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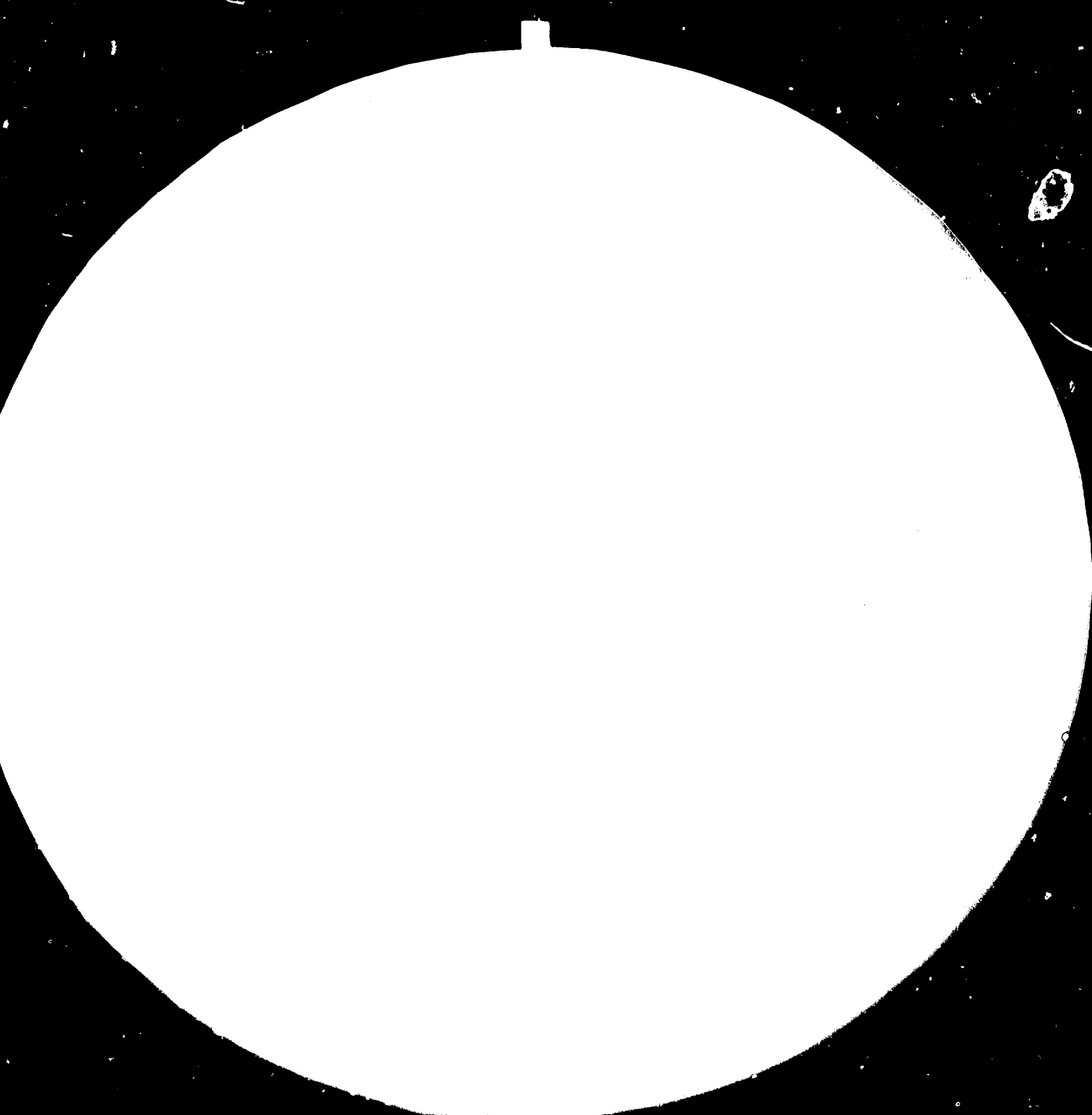

