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Final Report entitled:

A Review of Computer Aided Design and Analysis In ~~the~~ Republic of Korea

to

United Nations Industrial Development Organization (UNIDO)

Project No. DP/ROK/82/026/31.9.B/11-65

September 22, 1986

by

Dr. Gary L. Kinzel

Consultant in CAD Analysis

A REVIEW OF COMPUTER AIDED DESIGN AND ANALYSIS IN THE REPUBLIC OF KOREA

INTRODUCTION

The information in this report is based primarily on my visit to Korea during the period from August 26 through September 15, 1986. To a lesser extent, the conclusions are based on work with Korean students in CAD at The Ohio State University.

Most of the time in Korea was spent in Seoul at the Korean Advanced Institute of Science and Technology (KAIST). Approximately one week was also devoted to visiting other locations in Korea including the Korean Institute of Machinery & Metals (KIMM), Yonsei University, Daewoo Industries in Chang Won, and Korea Heavy Industries & Construction Co. in Changwon. A brief visit was also held with Dr. Yoon-Bae Ouh of Soong Jun University, and, finally, an effort was made to visit vendors who sell microcomputer hardware and software in Seoul.

The visit was part of a larger UNDP project aimed at establishing a Center for Mechanical Engineering Computer Applications (MECA) at KAIST. The main project is coordinated by Dr. Byung-Man Kwak who is currently a Professor in the Department of Mechanical Engineering at KAIST. The visit was arranged by Dr. Kwak, although much of the time in Korea was spent with other members of the KAIST faculty and staff. A general schedule for the visit is included in Appendix A.

According to the original job description for the consulting effort, the purpose of the visit was to:

1. Assess the facilities, knowledge, computer hardware and software for CAD available for the MECA program and make recommendations for better utilization and additional purchases.

2. Make recommendations for course development and CAD systems development aimed at making the center capable of managing and teaching graduate level courses and training courses for university staffs and engineers

3. Help perform the on-going projects such as CAD application software development by closely working with MECA staffs. The expert is expected to bring relevant information available in his institution for the purpose of promoting an environment similar to his.

4. Offer an intensive course and hold seminars for KAIST and university staff presenting the current status and future trends of CAD research and development in his institution.

5. Cooperate with MECA staff to develop the CAD analysis programs implemented on typical microcomputers such as the IBM/PC-XT or AT.

An effort was made to help in each of the areas identified in the job description, and this report summarizes the activities, observations, and conclusions germane to the effort. The report is separated into eight sections including the Introduction. The second section gives a general discussion of what is meant by CAD. The third, forth, fifth, and sixth sections give observations and suggestions associated with KAIST, KIMM, Yonsei University, and Korean Industry, respectively. The seventh section discusses intensions for follow on programs, and the eight section gives a general summary.

MEANINGS OF CAD

Much of this report deals with the status of "CAD" in Korea, and therefore it is important to establish a working meaning of CAD. In both Korea and the United States, CAD has many different meanings. Currently, the most commonly assumed use of Computer-Aided Design is in computer assisted drafting, and many of the new and expensive CAD systems are justified based on expected improvements in drafting efficiency. However, in engineering circles, CAD means much more than drafting. In the context of this report,

CAD is taken as any use of the computer which helps in the design process. Generally, this will involve some inclusion of computer graphics and interactive computing. The specific areas which I considered when reviewing CAD in Korea were;

Computer Assisted Drafting
General Graphics Oriented Interactive Design
Finite Element Analysis
Machine Component Design and Selection

and

Linkage Synthesis and Analysis.

It is my opinion that some minimal involvement in each of these areas is required before a complete computer-aided design program is possible.

OBSERVATIONS AND RECOMMENDATIONS CONCERNING CAD AT KAIST

Introduction

Currently, KAIST is the major state supported university for graduate work in science and technology in Korea. It is generally believed that KAIST attracts the best graduate students in Korea. KAIST itself is composed of two segments; one devoted to research and one devoted to graduate level education. There is some interaction between the two parts since some of the faculty are assigned to research laboratories, some of the research staff are attending graduate school part time, and some of the regular graduate students are working on research projects on the research side. However, on the working level, the two segments appear to be both physically and philosophically separated.

