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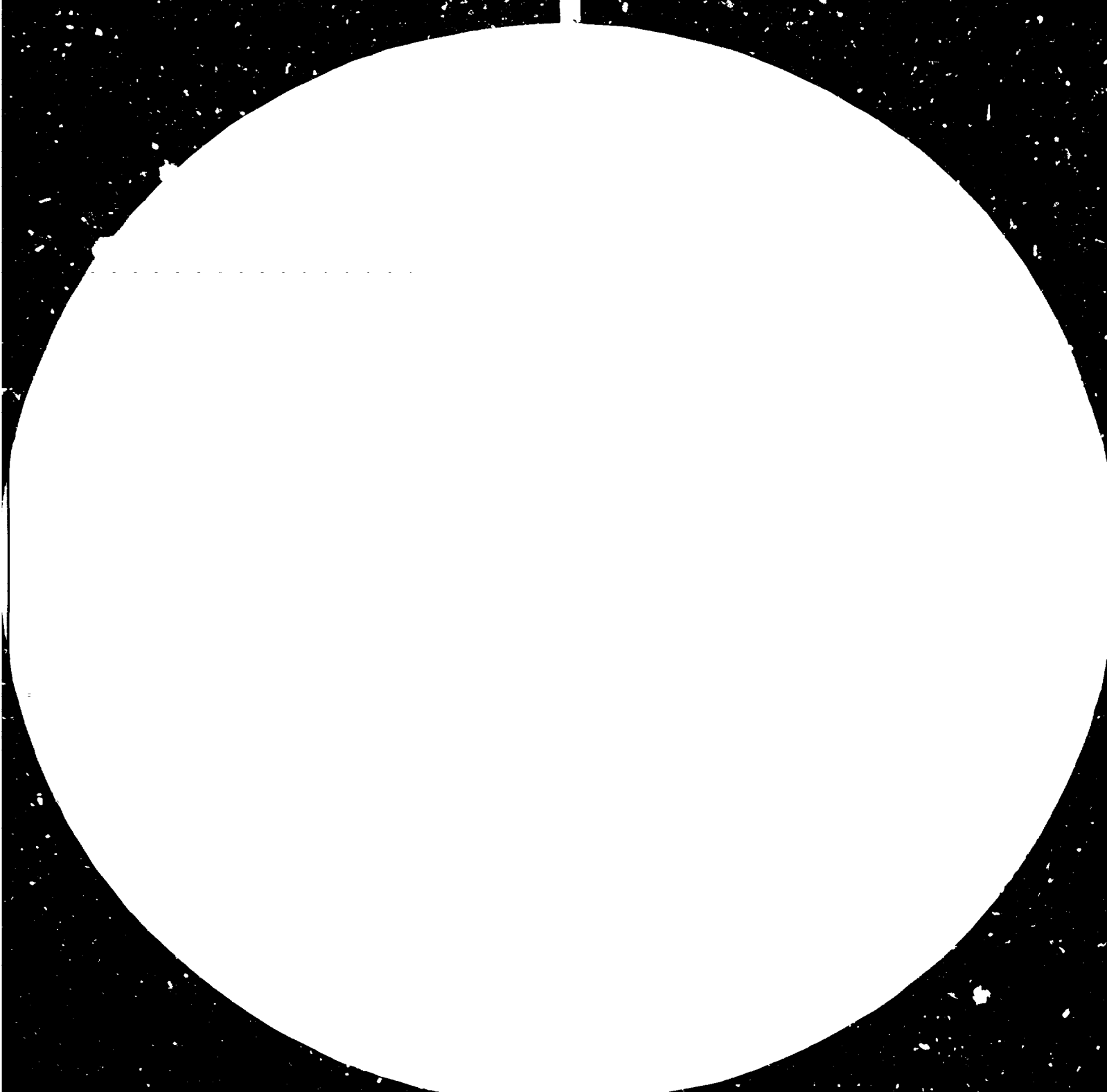
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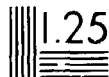
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28 2.5



Resolution Test Chart (NBS 1963-A) showing patterns of vertical and horizontal lines for various resolution values (1.0, 1.1, 1.25, 1.4, 1.6, 1.8, 2.0, 2.2, 2.5).