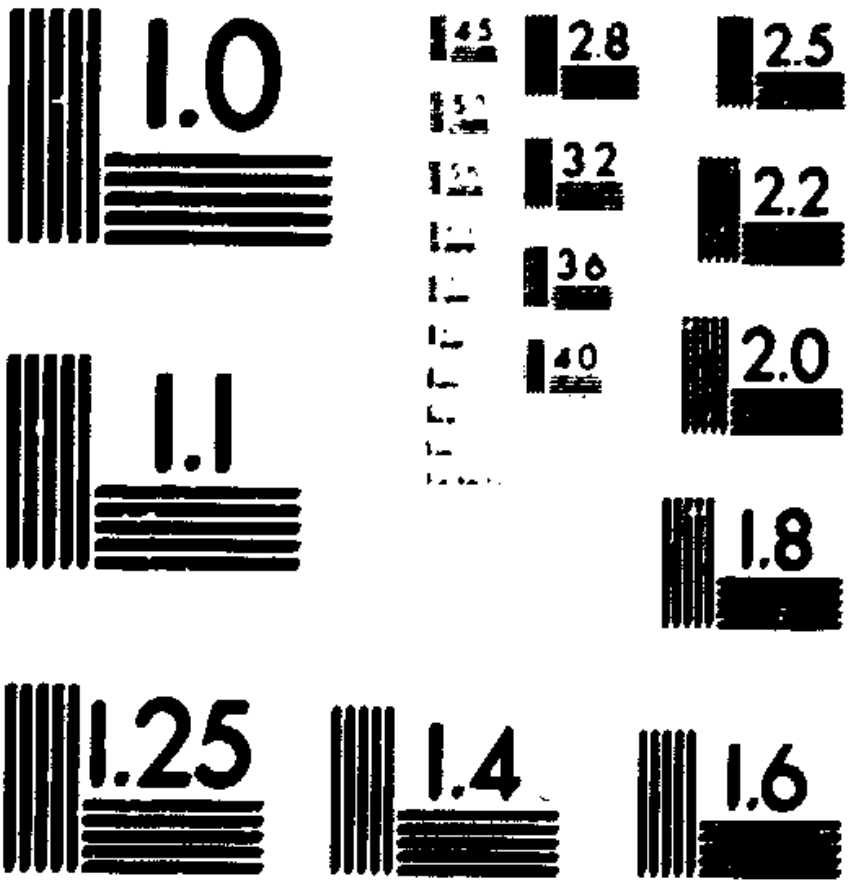

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KIST-INDUSTRY CO-OPERATIVE PRODUCTIVITY PROGRAMME

(MECHANICAL ENGINEERING AND RELATED INDUSTRIES)

DP/ROK/74/006

REPUBLIC OF KOREA.

Technical Report: Internal Combustion Engines*

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 Donald J. Patterson,
expert in Internal Combustion Engines

United Nations Industrial Development Organization
Vienna

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I. Description of Duties

The consultant will be assigned to the Korea Advanced Institute of Science and Technology and will work in close cooperation with the senior staff of the KAIST Mechanical Engineering Research Department. He will advise counterparts in the general field of internal combustion engines and specifically to:

1. Visit Korean factories to assess the local state of technology and to identify critical problems.
2. Advise the counterpart staff in the following areas:
   a. Fundamentals of internal combustion engines
   b. Modern trends in engine development
   c. Fuel efficiency and emission control
3. Assist in defining research and development projects in this field related to industry problems previously identified.
4. Assist in the selection of an engineering trainee and of a research topic for his study abroad.
5. Hold a seminar covering the present state of the art and development trends in this field.
6. Prepare a final report setting out the findings of his mission and his recommendations to the government on further action which might be taken.

II. Activities

The activities for the assignment are listed below. The first portion of the assignment was spent in the Seoul area and mainly involved discussions and consultations with KAIST personnel. A series of six lectures were presented to KAIST and industry personnel during the period May 9-14, 1983. Later several industrial visits were made and a one-week period spent at the Korea Institute of Machinery and Metals (KIMM) which included lectures on four days. Altogether 40 hours of formal lectures were presented. The schedule was:

May 3 (Tues); 8:00 a.m., leave home for Detroit Int. airport

4 (Wed) , 17:00; arrive at Seoul Int. airport

5 (Thurs), Holiday

6 (Fri), 11:00; UNDP Briefing, 2:00 KAIST Introduction

7 (Sat), 9:00-12:00, KAIST - arrange lecture and visiting schedule

8 (Sun)

9 (Mon), 10 (Tues), 11 (Wed): 9:00 - 12:00; KAIST, lectures - see attached schedule

