shibani Geroushi and others. Getting familiar with hardware and software at the Information Centre. Reading the project documents.
11 Aug.	16 Aug.	Visiting the High Institute of Industries and Iron and Steel Complex in Misurata. Assessment of facilities for a CAD/CAM training course. An approach to professional CAD/CAM workstations for the Strategic Industries.
18 Aug.	23 Aug.	Visiting selected factories and plants within Strategic Industries. The factories and plants are represantative for the sectors:metallurgical, chemical,construction materials (cement), engineering.Discussions and consultations with managers and involved engineers. Discussions on the conclusions arising from the visits.
25 Aug.	30 Aug.	Visiting selected factories and plants within Strategic Industries (continued). Survey and evaluation of the CAD software and high-level languages,which can be run during the training course. Assessment of the manufacturing methods and processes used in the companies visited. Working out the essential conclusions related to the CAD/CAM Project,planned for the Secretariat for Strategic Industries.

1 Sept.	6 Sept.	Preparing the CAD/CAM program for the training course. Writing the technical report for the Government of Libya (G.S.P.L.A.J).
8 Sept.	13 Sept.	Submission of the technical report (draft) for discussions within the managerial level of the Information Centre. Final preparation of lectures and exercises for the training course.
15 Sept.	20 Sept.	CAD/CAM training course.
22 Sept.	27 Sept.	CAD/CAM training course.
29 Sept.	4 Oct.	Summary of the CAD/CAM training course;conclusions. Final modification of the technical report. Discussions on the hardware and software proposed for CAD/CAM Project and other practical steps.
6 Oct.	7 Oct.	Preparation for departure;departure to Tripoli.

Annex 2

PROGRAM for the CAD/CAM Training Course
in the Secretariat for Strategic Industries in Misurata

From 15 to 27 September 1990
Lecturer: Dr.Stanislaw Zietarski,
CAD/CAM expert of UNIDO,Vienna

COMPUTER-AIDED DESIGN
and COMPUTER-AIDED MANUFACTURING
Lectures (36 hours)

1.Introduction to CAD/CAM 3 hours
CAD/CAM as a form of manufacturing automation;
fundamentals of computer technology;
main frame computers,microcomputers,and programmable controllers.

2.CAD systems 8 hours
Application of computers for design;
geometric modelling,engineering analysis,drafting;
manufacturing data bases;
hardware for CAD;
enginnering and graphics software;
integration of CAD with CAM.
Introduction to AutoCAD;
basic set of commands;
advanced commands and comparisons with main frame-based CAD systems.

3.CAM systems 8 hours
NC technology;
conventional (NC) and computer control of machine tools (CNC);
direct numerical control (DNC);
adaptive control machining systems (AC);
NC part programming;
introduction to APT system.

4.Industrial robots 2 hours
Physical configurations and motions;
programming the robots;
robot applications.

5.Computer-aided process planning 3 hours
Part famielies,group technology,machine cells;
automated process planning;
machinability data systems.

6.Computer-aided production planning 3 hours
Conventional production planning and control;
computer-integrated production management;
engineering and manufacturing data base;
material requirements planning,shop floor control;
computer-aided quality control (inspection and testing).

7.Computer process control 3 hours
Process interfaces;
hierachical computer structure and networking;
process control strategies;
distributed control and direct digital control.

8.Computer-integrated manufacturing 3 hours
Types of manufacturing systems;
flexible manufacturing systems;
functions of the computer in a CIM.

9.Summary; final examination 3 hours

Computer workshop (36 to 72 hours)

Exercises on the available application software:
FORTRAN, AutoCAD,Release 10, PC-APT.

1.Solving enginnering problems in FORTRAN 9 hours

2.Practical introduction to AutoCAD 14 hours
Drafting the parts designed or produced
in the participant's plant.

3.Part programming in APT language 13 hours
Programming the parts designed, drafted,
or produced in the participant's plant.

Course schedule

On workdays:	8.30 - 11.00	lecture
	11.00 - 11.30	break
	11.30 - 14.00	computer workshop
	14.00 - 17.00	computers and a consultant available

Annex 3

CAD/CAM Questionnaire for the Secretariat for Strategic Industries

Date:

Plant:

Address:

Names and positions (of persons inquired):

1. Products manufactured in the plant:

2. Do you have any automated part of your manufacturing processes? (if so, give details)

3. Scope of design and drafting activities:

4. Is there any computer system installed in your plant? (if so, give details)

5. Is there any computer controlled production equipment eg.CNC machine tool,coordinate measuring machine,process controllers (PLC),etc.?