At KAIST, CAD is addressed at four levels. The first is in Mechanical Engineering where there is a Prime 2655 computer which drives several monochromatic terminals, only a few of which are graphics terminals. There are also a number of microcomputers which are IBM PC compatible. From a software standpoint, several finite-element programs are available, and

graphics on the Prime is accomplished through PLOT10 TCS. A fairly complete version of FORTRAN is also available. On the PC's, general graphics is done using a set of routines called HALO and MicroSoft FORTRAN. Drafting is available using either AUTOCAD of VERSACAD. The laboratory in Mechanical Engineering is internally supported and can be used at no cost to the students. The only cost to the Department is the operating expenses which appear to be minimal. Maintenance is handled on a per call basis.

A second level on which CAD is addressed is in the Mechanical Systems Laboratory. This laboratory is on the research side of KAIST, and it is intended primarily for research on mechanical and electromechanical systems. In this laboratory, there is a small number of microcomputers, and terminals which are driven by one of several mainframes. To date, CAD activities seem to have been concentrated in the areas of structural analysis, optimal design of structures, and kinematics.

The third level on which CAD is addressed is in the CAD/CAM laboratory in the research side of KAIST. This laboratory is extremely well equipped with both state-of-the-art hardware and software. The local mainframe computer is a Prime 750. There are approximately seven high quality color graphics terminals of the Tektronix 4115x variety. These terminals are supported by high quality hardcopy devices and digitizers. There is one MEDUCA work station. There seems to be a large amount of high quality software which the staff were able to demonstrate. Some of the software was written by the staff. Although I visited this laboratory only a few times, my basic impression of it is that it is vastly under utilized. Discussions with the staff of the laboratory confirmed this impression. It seems that there are hiring restrictions at KAIST, and there is currently more equipment than the staff can utilize. In addition, the CAD/CAM laboratory operates on a "real money" basis. This means that other departments using the laboratory must transfer money to the CAD/CAM laboratory for using it. The cost of usage appears to be a typical commercial rate; however, it is more than the education side of KAIST believes that it can afford.

The forth level on which CAD is addressed is in the main computer center for KAIST. The current name for this center is the Systems Engineering Research

Institute. It is also very well equipped with hardware and software. The mainframes are a Cyber 170-835 (4 MB) and an IBM 3083 (8 MB). There are the same kinds of peripherals that would be located in any modern computer center in the United States. There are also a significant number of high quality graphics terminals. This center is managed as a self supporting institute affiliated with KAIST. All users outside the institute must pay real money for the use of the facility. Again, the usage rates quoted were about what would be expected for a commercial system, and again the usage of the system is minimized as much as possible by the education side of KAIST which finds the rates to be more than they can afford.

General Observations and Recommendations

The following comments are based on a very limited amount of time spent at KAIST. However, I think that they generally reflect the conditions at the Institute.

1. The quality of the faculty and students in mechanical engineering is uniformly good. It is extremely difficult to obtain a faculty position at KAIST, and consequently they probably have the best overall graduate faculty in Korea. Similarly, competition to attend the institute is also heavy so that the general student body is uniformly good. Most of the faculty have PhD's from top universities in the United States or Western Europe.

2. The general research being done at the institute also seems to be of high quality. Most of the faculty have published extensively in internationally-recognized, peer-reviewed journals.

3. The CAD staff in mechanical engineering is small but adequate. As in most universities in the United States, most of the staff is working in theoretical, analytical areas; however, professors Kwak, Yoon, and Yoo have formed a team which can address both theoretical and practical design problems.

4. Although there were a few exceptions, the vast amount of usage of the computer for design has involved the use of existing commercial programs. Although some programs are being written to support research, there is little indication that general programs are being written to support a continuing design activity. It appears that most of the students and researchers are using only their own programs. This seems to be because the software development environment is not very well structured. Documentation standards have not been well developed, and there is little emphasis on standard programming languages. Also, programs written seem to be system specific which means that the programs will fall into disuse as soon as there is even a small change in the equipment.

5. Although the students and staff seem to work hard, I was surprised to find that there is a reluctance to learn some of the large software systems well enough to become proficient with them. AUTOCAD was available on most of the systems;however, few people seemed to know how to use it. Several people told me it was easier to draw things by hand than to use one of the computer aided drafting systems. This is obviously true for a novice, but it is not true for one proficient with the software.