12 (Thurs), 13 (Fri): 13:00 - 18:00; KAIST, discussions with staff and visits to laboratories

14 (Sat) 9:00 - 12:00; KAIST lecture

15 (Sun)

16 (Mon), 17 (Tues), 18 (Wed): All day; Kia Heavy Industries: 3 lectures, discussions and visit to engineering and and production facilities

19 (Thurs) 9:00 - 18:00; KAIST, review report on Korean automotive industry and inspect dynamometer

20 (Fri) Holiday

21 (Sat) 9:00 - 12:00; Daewoo Heavy Industries

22 (Sun) Travel to Changwon

23 (Mon), 24 (Tues), 25 (Wed): 9:00 - 12:30; KIMM discussions, 2:00-6:00 lecture see attached schedule

26 (Thurs) 9:00 - 4:00; KIMM visit laboratories; 4:00-9:00; attend Changwon Chief Engineers monthly meeting and lecture

27 (Fri) 9:00 - 5:00; Hyundai, visit to automotive and heavy industries

28 (Sat) Tour area of Kyongju

29 (Sun) Return to Seoul

30 (Mon) 9:00 - 12:00; KAIST, work on UN report, 2:00-6:00; Final discussions with Dr. Lee

31 (Tues) 9:00 - 12:00; UNDP, final discussion with Mr. Jenkner 1:00 - 4:00; Seoul National University, tour of laboratories and discussions

June 1 (Wed) Depart for U.S.

2 (Thurs) Final report preparation

Lectures on Engine Emissions, Economy, and Future Directions presented at KAIST

May 9 - Emission Sources within Gasoline and Diesel Engines

10 - Internal and External Engine Emissions Control Strategies and Systems

11 - Engine Friction Characteristics and Related Research at the University of Michigan

12 - Future Trends for Engine Design in U.S. and Theoretical Possibilities

13 - a. Engine Torque and Balance Characteristics

b. Combustion in Gasoline Engines - Design for Fast Burn

14 - Feedback Fuel Systems for Gasoline Engines

Lectures and Discussions at Kia Heavy Industries

May 16 - Emission Sources and Control Strategies for Gasoline and Diesel Engines

17 - Turbocharging the IDI Engine - Possibilities and Potential Problems

18 - A.M. - Piston and Ring Assembly Friction Measurements

P.M. - Modern Practices in Engine Testing and Laboratory Equipment

Lectures on Engine Emissions, Economy and Future Directions presented at KIMM

May 23 - Emission Sources and Control Strategies for Gasoline and Diesel Engines

24 - a. Future Trends in Engine Design in U.S.

b. Turbocharging the IDI Engine - Possibilities and Potential Problems

25 - a. Engine Friction Characteristics and Research at the University of Michigan

b. Fast Burn Combustion in Gasoline Engines - Design Methods

c. Impressions of Korean Capabilities and Needs in the Automotive Area

26 - The U.S. Automotive Industry and Future Directions Especially the Power Plant Area.

III.. General Impression

It must be said that the impressions which follow are based on only a four week sample, and thus are subject to uncertainties due to a limited sample. The Korean scientists and engineers that I met have impressed me as being very sincere and hard working. They set high personal goals for themselves and have a strong sense of personal purpose which is strongly associated with the national goals of their country. The strong Korean tradition of education and family unity are important ingredients in their outlook.

Korea is a country which has made remarkable progress in the last two decades. The rate of industrial growth is very high at present. Korean industry has a competitive edge over many more developed countries because of the low wage rate which is about $1.50/hour average or one-fifth that in the U.S. Most manufactured goods and especially automotive products are built under license or by established designs obtained from other countries. While somewhat labor intensive, the manufacturing to which I was exposed appears to be well done and in general one would give Korean industry high marks for manufacturing a good quality product.

The industry is now ready to take the next step into product research and product development. To a very surprising degree there is a complete lack of understanding of the product R&D process and a lack of appreciation for the "technical artistry" of the R&D engineer. Most engineers I talked with gave me the impression that this R&D technology can be purchased abroad as needed.

In general engineers in industry had little confidence in either KAIST or KIMM engineers and scientists to help in the product R&D role or in fact to help industry in any manner whatsoever. On the other hand, the KAIST and KIMM personnel appears anxious to be of assistance to industry but are in general, sufficiently removed from the day-to-day problems

of the "real world" that they have difficulty formulating meaningful research programs. There is no question but that the scientific capability in Korea (which is concentrated primarily in KAIST) is excellent. Many well qualified Ph.D's are at work.