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12308

KIST-INDUSTRY CO-OPERATIVE PRODUCTIVITY PROGRAMME
(MECHANICAL ENGINEERING AND RELATED INDUSTRIES)

DP/ROK/74/006

REPUBLIC OF KOREA

Technical Report: Precision Engineering and Metrology Technology*

Prepared for the Government of the Republic of Korea
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of P.A. McKeown,
expert in precision engineering and metrology

United Nations Industrial Development Organization
Vienna

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5. Date of report : 19th Oct. 1981.

6. Activities :

| | | |
|---------------|---------|---|
| Oct. 18 (SUN) | 16:30 | Arrival Seoul CX410. |
| 19 (MON) | 10:00 | UNDP Office |
| | 14:00 | KAIST |
| 20 (TUE) | 08:30 | KAIST - KAIST President. - Seminar preparation |
| | 10:45 | British Embassy |
| | 13:00 | KOREA BEARING IND. CO. LTD. |
| | - 18:00 | BUPYOUNG PLANT. |
| 21 (WED) | 08:30 | Depart for CHANG WON area |
| | 11:30 | Korea Institute of Machinery and Metals (KIMM), Chang Won. |
| | 14:00 | DAE WOO HEAVY INDUSTRIES LTD. (MACHINE TOOL DIVISION). |
| | 16:00 | LUCAS CAV KOREA LTD. |
| | 19:00 | DISCUSSIONS with KIMM staff. |
| | - 21:00 | |
| 22 (THU) | 09:00 | KIMM |
| | 10:30 | SAMSUNG PRECISION INDUSTRIES Co LTD. - Precision Components Division. |
| | 12:00 | Aero Division. |
| | 14:30 | SEMINAR (KIMM) - "Precision Engineering - Recent Developments in Machines and Systems". |
| | - 16:00 | |
| | 16:30 | Travel to ULSAN. |
| 23 (FRI) | 09:00 | HYUN DAI MOTOR COMPANY. |
| 24 (SAT) | | |
| 25 (SUN) | | |

Oct. 26 (MON) 10:00 Ministry of Science & Technology
(MOST) - MINISTER.
11:15 KAIST - SEMINAR - "Organisation
and Management of advanced teaching,
research and innovation services to
industry - the Cranfield model".
16:00 KOGA FIRST GAGE LTD.
19:00 Discussions with KAIST & KIMM staff.
- 22:00

27 (TUE) 02:00 REPORT PREPARATION
13:00 KAIST - SEMINAR "Precision Engineering
- 18:00 - Recent Developments in Machines
and Systems".
19:00 Discussions with KOGA FIRST GAGE Ltd.
- 21:00 staff.

28 (WED) 08:00 REPORT PREPARATION
10:30 UNDP Office
11:40 British Council
13:00 KAIST (KAIS and KIST division
discussions).

29 (THU) 10:00 Depart Seoul KE 704.

7. Findings.

7.1. Visits to the six manufacturing companies listed in 6 above, together with discussions with KAIST and KIMM staff were sufficient to obtain an adequate understanding of the capability of Korean industry in metal component manufacture where consistent precision of size, profile and surface finish is highly desirable or essential (gears, rolling bearings fuel injectors, camera mechanisms, night vision optics, auto drill chucks, i.c. engine blocks, plain and threaded gauges etc.). There are 'pockets' of advanced precision manufacturing skills and experience, some at high level by world standards. However, for Korean manufacturing industry to become generally more competitive in sophisticated world markets it must not only improve productivity and successful product innovation but also its general capability in precision manufacturing levels.

7.2. Remarkable progress has been achieved in a short time in general manufacturing expertise. Especially where precision/high quality manufacture has now reached high levels, this has resulted from technology transfer from companies in more advanced nations. So that Korean industry is not permanently one or two technology steps behind, through dependence on foreign technology, it is clear that a sound foundation of self generated technology must be established.

This need is widely appreciated by senior industrialist, research institute and university personnel.

- 7.3. The KIST (KAIST) - Industry Cooperative Productivity Programme (Mechanical Engineering and related industries), appears to be well structured and KAIST is clearly a most appropriate and competent body to organise and progress this programme.

Response from nearly all industrialists met was very positive in spite of the fact that there is a marked shortage of staff in KIMM and KAIST with industrial experience/expertise in manufacturing engineering - and in precision engineering in particular. Certainly the 'critical mass' of staff has not yet been achieved in these areas.

