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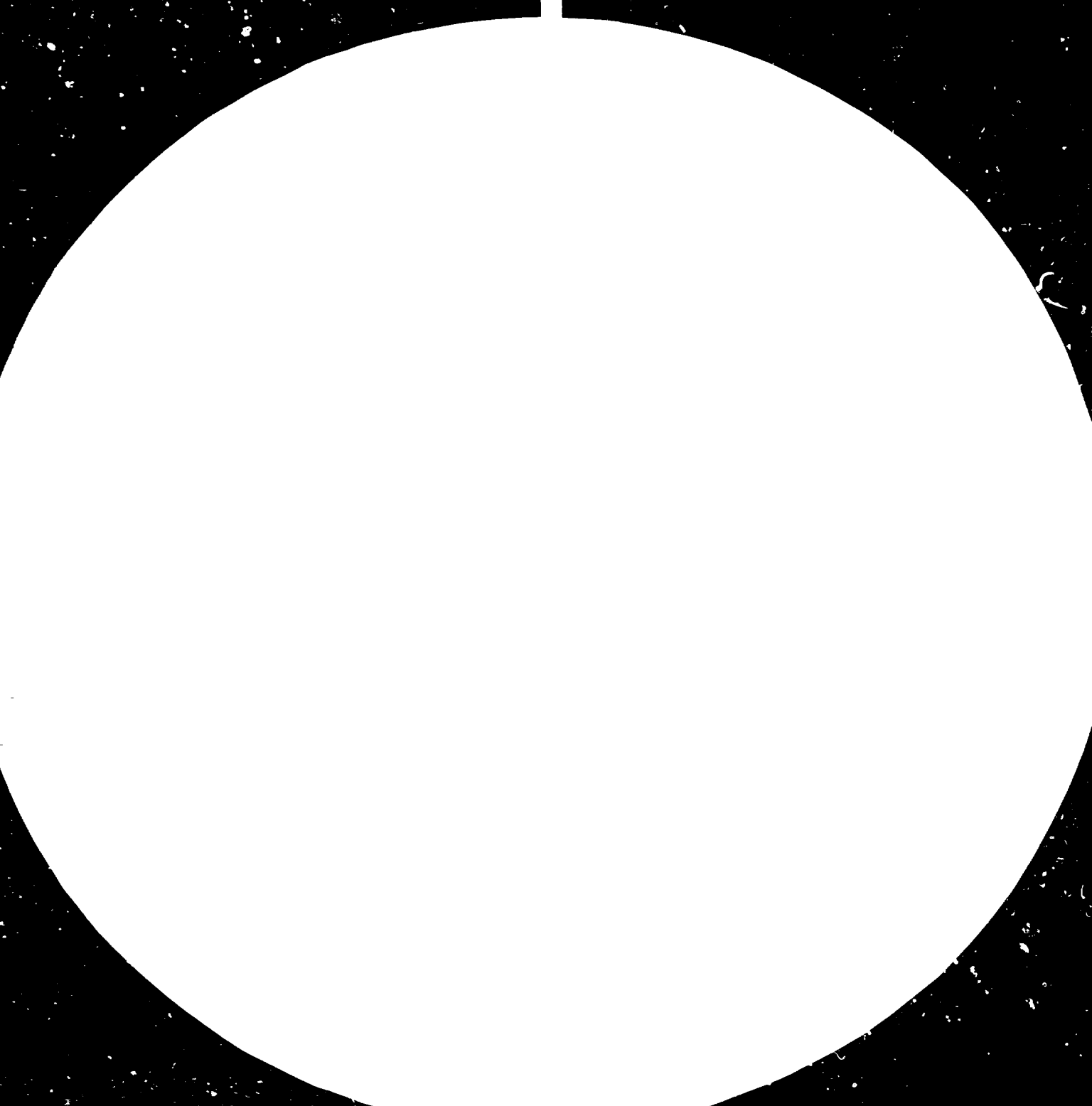
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2.8



3.2



3.6



4.0



Figure 1. Resolution test targets used for the experiment.

Figure 2. Example of a resolution test target used for the experiment.



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INDUSTRY - INDUSTRIAL RESEARCH AND SERVICE INSTITUTES (IRSIs)

CO-OPERATION

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1. INTRODUCTION

All IRSIs are erected for the purpose of promoting industry, in the short term and in the long term. It is well documented that IRSIs in developed as well as in less developed countries often have had an unsatisfactory relationship with industry. This is particularly the case with the multi-branch multi-discipline institutes, M-IRSIs, to a lesser extent the mono-branch institutes or just branch institutes, B-IRSIs - as they are usually called.