To summarize I find well qualified people in science and in manufacturing. These two groups have little communication and are suspicious of each others motivations and capabilities. The product R&D expertise simply does not exist.

There are many developing nations, i.e. China, which are behind Korea developmentally and which are developing their own basic industry capability. This could squeeze out the Korean heavy industry in time due to lower labor costs in a period when labor cost in Korea would be rising.

The only way for the Korean automotive industry to succeed in world competition is to develop product R&D capability. The final "cutting edge" of technology cannot be bought. It must be developed internally. The alternative is to relegate the Korean automotive industry to a second-class status, squeezed between low labor costs in other developing countries and unable to produce the high profit margin, technically sophisticated products of those countries which are able to develop sophisticated products internally.

IV. Recommendations

1. It is essential for the continued success of the Korean automotive industry to develop an adequately strong product R&D capability internally within Korea.

2. The "technical artistry" of the product R&D engineer must be given sufficient stature that talented and creative engineers are attracted to that as an honorable and recognized profession. Clearly the Ph.D. scientist has such a stature in Korea.

3. In the long run, the majority of product R&D is best done by the manufacturers themselves who are the best judges of their product limitations and needs for the future.

4. Organizations like KAIST and KIMM can play an important supporting role. They can bring their technical expertise to well defined problems. Since it is the responsibility of industry to create its own success, it is incombent upon them to utilize fully the resources available. Industry must identify product R&D needs which it feels are capable of being supported by KAIST and KIMM. These should be submitted periodically as a "Request for Technical Support." In joint discussions, it will normally be possible to define programs which are satisfactory to all parties and include compromises on scope of work and expected results. The industrial engineers wish to have an immediate total answer to a seemingly impossible problem. In time the scientist can give an answer to a well defined portion of a larger problem. The use of KAIST and KIMM facilities by industry is expected to develop some product R&D engineers. All must learn to work together in a mutually respectful manner. To promote this it would be desirable to have some scientific people spend a consulting day in industry from time to time.

5. There is a need to develop some centralized automotive R&D facility in Korea. This is already in the planning stage. Such a facility should concentrate on product areas which are non-competitive. Safety and emission control are two obvious areas. Another might be advanced manufacturing techniques including robotics. I am left with the distinct impression that the automotive industry will not participate in any centralized laboratory activities which could in any manner compromise their product security. Because the foregoing is such a strong and overriding concern for industry, it is essential to focus the new facility on non-proprietary aspects and to take every possible step to

assure product secrecy. This means that no information can be released except by the manufacturer who is deemed to have complete and exclusive use of data obtained. If a high ranking industrial or government official can obtain information directly, then there is no product security and the manufacturer will avoid the use of the facility in any meaningful manner where product security is a concern.

6. Air pollution is a serious problem in Seoul. While only a portion is due to automobiles, there is sufficient incentive to control emissions from gasoline and diesel engines. The engineering organizations in Korea should study the methods of exhaust and evaporative emission control and develop systems for newly manufactured vehicles. I have recommended research related to ceramic diesel particulate traps.

7. The automotive powerplants of the future are expected to be similar to today's engines except for numerous incremental design improvements for improving economy and emission control. I have recommended research related to the "adiabatic" direct injection diesel, continuously variable transmission, and electronic engine controls for advanced automotive power systems for the timeframe 1990 - 2000.

VI. Concluding Remarks

The Korean automotive industry appears to be strong and healthy at this time. In order to succeed in the future it is essential to develop a strong product R&D capability where none exists today. Significant help in this endeavor can be obtained from KAIST and KIMM in well defined problems which are of importance to industry.

A need exists for a centralized product R&D laboratory in Korea. Its success requires an extremely well designed administrative structure to assure product security. To minimize the aforementioned problems, emphasis should be on research areas

and programs which do not deal with matters where product security is a significant concern.

Several prospective Ph.D. students were interviewed and discussions held relative to a thesis topic for a current U-M Ph.D. student and possible research in the United States supported by Daewoo Heavy Industries. Some discussions were held also related to a possible return visit of two weeks in the spring of 1984.