



BRIDGING THE GAP BETWEEN ENGINEERING RESEARCH AT UNIVERSITIES AND INDUSTRY NEEDS, BARRIERS & SOLUTIONS

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ABSTRACT

This paper addresses barriers and solutions involved in the establishment of a close cooperation between university engineering research activities on one hand, and on the other hand, the needs of industrial institutions for improved operating strategies and manufacturing technologies. In discussing these issues, the following topics are covered.

Barriers standing in the way of establishing or reinforcing the desired cooperation are identified. The barriers are discussed from the point of view of both sides as these barriers differ in nature depending on the side from which they are viewed.

Solutions are proposed, the acceptance and implementation of which, can provide opportunities for the elimination or reduction of existing barriers. These proposed solutions deal with the identified barriers facing both sides, and suggest how the desired cooperation can be achieved.

Finally, the paper gives a general discussion of the importance of establishing a close cooperation between the two sides.

Keywords: *engineering, research, industry, cooperation, barriers, solutions*

الملخص

1. INTRODUCTION

This paper addresses the issues involved in the establishment of a close cooperation between university engineering research activities on one hand, and on the other hand, the needs of industrial institutions for improved operating strategies and manufacturing technologies so that competitive and high quality products can be achieved. University engineering research activities will be referred to as “Research”, and industrial institutions will be referred to as “Industry”. The term Industry is used in the broad sense of the word to include institutions whose output is either physical products or services.

In all developed countries, Industry is at the backbone of the national economy. It offers the country social stability in view of the very large numbers of job opportunities it creates while producing physical products or providing services. On the other hand, universities are the “production line” that provides Industry with its needs of qualified manpower without which industry progress and improvement cannot be achieved.

In view of this mandatory “organic” and operational tie-up between these two entities, it is natural and essential that a close cooperation be established between the two entities to ensure the interests of both sides. The existence of a close cooperation between Industry and universities in general takes on several forms. One very important form of this cooperation involves interaction between research centers at universities and industry, and in particular, between engineering and faculties of science research centers and industry.

In industrially developed countries, cooperation between Research and Industry has been established and maintained for a long time. Industry approaches Research seeking assistance in resolving its technical and operational problems. Alternatively, Research reaches out to Industry to obtain financial support for new ideas that could improve or fully change operational practices and applied technologies. In countries where Industry constitutes a small part of the country’s national economy, cooperation between Research and Industry is generally not well established due to barriers that stand in the way of such cooperation.

The discussion presented in this paper is based on the authors experience with both sides for over twenty-two years (1976-1999) at an industrial facility operating in the field of electricity and electronics. Activities covered product conception, design, prototyping, testing, production and sales. Equipment handled covered power electronics, security systems, industrial controls, data acquisition systems and a large variety of electrical engineering and electronics laboratories and training equipment designed and built for universities and technical colleges. A considerable amount of the work involved electrical engineering faculty members and engineering students working on final year projects or Master’s degree requirements. The interaction with engineering faculty and students was continuous throughout the period indicated above. Many of the completed projects produced equipment with important industrial potential. Unfortunately, it was not possible to create a suitable

industrial environment to commercialize these products due to the small market size and foreign competition. Also, many obstacles were faced due to barriers existing between Industry and Research that could not be overcome.

The author's experience mentioned above was in Lebanon, and admittedly, involved only a specific type of industry, namely the electrical-electronics industry. However, it is believed that there would be many similarities as well as some differences between the situation existing in Lebanon and that existing in the Kingdom of Saudi Arabia. Additionally, it is believed that barriers facing the cooperation between Research and the electrical-electronic Industry will be similar in nature to those facing the cooperation between Research and other types of Industry. Accepting that the above mentioned similarities are true, the author hopes that the experience gained from the Lebanese situation can provide insight into the situation prevailing in the Kingdom of Saudi Arabia.

2. BARRIERS

Barriers hindering cooperation between Research and Industry differ in nature depending on the side from which they are viewed. It is therefore necessary to identify and present barriers relating to each side separately.