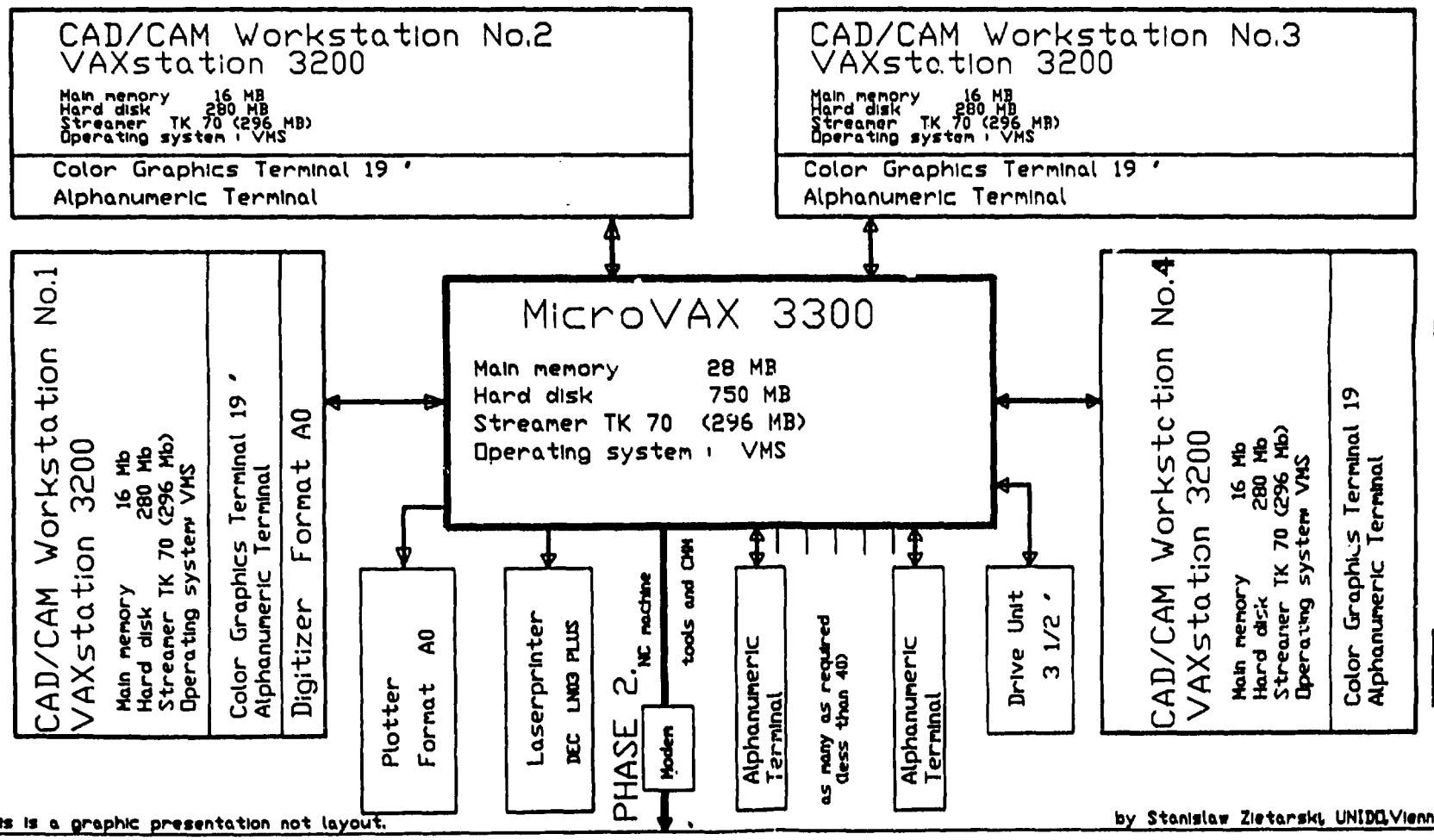
6. Where in your plant would you introduce CAD/CAM techniques?

7. Do you intend to send anybody to CAD/CAM Course organized by the Secretariat for Strategic Industries ?
(if so,please give names)

PILOT CAD/CAM PROJECT for the STRATEGIC INDUSTRIES

Hardware configuration Misurata, September 1990

PHASE 1. Design, drafting, CNC programming, simulation



This is a graphic presentation not layout.