6. Throughout Korea, there is a general, institutional disregard for foreign copyrights. In central Seoul, programs such as AUTOCAD are sold for about $30.00. The commercial price for the same program is about $2600 in the United States. On the practical side, this unlicensed use of software has several negative consequences. One of these is a general lack of appreciation for the costs associated with software development. Companies are reluctant to pay for software development (which is expensive in any country) when their general perception is that software should be essentially free. A second problem is that the only programs available are those which can be easily copied. A large number of copy protected programs are available for computer aided design (this includes the newest version of AUTOCAD), and these are practically excluded from the Korean market.

This situation is supposed to change in 1977 when Korea is to begin to honor foreign copyrights. However, until then there is not likely to be any significant software development for the general Korean market. General CAD activities are not likely to develop very rapidly until it is profitable to write marketable software.

7. Although the general courses offered in CAD are good, there is a noticeable lack of courses in kinematics. While linkage design is treated in optimization courses, there is no course on kinematic synthesis per se. In my opinion, such a course should be added to the program because all linkage design problems cannot be efficiently handled using optimization and analysis.

8. Although there are a large number of terminals and computers at KAIST, and the facilities in the CAD/CAM laboratory and in the Systems Engineering Research Institute (SERI) are of top quality, the general ME students and faculty use only the facilities in the Mechanical Engineering Department for CAD and CAM. The reason for this is the costing procedure used: the facilities in Mechanical Engineering are free while those in the CAD/CAM and SERI laboratories cost real money. As a result, the students get very little experience on state-of-the-art hardware and software even though the facilities in the CAD/CAM and SERI laboratories appear to be under utilized.

KAIST has chosen to operate the CAD/CAM and SERI facilities such that there is a maximum generation of revenue rather than a maximum utilization of equipment. If the facilities were made essentially free for education, they would be utilized by the students more heavily; however, the cost of operation would be increased somewhat. This increased cost would have to be made up by an increased in appropriation from the central administration. In my opinion, KAIST should underwrite the cost to encourage more student access to the advanced facilities. This will require significant "soul searching" on the part of the institute because on the surface, it is only reasonable that departments which wish to use the facilities should pay for them. However, I believe that the administration of KAIST should consider not only short

term institutional gains but also long term national needs. If the students are not given better access to modern CAD/CAM equipment, the best graduate students in Korea will continue to be trained on machines which are about five years behind those in common use in universities in the United States. It might be noted here that several universities in the Unites States have tried the "real money" approach to computing and have had the same experiences as at KAIST. Many of these universities have since revised their funding policy to encourage more computing.

9. The CAD faculty at KAIST under Dr. Kwak's guidance has done a good job transferring technology to Korean industry through short courses on CAD. These should continue as there seems to be real need for CAD fundamentals in the industries that I visited. KAIST might consider working with KIMM to offer workshops in the southern Korea area since a significant amount of industry is located there.

10. The support staff in the CAD areas at KAIST are mainly computer science types who do not have much experience in engineering. Also, I did not detect an in depth knowledge of graphics on the part of the operators. In fact, during my trip to Korea, I did not talk to anyone who appeared to an expert in both mechanical engineering and computer related issues. Such people are needed to lead the development of graphics-oriented design software.

OBSERVATIONS AND RECOMMENDATIONS CONCERNING CAD AT KIMM

Introduction

KIMM is probably second only to KAIST in supporting CAD activities in Korea. They have an impressive array of experimental facilities, and a dedicated, hard-working staff. Most of the people in senior positions have PhD's from some of the best known universities in the West. In CAD, most of the work is being done in the Production Automation Department, and the CAD/CAM laboratory is structured around a VAX 11/750 computer with 2 megabytes of

memory. There are a number of inexpensive monochromatic terminals (mostly alphanumeric) and one relatively high performance Tektronix color terminal. They have a reasonable amount of software for supporting analysis and computer-assisted drafting. There did not seem to be much software to support engineering design (eg. kinematic and machine element design); however, this was an active project area.

The CAD/CAM group under Dr. Sam-Jin Park, has done a good job of identifying the industries which need and will accept assistance from institutes such as KIMM (and KAIST) in the CAD area. These are companies which have on the order of 100 employees. Larger companies tend to do all of the work themselves and keep the results as proprietary. Smaller companies cannot afford to invest in CAD hardware and software. Midsize companies can profit from CAD; however, their size dictates that the software be PC based.