The idea of general purpose IRSIs or M-IRSIs became widely accepted during and after the second World War. Before that time, the scientific and basic Research was done at universities and the very large industrial cooperations. Product and process development R&D was undertaken by industry. - When an IRSI is established, it is mainly staffed with university people and young graduates with no industrial background and little understanding of commerce and production. Most of them are inclined to continue doing more or less basic research the way they had learned to do it at school. They accepted that it must be in a field which potentially can help industry. But very little communication with industry results from this approach. The way from basic research findings to selling products seems a very long one. After a while, the governments and the industry in most countries became impatient and decided they wanted the IRSIs to be more applied. The IRSI then tried to invent products and processes, which they hoped industry could take into use. But industry, as a rule, finds their ideas far fetched, not representing a business opportunity and seldom has confidence in the processes and products offered. Some IRSIs, therefore, decided to go one step further in the R&D process

and produce prototypes and build pilot plants to convince industry. Some IRSIs also went into engineering and management, prepared to spoonfeed industry if necessary to sell the R&D results. When also this strategy fails, some R&D policy makers conclude that branch, multi-discipline IRSI concept is a poor idea and that mono-branch institutes is the solution. And, indeed, it is much easier to establish close relations with a limited number of enterprises. It is easier to acquire know-how and high skill in a limited field of technology and in close contact with the branch. The B-IRSIs, as a rule, function quite well.

2. WHY MULTI-DISCIPLINE, MULTI-BRANCH INSTITUTES (M-IRSIs)?

Since it is the M-IRSIs which have problems with their industry relations, I will in my paper mainly deal with M-IRSIs, from which I also have my personal experience.

First of all, if the B-IRSIs function better than the M-IRSIs, why have M-IRSIs? There are several valid reasons:

- There are so many kinds of industry which do not fit together as a branch.
- There is a demand for highly sophisticated research disciplines which are used by many branches, and each branch institute is too small to establish its own expertise.
- It is recognized that a multi-discipline approach is often necessary in order to tackle problems involving e.g. physics, chemistry and engineering, so-called interdisciplinary projects.
- The M-IRSIs are undoubtedly more fit to do long-term and sophisticated research. The branch institutes tend to become part of industry and become fully occupied, solving pressing problems of today. As a result, they cannot do more demanding research. The B-IRSIs are staffed with more technicians and fewer academics than the M-IRSIs.

3. WHO ARE THE IRSI CLIENTS?

An M-IRSI has hundreds and perhaps thousands of potential customers, while a B-IRSI has a handful. The potential M-IRSI customers come from a great number of industry types, so great that the researchers usually know little about their products and production. The M-IRSI researchers are not experts in the clients' field like the B-IRSI people are. The M-IRSI people are specialists in fields where the clients lack know-how and need help. An example is an oil company which needs a tailor made computer. The type of relationship between the IRSI building the computer and the oil company is very different from the kind of relationship which exists for a B-IRSI doing standard testing and trouble-shooting. They have a small communication problem. The M-IRSI has a very difficult communication problem. The B-IRSI knows very well the processes involved - and even the people. They have a common language. The computer men tend to talk a language that the oil men do not understand and vice versa.

4. M-IRSIS IN THE PAST AND TODAY

If the industry is unsophisticated, it is in a way easier for the M-IRSI people to catch up with the know-how of the client. They may even undertake some engineering. It was a different story to run an IRSI in Norway in the 60's than it is today. In those days, we could make ourselves useful by designing equipment, run chemical engineering pilot plants and similar. Today, there is no market for this in Norway. The industry is so sophisticated, and all kinds of excellent equipment and know-how can be purchased in the open market, better and cheaper than from an IRSI. In those days, there were not so many consultants, engineering firms and industry promotion technological institutes and similar. The IRSI came handy in, and filled the many gaps.

In Norway today, we can only sell sophisticated services based on high academic skills or very costly equipment. Some developing countries are certainly less developed than Norway was in the sixties, but this does not imply that they want home made equipment and processes.

The sixties will never come back. The industry must itself have capability to purchase the proper and most appropriate technology. An M-IRSI can seldom give adequate advice. It does not have the branch knowledge. Common sense is not enough. The amateur researchers' days are gone for ever.

A modern IRSI plays a different part. They leave the bulk of the work to industry, engineering firms and consultants, and so to say only provide the "dot over the I". Let me give an example. Norwegian companies joined forces, and developed the now so famous Condeep concrete gravity platform for petroleum production offshore. But they needed help from our IRSIs. The IRSIs did all the model testing, they produced part of the software for the complicated design calculations. They made the instruments needed to installing the structures on the sea floor. They developed the methods for calculating the environmental forces, and found out if the soil had the capacity to carry the load of 300 000 tons. We were called upon to undertake computer-aided risk analysis.

Prior to the success offshore, the Royal Norwegian Research Council had for years financed more or less basic research to build up these skills at the institutes. One useful mechanism to secure industry relevance of the research, was to put people from industry on the steering committees of all large projects and as advisors to the Council. When an IRSI asked for money to a project, e.g. for the purpose of developing a new idea or for learning about a new technology, we were told that we had to find an industry partner, willing to put at least some money into the project. If no industry was willing, it was concluded that the project lacked realism.

I must admit that we pushed some pet projects through without industrial support, and in some cases with success. Industry is admittedly sometimes too conservative and lacks ability to see the potential of new technologies in the early stage of development.