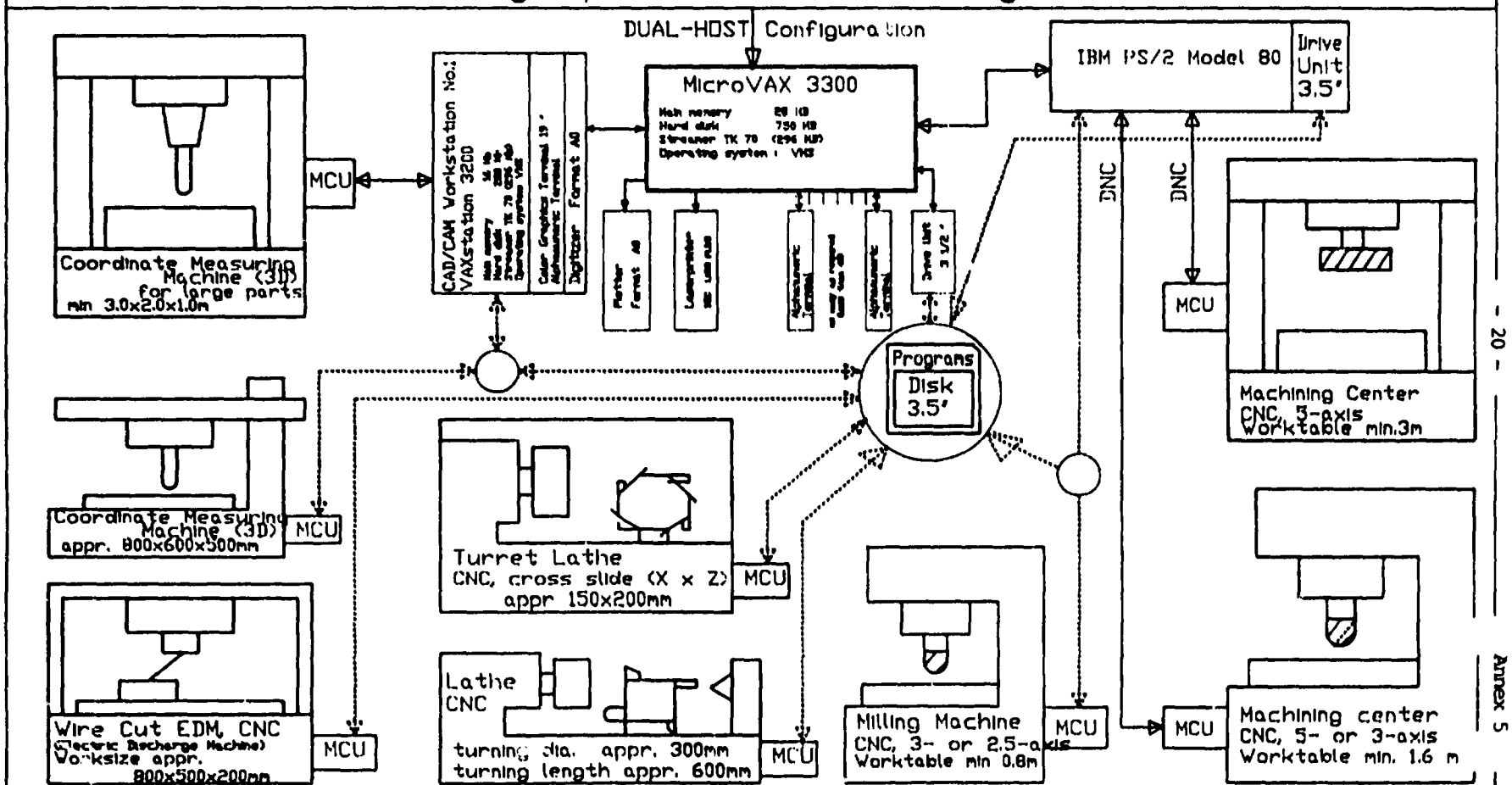
by Stanislaw Zietarski, UNIDO, Vienna

PILOT CAD/CAM PROJECT for the STRATEGIC INDUSTRIES

Computer hardware and machine tools

Misurata, September 1990

PHASE 2. CNC programming (with machining simulation), measurements, manufacturing, inspections, DNC networking



This is a graphic presentation not layout.

by Stanislaw Zietarski, UNIDO, Vienna

Annex 6

The computer hardware and peripheral equipment for PHASE 1 of the pilot CAD/CAM project.