General Observations and Recommendations

1. KIMM should continue to concentrate on software for the PC area; however they should structure their programs so that they will run on either the VAX or the PC. This can be done using the software development procedures and utility software that I discussed with them.

2. As at KAIST, the staff seem to be very dedicated at KIMM; however, I found a general lack of background in software development protocols and maintenance standards. There also seemed to be the same lack of technical people who are experts in both computer science issues and graphics as applied to mechanical design. As a result, the "infrastructure" required for professional software development is lacking. The people are able to install well written commercial software, but when modifications are required for the installation, there are problems. (This is also a problem in the United States in many locations.) There is also the lack of discipline evident when the staff are not used to working in software development on a large scale. When I got to the lab, I found that Plot10 had been somehow modified for

some special piece of software, and as a result Plot10 would not run for software requiring a standard Plot10 package.

I believe that a UNDP sponsored consultant who is an expert in both computer science and engineering computer graphics would be of great help to KIMM (and KAIST). This person would typically be an MS level researcher and not a senior faculty member. The latter tend to know the broad picture but are unfamiliar with the details which must be addressed when writing and implementing software packages on a wide variety of systems.

3. Currently, KIMM has a very limited selection of terminals, and the staff use monochromatic terminals most of the time when developing programs. When funding permits, low cost raster color terminals should be purchased as commercial software will almost certainly involve color. A good choice for such a terminal is the Tektronix 4107 or one which emulates a 4107.

OBSERVATIONS AND RECOMMENDATIONS CONCERNING CAD AT YONSEI

Introduction

Yonsei University is a privately owned university which was started about 100 years ago by a missionary. All students (approximately 20,000) pay tuition, and the university supplements this income with funding form other institutions and organizations.

CAD teaching activities seemed to be concentrated mainly in the finite elements area although kinematics was also emphasized. Computer hardware consisted mainly of PC's and monochromatic terminals hardwired to the university's mainframe. In general, CAD instruction seemed to be mostly from books with little hands on experience at computer terminals. There was no evidence of high-performance graphics.

General Observations and Recommendations

1. Funding at Yonsei seems to be very limited. Therefore, it is unlikely that the mechanical engineering department or even the engineering college can get the mainframe minicomputer and color raster terminals needed to support a major CAD/CAM teaching effort. However, it may be possible for them to obtain a limited number of PC's with color monitors. These could be used to support a credible CAD program if software development and acquisition is done carefully.

2. The staff at Yonsei seemed to be enthusiastic and eager to develop their CAD program. They also seemed to have done a very good job with limited resources.

OBSERVATIONS AND RECOMMENDATIONS CONCERNING CAD IN KOREAN INDUSTRY

Introduction

When in Korea, I visited two companies, Daewoo Heavy Industries, Ltd., and Korea Heavy Industries & Construction Co., Ltd., both in the Chang Won area. While this is obviously a limited sample, I think that the observations and conclusions made can be extended to other industries in Korea. As the names imply, both companies are involved in the fabrication of relatively large components, although in the case of Daewoo, relatively small (automobile sized) components were also being fabricated.

General Observations and Recommendations

1. In both companies, the manufacturing capabilities were impressive. Except for fewer robots, both companies look to be as modern as the best companies in the United States. In fact, both companies are now fabricating many systems which were once manufactured in the United States. CAM was very much in evidence, especially in Daewoo where an

IBM CAD/CAM system was demonstrated. They appear to be just learning how to use this modern system, and the main software packages being used are CADAM and CATIA. These are used primarily for CAM rather than CAD.

2. Neither company expressed much interest in design either from a traditional or computer-aided standpoint. All of their major designs are purchased from abroad. This includes both conceptual design, engineering calculations to support the designs, and layout drawings. In some cases, they will do the detailed drafting; however, in general, the detailed drawings also seem to be purchased from abroad. About the only design done is small modifications to existing designs. In their current state of development, a dependence on licensing agreements is probably reasonable. In this regard, Korea can probably be compared to the Japan of 15 years ago. However, they should conscientiously work to improve their expertise in design. As their labor costs increase, they will lose their competitive edge relative to other Asian countries if they depend on manufacturing alone for growth.