5. SHALL AN IRSI SERVE THE BIG OR THE SMALL?

You can probably appreciate that an IRSI cannot function in a vacuum. It cannot create industry. (Unfortunately, many developing countries expect it to do so.) An IRSI can only function when it has industrial counterparts. In Norway, the IRSIs still make inventions, using in-house money, but they always try to find a sponsor at an early stage. We don't wait until we have a finished product. We do not build prototypes or run pilot plants with in-house money. We have learned that we need to cooperate closely with the industry in all phases of a project. In the past, we came together and discussed the problems of transferring the IRSI results to industry. We used to develop prototypes which the industry had to do all over because we lacked the knowledge of production, industrial design, use of the various pre-fabricated components, etc., etc. We do not discuss this transfer problem any more. It does not exist. We work hand in hand with industry. The sponsors participate much more actively. They usually produce the prototypes, we solve specific problems.

A few years ago, I was asked if I would undertake a risk analysis of Simultaneous Drilling and Production for one of the large oil companies. I had never done such a thing, which I said openly. But my institute offered to take the project on the condition that the oil company would participate very actively: Take us out to the platforms, explain their equipment and procedures. They agreed, and they did. The project became a success. We learned a lot and could more easily do other projects of a similar nature. It was a break for us. We had an unexpected opportunity and grabbed it.

The role of industry in IRSI R&D is absolutely essential. It has for this reason no purpose to start with research, hoping that it will create industry. I am sorry, but that is not the way to go, is not the role of IRSIs, and less so the less developed a country is.

In the early days, few of the trans-national or foreign enterprises used Norwegian IRSIs. Today, they all do - and are our best customers. It is a fact that most of the projects, and particularly the large and interesting ones, come from large enterprises. Again and again it has been said that we should do more for the small. Various models to

improve this situation have been tried, but with rather limited success. It seems that the small are better served by other types of institutions than M-IRSI's. One obvious reason is that it may cost the same to solve a problem for a large and a small company. The large one produces many units, and the research expense becomes small per unit produced. The small companies produce fewer items and the research is not cost/effective. In a small, less developed country, research is not as cost/effective as in a large and developed country.

Of course, Norway has not solved once for all the IRSI industry cooperation problems. There is a continuous discussion about whether we become so applied that we begin to compete with industry and exhaust the superiority built up by doing long-term, basic, strategic research. We also have the problem of competing IRSIs, which all want to go into the new, promising fields like oil. The result is that the milieus become too small. But, competition and ability to grab opportunities are probably more important. The free competition creates more dynamic IRSIs. I am afraid that too much central planning, telling who shall do what, in the final result may be counter-productive. But views on this vary a good deal.

6. IRSI-ADAPTATION TO INDUSTRY

In designing or re-designing an IRSI, the starting point should be to analyse the industry of today and what we expect it to be tomorrow. If the industry is protected and mainly serves the home market, it is probably not much motivated for research. Launching projects which need research to succeed, is risky and troublesome. Industry does not go into such adventures, unless it is needed in order to survive or reach ambitious goals. When industry is not research motivated, the IRSI must emphasize services rather than R&D. If the country has a good potential and resources of people and finance, it can go into strategic (long-term) and more basic research in order to prevent brain drain, and build up capabilities which will be needed in 10 or 20 years. It is questionable, if such research should be done by establishing a grass-root IRSI. It may be done, some countries, like Venezuela, have successfully done so.

But the institute I have in mind was not a typical IRSI. In smaller countries, the basic research should be done at universities, in order to economize with resources.

7. PRACTICAL PROBLEMS

Smooth cooperation between an IRSI and its industrial clients requires certain managerial skills. There must be adequate routines for R&D contracts, which define the rights of both parties. There must be proper billing routines and reporting routines. There must be a system which secures high and consistent quality of the work. The reports must be written in a language which the receiver can understand. The reports must answer the questions which the sponsor has asked - rather than being an exercise enjoyed by the researcher but not the client.

The IRSI must learn to keep the schedule for costs and to complete the work in time. This requires both experience and discipline, and often leaves much to be desired in developing countries. Unless the IRSI can and will play the game the way the client demands, he will be reluctant to come to the IRSI next time.

8. SALARIES ETC. MUST ATTRACT GOOD PEOPLE

Unless the IRSI is able to pay salaries and give its staff opportunity to develop high skill, the industry has nothing to gain by employing the IRSI. I know that in some countries it is impossible to pay competitive salaries to the researchers. I accept that, and I do not hesitate to draw the conclusion. Forget doing R&D and undertaking difficult projects, let the institute be a pure service institute doing routine work, testing, analysing, and similar.

9. CONCLUSION

A multi-disciplinary, multi-branch - or so-called M-IRSI - can only have satisfactory relations with industry on certain conditions.

1. There must be an industry which is motivated for research.
2. The IRSI must have capabilities to offer what the industry needs.
3. An IRSI must not try to deliver production prototypes or turnkey processes. It must through all stages work hand in hand with industry.
4. If there is not an industrial environment which can function as counterpart, product and process R&D is not worth-while. Under such circumstances, it is better to do university research, and have Industrial Service Institutions, ISIs.