Item	How many	Supplier
1.MicroVAX 3300 Main memory 28 MB Hard disk 750 MB Streamer TK 70 296 MB Drive Unit 3.5 " Operating system : VMS FORTRAN,C compilers	1	Digital Equipment GmbH Hauptverwaltung Freischutzstrasse 91 8000 Muenchen Tel.(089) 95 91-0 or
2.VAXstation 3200 Main memory 16 MB Hard disk 280 MB Streamer TK 70 296 MB Operating system: VMS Color Graphics Terminal 19 " (or larger) (appr.1600 x 1200)	4	Digital Equipment Corporation,GmbH Wien Vosendorfer Nordring 2 A-2334 Vosendorf-Sud Tel.(02 22) 6901-0
3.Alphanumeric terminals	min.12	as above or any other compatible
4.Plotter A0 Format	1	as above or Calcomp, Benson,Watanabe,Aristo Graphic,Quest Autom., Tektronix,etc.
5.Digitizer A0 Format	1	as above or Calcomp, Benson,etc.
6.Laserprinter	1	DEC LN03 PLUS or any compatible for CAD applications

Annex 7

The additional computer hardware,CNC machine tools, CNC wire-cut EDM,and coordinate measuring machines for PHASE 2 of the pilot CAD/CAM project.

Item	How many	Supplier
The additional computer hardware and peripherals		
1.MicroVAX 3300 Main memory 28 MB Hard disk 750 MB Streamer TK 70 296 MB Drive Unit 3.5 " Operating system : VMS FORTRAN,C compilers	1	Digital Equipment GmbH Hauptverwaltung Freischutzstrasse 91 8000 Muenchen Tel.(089) 95 91-0 or
2.VAXstation 3200 Main memory 16 MB Hard disk 280 MB Streamer TK 70 296 MB Operating system: VMS Color Graphics Terminal 19 " (or larger) (appr.1600 x 1200)	1	Digital Equipment Corporation,GmbH Wien Vosendorfer Nordring 2 A-2334 Vosendorf-Sud Tel.(02 22) 6901-0
3.Alphanumeric terminals	min. 4	as above or any other compatible
4.Plotter A0 Format	1	as above or Calcomp, Benson,Watanabe,Aristo Graphic,Quest Autom., Tektronix,etc.
5.Digitizer A0 Format	1	as above or Calcomp, Benson,etc.
6.Laserprinter	1	DEC LN03 PLUS or any compatible for CAD applications
7.IBM PS/2 Model 80 20 MHz 80386 microprocessor 2 MB RAM (expandable to 16 MB) Hard disk 314 MB Drive unit 3.5" Operating system : DOS and OS/2	1	IBM,USA
CNC machine tools,the CDC EDM,and coordinate measuring machines		
1.Milling machine CNC,3- or 2.5-axis Worktable min. 800 x 550 mm Postprocessor.	1	At least 40 manufacturers from Europe,Japan,USA,etc.

2.Machining center CNC, 5-or 3-axis Worktable min. 1600 x 1000 mm Postprocessor to APT-like systems.	1	Waldrich Coburg,Droop&Rein, Heyligenstaedt (all Germany), Forest-Line,France, Parpas,Rambaudi (all Italy), Cincinnati Milacron,Wotan, Kearney&Trecker,Deckel, Ex-Cell-O,Pratt&Whitney (all USA),Nomura,Yoneda Tekkosho, Homma,Niigata,Mitsui Seiki, Toyoda (all Japan),and others
3.Machining center CNC, 5 axis Worktable min. 3000 x 2000 mm Postprocessor to APT-like systems.	1	Waldrich Coburg,Droop&Rein, Heyligenstaedt (all Germany), Forest-Line,France, Cincinnati Milacron,Wotan, Kearney&Trecker,Deckel, Ex-Cell-O,Pratt&Whitney (all USA),Nomura,Yoneda Tekkosho, Homma,(all Japan),and others
4.Lathe,CNC turning dia. 300 mm appr. turning length 600 mm appr. Postprocessor	1	At least 60 manufacturers from Europe,Japan,USA,etc.
5.Turret lathe, CNC cross slide (X x Z) approximately 150 x 200 mm Postprocessor.	1	At least 30 manufacturers from Europe,Japan,USA,etc.
6.Wire-Cut Electric Discharge Machine,CNC Worksize 800 x 500 x 200 mm approximately Programming system.	1	Ingersoll,USA,Charmille, Switzerland,Japax,Japan, and others.
7.Coordinate Measuring Machine 3 Dimensional for parts 800 x 600 x 500 mm appr. Programming system.	1	DEA,Olivetti (all Italy), Opton,Leitz,Mauser,Stiefelmayer (all Germany),Ferranti, LK Tools,Vickers (all G.Britain),Renault (France),Bendix, Brown&Sharp,Cordax,Moore (all USA),Mitutoyo,Shin Nippon Koki,Tokyo Boeki (all Japan), and others.
8.Coordinate Measuring Machine 3 Dimensional for large parts 3000 x 2000 x 1000 mm minimum Programming system.	1	DEA,Olivetti (all Italy), Opton,Leitz,Mauser,Stiefelmayer (all Germany),Ferranti, LK Tools,Vickers (all G.Britain),Renault (France),Bendix, Brown&Sharp,Cordax,Moore (all USA),Mitutoyo,Shin Nippon Koki,Tokyo Boeki (all Japan), and others.