3. Although members of the staff at KIMM indicated that large companies such as Daewoo would tend to write their own software rather than pay for its development at institutes such as KIMM, I did not see any evidence of any major software development efforts during my visits. It could be that the companies are developing software at other locations, or they are relying almost entirely on commercially available software. As CAD becomes more common, they will need custom developed software. I would suggest that they solicit help (from KAIST, KIMM, or foreign firms) in this regard once they recognize the need. Otherwise, they are likely to waste millions of dollars on software which cannot be maintained.

FOLLOW ON PROGRAMS

In addition to the information transferred during my visit to Korea, two programs were set up which should ensure future collaboration. The first program will involve one of the staff (Mr. Myung-Sik Kim) from the MECA

Project spending about six months at The Ohio State University working in our computer aided design laboratory and taking courses in computer graphics. This will ensure that KAIST is familiar with both the software that we have (and will share with KAIST) and also the programming protocol that we use.

The second program which has been tentatively set up is a joint software development effort in kinematics. For the last several years at Ohio State, we have been working on a major effort to develop programs for the design of linkages. As part of this and other programming projects, a protocol has been developed which ensures that the programs will operate on a large range of terminal devices and computers. The details of this project are outlines in Appendix B. This project will be mutually beneficial since both of us will be able to use the software developed, and by following the programming protocol developed at Ohio State, it will ensure that the programs will be upwardly mobile as new equipment is acquired. It should also ensure a long-term, active relationship between personnel at KAIST and The Ohio State University.

GENERAL DISCUSSION AND RECOMMENDATIONS

The problems in CAD are complex in Korea, and the ability of KAIST to make a major impact in this area is complicated by the country's history of being willing to import designs and drawings from the US, Europe, and Japan. The major companies seem to lack the expertise and to some extent the interest to create their own designs. The CAD future is further complicated by the general lack of appreciation of the value of software. Foreign copyrights are almost totally ignored especially with regard to personal computer software, and the value of any program is perceived to be about $5.00 per disk. This is the general fee the computer stores charge to copy a commercial program which may be worth 500 times this price. It costs millions of dollars to develop a program such as AUTOCAD, and there will be little incentive to spend the resources necessary to develop local programs if the perceived value is so low. This environment should change when the import/export agreements take place in 1977; however, it will take longer

than a year to change the attitude toward software that has been developed. Until that attitude changes, I would suggest that KAIST not spend any time on developing software in areas where programs are readily available. Examples of such areas are linear elastic finite elements, drafting, and geometric modeling. Areas where available, copyable software is limited is in kinematics and machine element design.

Although Korea is somewhat behind the developed world in CAD, this is not entirely bad for a country with limited resources. Much of the money spent in the industrial world on CAD hardware and software has not been productive because of nonstandard hardware and software. Now, however, both hardware and software standards are being developed so that systems established in the future are not likely to become functionally obsolete so quickly. This means that programs and equipment developed now will at least function as newer systems are developed even though the old systems do not contain all of the features of newer systems. This is especially true of graphics software. In the past, it was not uncommon to have to discard huge amounts of code because the nonstandard programming system became obsolete. Since so little Korean developed software is available in Korea, there is not a large base of nonstandard software which inhibits the purchase and/or the development of current hardware. Also, all of the new software can be written using established standards to ensure portability.

It is assumed that much of the initial CAD software development will be done in institutes such as KAIST and KIMM. However, I did not detect much collaboration among the different institutes and universities. If Korea is to advance as rapidly as possible in the CAD area, some effort should be expended to ensure that there is a minimum of duplication of effort in software development. I would therefore recommend that two types of meetings be held annually. One would involve KAIST and the other Korean universities, and problems and solutions in CAD could be discussed. A possible model for such a conference would be the one on "University Programs in Computer-Aided Engineering, Design, and Manufacturing" which is held annually in the United States. Speakers could identify their programs, plans, problems, and accomplishments. There also needs to be a willingness to share software among the different universities and institutes.

The second type of meeting would be aimed mainly at industry. Here, the benefits of CAD must be stressed. The workshop/shortcourse format seems to be especially good for this. This might be held jointly with KIMM, and could be held twice a year (once in Seoul and once in Pusan or Chang Won). If a CAD(/CAM) short course were held twice a year for the next several years, it would quickly improve the national level of appreciation and understanding for CAD (and CAM).