- 7.4. There appears to be only one manufacturer (82% Korean owned) of 'solid' gauges (plain, tapered and threaded rings and plugs; go; not go gap gauges).

There appears to be no Korean manufacturer of semi-automatic and automatic air and/or electronic gauging equipment - for rapid, efficient post process measurement or in - process measurement and control of size, profile and finish (QC gauging systems). It is not clear that a sufficient market yet exists in Korea to establish a viable business without funding assistance.

- 7.5. The application of this type of Quality Control equipment to the manufacture of rolling element bearings is essential, if higher quality and performance/ lower reject levels are to be achieved, thus enabling a more competitive attack to be made on the lucrative SE Asia/ chinese markets for bearings.
- 7.6. Tax levels on imported metrology instruments appeared to add nearly 40% to prices which are already high in terms of the long time which is necessary in order to 'recover' such investment in what is seldom seen as productive equipment (metrology instruments and machines are an essential basis for effective gauge and product quality control).
- 7.7. There is no evidence that the manufacture and measurement inspection of precision gears is a particular problem.
Good gear grinding and metrology facilities exist at Dae Woo Machine Tool Division, Chang Won area, for example.
- 7.8. The objectives of the newly formed KAIST providing a range of services to industry are very similar to the ethos of the Cranfield Institute of Technology, (CIT).
There was particular interest amongst senior staff of KAIST in the seminar of 26/10/81 describing and discussing CIT'S organisation and management methods (including financial aspects)

8.0. Recommendations

8.1. The UNDP supported programme should be followed through and extended if necessary.

8.2. Universities and Research Institutes should encourage greater interest of their engineers and students in manufacturing engineering, and build up groups of 'critical mass' in

- * design of precision machines and control systems- and linked machine systems
- * design, development and application of quality control gauging systems.
- * effective operation of NC/CNC machine tools etc.

In particular, KAIST and KIMM should organise seminars, lectures and short courses for engineers from industry as well as for faculty and students. Cranfield frequently runs one week short courses in U.S.A and other English speaking countries; it would be pleased to run courses at KAIST for industrial engineers on

- * Design of high Precision Machines and Control Systems
- * Electronics for Mechanical Engineers
- * Principles and Applications of EDM, etc.

Cranfield's Department for Design of Machine Systems will also be pleased to arrange for its specialist faculty members to visit KIMM/ KAIST to help plan, build up and provide seminars in subjects such as NC/CNC, Modern Transducer Systems, Application of microprocessors.

- 8.3. The programme of sending advanced students to appropriate overseas universities and research institutes for Ph.D., M.S. and special course training should be stepped up to achieve critical mass groups in the specialised skills listed in 8.2. KAIST already has good contacts with appropriate overseas universities. Cranfield, with its similarities to KAIST would be pleased to agree a five year program for training at Master level of KAIST/KIMM students and staff in
- * the design of production Machines and Control Systems (with precision engineering option).
 - * Manufacturing systems engineering
 - * Quality control engineering
(thermal engineering, gas turbine technology and aeronautical engineering also available).
- 8.4. Sabbatical leave for senior KAIST staff at appropriate overseas universities should be arranged - in departments where participation in teaching and research in appropriate subjects can be agreed. (Dr. Chong Won Lee whose interest in precision engineering is high, is invited to join Cranfield's Department for Design of Machines Systems in October 1983).
- 8.5. KAIST and perhaps, KIMM should design and develop test/ experimental/demonstration equipment for teaching and research in advanced servo-positioning systems.

This equipment could, with some special funding be designed, built and commissioned by Ph.D. students at overseas universities as suggested in 8.3 Other rigs/ equipment of similar nature would provide valuable R & D work in, for example diamond machining/ fly cutting of non ferrous materials.

- 8.6 KIMM and KIST division of KAIST must attempt to build up credibility for efficient implementation of product and process innovations in industry - on a joint project team basis with particular companies. For example the Korea Bearing Ind. Co. Ltd. at Busyong has a great need to improve the precision of its bearing components through
- * machine accuracy capability studies of its present machine tools
 - * replacement of several machine tools by modern higher precision machines
 - * application of semi-automatic/automatic gauging systems where required (with microcomputer recording and quality analysis facilities)
 - * specify, select, purchase and introduce automatic machines for the precision watching of bearing components.
 - * improve general operating conditions etc.