Annex 8

Draft

PROGRAMS for CAD/CAM Training Courses
in the Secretariat for Strategic Industries in Misurata

Computer-Aided Design system:
EUCLID-IS.

Lectures ..... 160 hours
Computer workshops .... 160 hours

Duration: 2 months

1. Introduction; EUCLID terminology 21 h
   Parametric geometry, splines, B-splines;
   Bezier and Coons surfaces.

2. The workstation and interactive system 15 h
   Screens (graphic and alphanumeric);
   main menu functions, initialization table.

3. Introduction to EUCLID-IS functions 15 h
   Screen management functions, selection functions;
   auxiliary selection and creation functions;
   graphic attributes.

4. Creating points and lines 18 h
   PIC/CRE modes, grid, numerical input, point projections;
   segments, arc, circle, curve, compound line;
   utility, edit.

5. Solid/Surface 18 h
   Solid/Surface menu, prism, pocket, box, cylinder;
   revolution, sphere, sweep, cone, complex volume;
   surfaces: polynomial, Bezier patch;
   topology: cut, fusion, common;
   tree editing.

6. Transformations 12 h
   Translate, rotate, reflect, scale, copy, array;
   dragging, reverse, repeat, deform;
   build transformation.

7. Detailing 15 h
   Drafting, crosshatch, attributes, 2D detailing;
   3D detailing, symbols, fonts.

8. Management 15 h
   Drawing, view editing, 3D view, layers;
   assembly, local axes, names;
   data base, documents management, exits.

9.Utilities 15 h
Plotter,measure,decode,interference;
perimeter,surface area,center of gravity;
moments of inertia,volume/weight;
data structure,calculator,DCL,macros.

10.Display,erase,delete 11 h
Erase only,layer,all,display points,layer;
recompute,purge,delete object,all,points;
recover,packing.

11.Applications modules (special programs 5 h
from 10 to 100 hours,eg.FEM,VDA,SURF-APT,etc.)

Computer workshop (160 hours)

Exercises on the available EUCLID-IS software.

Computer-Aided NC/CNC Programming
APT - IV .

Lectures ..... 160 hours
Computer workshops .... 160 hours

Duration: 2 months

1.Mathematical elements 21 h
Parametric geometry,splines,B-splines;
Bezier and Coons surfaces.

2.Introduction to APT - IV 8 h
System structure,part program structure;
system description,statements.

3.Geometrical definitions on plane and in space (2D,3D) 13 h
POINT,LINE,CIRCLE,ELLIPS,HYPERB,LCONIC,PLANE,PATTERN;
transformations-MATRIX,SPHERE,CYLNDR,CONE,QADRIC;
TABCYL,RLDSRF,reference system-REFSYS,ZSURF.

4.Input,output,canonical forms 8 h
PRINT,TITLES,PUNCH,READ;
CANON,OBTAIN.

5.Parametric curves and surfaces 16 h
conic curves -CURSEQ,splines -SPLINE,COMBIN;
surfaces-GENCUR,MESH,PATCH,SWEEP,COMBIN.

6.Build-in functions,loops,macros 8 h
Special applications as MACRO.

7.Tool motions 14 h
Point-to-point movements:GOTO,FROM,GODLTA;
part surface-PS,drive surface-DS,check surface-CS;
contour movements-GO,TLLFT,TLRGT,TLON,CORGT,COLFT;
tolerances-TOLER,INTOL,OUTTOL;
limits to ARELEM;
PATERN,POCKET.

8.Milling the sculptured surfaces 13 h
PS,DS,CS,REGIONAL MILLING;
collisions.