Although Korea thus far has been able to encourage its foreign trained engineers to return to Korea after obtaining advanced degrees, there is a potential problem with training people too fast for the economy. This is especially true if the level of design activities is not improved. It is therefore necessary that the government recognize that the students must have recognizable progessional career opportunities if the country is to avoid the "brain drain" that has plagued other developing countries.

Although KAIST has thus far concentrated on attracting senior experts in CAD to spend time in Korea, I would strongly suggest that they consider inviting an individual who is an expert on the details of both design-program development and computer system software. Such a person would be of great help to KAIST once some of our initial programs are ready for installation on the Prime system. The person could also greatly improve the programming infrastructure at KIMM. Typically, such a person would be relatively young and would have only an MS degree. Therefore, their resume would not be as impressive as that of the experts which have been coming to Korea. Also, the person should stay in Korea for at least six months for maximum impact.

Finally, I would like to encourage UNIDO to continue to support the CAD/CAM development programs in the developing countries. I have visited both India and Korea in conjunction with this program, and in both cases have found the money to be wisely spent by the local personnel with no apparent waste. Also, in both places, the program has had a significant impact on the level of CAD activities. Especially in Korea, the government is encouraging industrial development, and with the aid of programs such as that sponsored by the UNDP, the country should have a bright future.

APPENDIX A

Schedule of Professor Kinzel

(UNDP Expert in MECA)

Schedule for Professor Kinzel

(August 26 through September 15, 1986)

August	26 (Tue)	Arrival
	27 (Wed)	Visit UNDP Office, Seoul and meet with MSL staffs
	28 (Thu)	Seminar on "CAD at Ohio State"
	29 (Fri)	Seminars on "Structuring Design Programs" and "Documenting Design Programs"
	30 (Sat)	MSL Consultation and lab visits
	31 (Sun)	Travel to Kyungjoo
Sept.	1 (Mon)	Travel to Pusan
	2 (Tue)	Travel to Chang Won and meet with Dr. Shin at KIMM
	3 (Wed)	Visit KIMM, Daewoo Heavy Industries, and Korean Heavy Industries & Construction
	4 (Thr)	Visit KIMM and give seminar on "Interactive Design"
	5 (Fri)	Consultation with Dr. Shin at KIMM
	6 (Sat)	Travel to Seoul
	7 (Sun)	Holiday (Bongeun Temple)
	8 (Mon)	MSL Consultation and seminar on "Walking Machines"
	9 (Tue)	MSL Consultation
	10 (Wed)	MSL Consultation and seminar on "Optimum Design of Crank-Rocker Mechanisms"
	11 (Thr)	Visit Yonsei University and seminar on "An Introduction to CAD"
	12 (Fri)	MSL Consultation
	13 (Sat)	MSL Consultation
	14 (Sun)	Holiday (Korean Folk Village)
	15 (Mon)	Final discussions, departure

APPENDIX B

Korea - US Collaborative Project Proposal

Summary of Discussions for Development of a

Korea - US Collaborative Project :

Software Development for Mechanism Design

Date : September 13, 1986

Place : Mechanical Systems Lab., KAIST

Participants : Professor Gary L. Kinzel, Director, ADML, OSU
Professor Byung Man Kwak, Head, MSL, KAIST
Professor Y.S. Yoon, Y.M. Yoo

Summary of Discussions :

Following the suggestion for a collaborative research made between the ADML, OSU and the MSL, KAIST, in June 1985 during a visit to OSU, the following agreement is made during Professor Kinzel's visit to MSL, KAIST.

1. The collaborative project between the MSL and ADML will be mutually beneficial extending their expertise on an international level.
2. The basic objective of the project is to conduct basic research and to develop a general purpose program composed of a set of relatively independent modules for kinematic design by assigning appropriate tasks between tne two parties.
3. Bilateral communications and exchange of resources in personnel technical information, and established research results will be the main methods of collaboration. In particular, the next items are important and will be cross referenced during the project period:
   - Standardization of software structure and interface with different H/W equipment on both sides
   - Overall outline of the S/W system to be developed
   - Problem formulations
   - Selection of typical motivating trial problems
   - Test of developed S/W
   - Personnel visits or training
   - Information for published works or existing S/W's.