It is suggested that a project of this type carried through by a joint KAIST/KBC project team with some Government special funding could be a good 'entry' project for KAIST in the important field of improving precision and quality in industrial manufacturing plants.

- 8.7. Government should carefully consider tax reduction incentives on purchase of metrological instruments and semi-automatic and automatic quality control equipment for a period of three to five years. If implemented, this should terminate when a Korean manufacturer is ready to market its own equipment of this type.
- 8.8. KAIST and KIMM should purchase a suitable Machinability Data Bank System, become proficient in its use in their own research and teaching work and then provide contract information services to industry, backed up by consultancy/ advisory service visits.
- 8.9. The development of Computer Aided Design (CAD), Computer Aided Design Draughting (CADD) and Computer Aided Manufacturing (CAM) must be topics for collaborative work between KAIST/KIMM and industrial companies. Hyun Dai Motor Co. has agreed work with KAIST on CAD. development for car structural design. It is important that the industrial organisation commits one or more staff on a regular basis (even full time) to the joint project.
- 9.0. Conclusions:
- The people of necessary intellect and interest exist in the universities, research institutes and industry to develop the desirable skill groups and R&D base for precision manufacture in Korea, I believe that implementation of the proposals made in 8.0 above, together with advice and guidance from other UNIDO experts in manufacturing engineering,

will successfully establish the technological base
needed for improved general quality of manufacture
and product innovation.



P.A. McKeown

29. October 1981.

Appendix

SEMINAR : "PRECISION ENGINEERING - RECENT
DEVELOPMENTS IN MACHINES AND SYSTEMS".

by PROFESSOR P.A. MCKEOWN
Professor of Precision Engineering
Director of Cranfield Unit for Precision Engineering
Head of Department for Design of Machine Systems
CRANFIELD INSTITUTE OF TECHNOLOGY CRANFIELD UK.
VISITING REPUBLIC OF KOREA AS UNDP TECHNICAL EXPERT
OCTOBER 1981 27.

Over the last 20 years a new grouping of engineering and scientific skills and techniques has emerged in response to the steadily increasing need to manufacture with higher precision.

This is known as precision engineering. It is firmly based on metrology, the science of measurement, and is concerned with manufacture with high accuracy (size, profile and surface finish) over a wide spectrum of size from the micro-circuit through gears, cams and high speed bearings to right vision lenses, X-ray telescope and laser fusion mirrors. The demands for increased precision in manufacture include:

1. To eliminate the fitting process and promote automatic assembly.
2. To improve interchangeability of parts.
3. To improve wear-life performance of moving parts

4. To improve quality control through higher machine accuracy capabilities and thus reduce inspection costs, rejects and re-work.
5. To achieve miniaturisation for higher packing densities and performance.
6. To make possible new discoveries in experimental science and produce product and process innovations in engineering.

Precision Engineering has come to be recognised as a body of knowledge, a grouping of disciplines and a range of technologies which are of strategic importance in international competitive development.

There are two major accuracy 'regimes' in precision engineering:

MICROTECHNOLOGY - Where precision in the order of 1 micrometre ($1 \mu\text{m}$) is achieved.
(Processes of grinding, honing, lapping, opto-lithography)

NANOTECHNOLOGY - Where thin films and surfaces are controlled to a precision in the order of a few nanometres (1nm)
(processes of electro-lithography, ion sputtering and implantation, elastic emission polishing).

A crucial element in the practice and progress of precision engineering is the design and manufacture of the necessary high precision machine tools/measuring machines and their (micro) computer control systems.

Some recent developments in the design and development of high precision machines will be described. They include:

- * a high speed CNC measuring machine for the quality control of cam shafts.
- * A CNC grinding machine for cams with in-process/adaptive control for size and profile.
- * An ultra-precision CNC diamond turning machine for the manufacture of metal optics such as aspheric lenses and X-ray telescope mirrors.

Some of the important principles in the design of machines for high precision will be high-lighted.

SEMINARS given at :

1. KOREA INSTITUTE of MACHINERY and METALS,(CHANG WON STATION)
- WED. 21 OCT. '81.
(about 140 attendees from KIMM, industry).
2. KOREA ADVANCED INSTITUTE of SCIENCE AND TECHNOLOGY, SEOUL
- TUES. 27 OCT. '81.
(about 25 attendees from KAIST staff & students).