9.Tool definition and tool positioning 14 h
TOOLDF,CUTTER;
3-,4-,5-axis machining-MULTAX,TLAXIS;
tool in REGIONAL MILLING.

10. Tool path transformations 11 h
    Transformations-TRACUT,COPY;
    transformations-VTLAX;
    CLDAT applications.

11. Differences between APT-IV and other APT-like systems 4 h

12. Tool path simulation system CASPA 15 h

13. Interface EUCLID-APT (VDA) 10 h

Computer workshop (160 hours)

Exercises on the available APT-IV,CASPA,VDA,EUCLID-IS software

Dates

Departure from	Warsaw	Tuesday,31 July 1990
Arrival to	Vienna	Tuesday,31 July 1990
Departure from	Vienna	Friday,03 August 1990
Arrival to	Tripoli	Friday,03 August 1990
Departure from	Tripoli	Monday,06 August 1990
Arrival to	Misurata	Monday,06 August 1990
Departure from	Misurata	Sunday,07 October 1990
Arrival to	Tripoli	Sunday,07 October 1990
Departure from	Tripoli	Sunday,07 October 1990
Arrival to	Vienna	Sunday,07 October 1990
Departure from	Vienna	Wednesday,10 October 1990
Arrival to	Warsaw	Wednesday,10 October 1990

TECHNICAL COMMENTS ON EXPERTS REPORT.

Project SI/LIB/89/801: Consultancy services regarding computer application in office and industry.

Post 11-02 (10 weeks) : Expert in Computerized Automation Systems.

Expert : Mr. S. Zietarski.

A. Aim of Mission

The aim of the mission was to advise and assist the Secretariat of Strategic Industries on the potentials for utilizing CAD/CAM (PC based) for industrial applications particularly in engineering industries.

B. Comments on Assignment

The only right approach in projects heading for implementation of automation projects, is to analyze very carefully the situation of the end-user, in this case the engineering industry. Only based on a proper assessment of the existing and future needs, in relation to the possibilities and impossibilities of computer systems, the positive results of computer application can be maximized. In order to analyze the current situation in Libyan industry, the expert carried out visits to selected factories, as well as gathered information through questionnaires. Although the situation varies largely from company to company, he found out that there was a good understanding of Computer Aided Drafting techniques.

It is generally experienced that for several reasons implementation of CAD/CAM systems should be carried out in different phases. The following main reasons can be mentioned:

First reason is from investment point of view: A large system with a wide functionality can never be used to its full extent directly from the start. It is not unusual that only after 2 years a company or institute is able to use all functions of a major integrated CAD/CAM system. Starting with a full capacity system would imply a non use or partial use of software and hardware. Money spent on these unused parts could better be spent in a later stage, profiting that way from new developments that took place in the meanwhile.

A second reason is the organizational growth and development. Using a CAD/CAM system implies another way of organizing the design and manufacturing activities. People therefore have to be assigned to other functions, with different responsibilities. It simply takes time and effort to go through such a transition stage. It is generally acknowledged that a carefully phased approach produces the best results.

A third reason is technical. A computer system mostly is a standard product, but has the tools in it to tailor it to the specific requirements of the user company. Now in most cases, neither the possibilities of a system nor the exact requirements of the user company are quite known at the outset of an automation project. A phased approach tailoring the system step by step, will reduce the risk of purchasing a complete system which at the end appears to be unable to fulfill all the requirements.

The expert recommended therefore further integration of design and manufacturing functions which can be achieved through a pilot CAD/CAM project. The expert prepared a concept paper along these lines according to his analysis of the requirements. The report gives a detailed and practical description of the layout of such a pilot project, implementation of which could require 2.5 to 3 years.

Main goals of the pilot project are implementation of CAD/CAM systems, and training of the personnel. It was concluded that training of personnel should have top priority, not only during project implementation, but also afterwards. Directly related to the training programme is the recommendation to establish contacts with local universities.

C. Report

Expert report gives a good overview of the activities carried out during his mission, and gives a practical analysis of the current situation. Future activity phases are in sufficient detail.

Report could have been more complete if the results of the questionnaires and factory visits were attached as an annex. Also some annexes (system layout) should preferably have been put in A4 format for better reproduction.

D. Additional activities

In addition to the tasks in the job description, Mr. Zietarski further proposed a programme for an intensive training course in the field of CAD/CAM. He also lectured, organized workshops, and gave advice on programme topics.

E. Conclusions

Expert fulfilled his assignment completely, and performed technically at a sufficient level.

Report found to be satisfactory, with comments only on minor aspects.