4. Commercialization or distribution of the final project output is sought and proper credit is made between both sides.
5. A project period of 3 years is recommended and so proposed.
6. Some of the sample programs developed by the ADML have been brought by Professor Kinzel during this visit.
7. A UNDP supported fellow, Mr. Myung-Sik Kim will be relocated at the ADML in September.
8. Tentative project contents and other details agreed on follow in separate sheets.

Byung Man Kwak
Professor, Dept. of Mech. Eng.
Head, Mechanical Systems Lab.
KAIST

Gary L. Kinzel
Professor, Dept. of Mech. Eng.
Director, ADML
Ohio State University

Korea - US Collaborative Project Proposal

1. Project Title : Software Development for Mechanism Design
   (Formerly, Design Automation in Electromechanical Systems)

2. Implementing Agency
   - Korean Side : Mechanical Systems Laboratory (MSL), KAIST
     Project Director, Professor Byung Man Kwak
   - US Side : Advanced Design Method Laboratory (ADML),
     The Ohio State University
     Project Director, Professor Gary L. Kinzel

3. Objectives : Develop a general purpose software system composed of a set of independent modules for the design and analysis of mechanisms, and perform basic research for expert systems.

4. Common Interests : The existing capabilities on the Korean side of high-quality manpower in both theoretical and practical research and the demonstrated capability and experience of personnel in the ADML in software development for machine elements and kinematic analysis are well matched with each other.
   An important role of the MSL in a direct relationship with Korean industry and the estabilished, industially supported mechanism consortium in the ADML are very conducive to the development of a software product which can be marketed.

5. Contents of Project
   - Common areas of major efforts
     - Standardized program structure which will permit the programs to be maintained and will enable them to run on a wide variety of hardware.
     - Basic data base structure for system layout and software interface
     - Development of problem sets from practical field applications

- Comparison of different algorithms and methods
- Creative basic research on expert systems of the future
- Enhancement of S/W efficiency by increasing generality of modules (PRIME vs. VAX, Various PC's)

. Subtopics for Korean Side

- Computer representation of layout of mechanisms and kinematic analysis. Start with 2-D and later expand to 3-D mechanisms.
- Dynamic analysis of mechanisms with clearance and flexibility.
- Optimal design formulation and solution techaniques for planar mechanisms
- Basic study on expert system development for a selected category of mechanism systems

. Subtopics for US side

- Rigid body guidance module for 4-bar, 6-bar, and dual mechanisms
- Synthesis routines for path and function generation
- Optimal design techniques and comparison
- Basic study on expert system for rigid body guidance problems, and design automation modules for the designs of miscellaneous systems such as gear boxes.

6. Expected Effect :

- An identifiable independent software system, which is general enough for mechanism design and salable for practical use.
- Enhancement of research paper publications or presentations
- Integration of existing capabilities from both sides
- Utilization of unique environments of both sides in relation to industrial applications
- The formation of an internationally recognizable group and a successful case of bilateral technology transfers.

7. Project Period : Starting from early 1987 for 3 years.

8. Contributions

	1st year	2nd year	3rd year
Korean Side (in Million Won)	46	53	63
US Side (in thousand dollars)	50	30	40

9. Remarks

1) A collaborative project was suggested during Professor Kwak's visit to the ADML in June, 1985 and basically agreed between Professors Kinzel and Kwak.

2) A collaborative project proposal was submitted to MOST in June 1986, under the title, "Design Automation in Electromechanical Systems."

3) A brief summary of the proposal was sent to Professor Kinzel

4) The project topic was included as a collaborative item in a meeting of the ROK-US Science and Technology Subgroup of the Korea-US Joint Economic Consultations.

5) An agreement based on a detailed discussion was made in September 1986, during Professor Kinzel's visit to MSL.

6) The following actions were taken during Professor Kinzel's visit:

- Several Software packages developed in the ADML were brought to MSL
- A fellow, Mr. Myung-Sik Kim from the MSL was placed in the ADML for a 6 month training period.
- Professor Kinzel delivered a series of lectures regarding S/W development and mechanism design.
- Professor Kwak explained some of the research result of his group and delivered related materials.
- A memorandum was prepared as a summary of discussions on the collaborative project