2.1 Industry-Side Barriers

2.1.1. Lack of Awareness Barrier

In countries where Industry represents a small part of the national economy, and with the exception of large industrial complexes, most industrial institutions are privately owned. Individuals, a small group of individuals or families, possessing sufficient financial resources, are in general behind the establishment of Industry. Therefore, most Industry can be classified as private businesses. Management in this type of Industry is "Individual Management" as opposed to "Board Management" in industrial institutions that are government or publicly owned. "Individual Managers" generally occupy their managerial positions because of their relationship to the source of capital invested in the industrial project. On the other hand, if Industry is government or publicly owned, managerial positions are more likely to be filled by persons with previous experience and history in the management of similar industrial projects. Consequently, "Individual Management" is not very likely to be aware of the benefits that can be obtained from cooperation with Research. Alternatively, "Board Management" with long standing experience in the Industry field of activity, would have a higher level of awareness, acceptance and appreciation of benefits that can result from cooperation with Research.

2.1.2. Mistrust Barrier

This barrier represents a very serious situation due to its nature. Most Industry managers feel that they cannot disclose information about their managerial practices, supply sources, industrial processes and capabilities of their work force. Generally speaking, Industry

managers feel that they possess in-house what is needed to run and develop their Industry. Consequently, they do not believe that they can let “outsiders” know, or become involved, in their activities. Most Industry obtains its production equipment from industrially developed countries. Such equipment suppliers are mainly interested in selling their products, and would not give out sufficient technical information about the equipment to permit the purchaser to modify or improve the equipment to suite their changing production needs. As such, Industry will go to, or obtain consultations from their machinery and materials suppliers to solve any existing difficulties or problems, or, to modify or develop their production equipment and processes. When Industry is approached by local Research offering assistance, they are highly skeptical and hesitant to accept such offers for fear of interruption of productivity or loss of the equipment manufacturer support (The subject of transfer of production capability from developed countries to developing countries without real transfer of technology is a well known issue and is subject to continuous discussion by those concerned in developing countries).

2.1.3. Financial Barrier

Research can only be conducted if sufficient financial resources are available. Faculty members, students, laboratory assistants and other needed support staff must have financial resources to operate. In addition, research in which Industry may be interested, must be applied research and not theoretical in nature. This necessitates the establishment of laboratories and the purchase of equipment and materials to utilize in performing applied research projects. Industry is reluctant to support Research financially by supplying part or all of the needed financial resources. Industry does not feel that expenditure on studies and development represents justifiable expense in view of the fact that no equipment or materials are provided as a result of the research work. Additionally, industry does not appreciate the time needed to do the research and product development, and considers this to be loss of time and money.

2.2 Research-Side Barriers

2.2.1. Academic Barrier

Most university faculty members move directly from the university from which they obtained their higher degrees to universities in which they teach. Industry does not have research facilities, nor is it willing to pay such highly qualified individuals to do work commensurate with their level of education. Consequently, individuals with higher degrees have no alternative but to stay in academic work, and do not get the opportunity to do research work within the environment present in Industry. This barrier is more pronounced in technical fields (engineering and applied sciences) than it is in managerial and administrative fields. A good number of individuals with higher degrees work in management and administration in Industry, while it is almost impossible to find engineers or scientists with higher degrees working in Industry.

2.2.2. Education Program Related Barrier

Since engineering programs offer students the knowledge required to perform work in Industry, it is important that such programs include specialties closely related to industrial work. For example, there are very few faculties of engineering that offer degrees in industrial engineering, process engineering or instrumentation engineering. These programs are offered in industrially developed countries, and in many cases, engineers from industry participate in the teaching of these programs. The importance of having such programs goes beyond their educational value. They can help bring Research and Industry closer together, and especially if they are conducted in a way that ensures transfer of knowledge and experience from each side to the other.

2.2.3. Operational Barrier

This barrier is a result of the nature of work required at universities and other higher educational institutions. In addition to the relatively high teaching loads, university professors are required to participate in many academic activities that are important, yet time consuming. This does not leave sufficient time for going out to Industry to find out about difficulties and problems that can be resolved through research and development work.

2.2.4. Institutional Barrier

Academic institutions at the university level require faculty members to do research and to publish peer reviewed work. This is an important requirement for faculty members to maintain their positions and for eventual promotion. Not all universities have the facilities and equipment for doing research that can be classified as original work. Consequently, research at universities tends to be of theoretical nature rather than of an applied nature. Little laboratory work is done to demonstrate possible practical applications pursuant to the research. Work done by faculty members for Industry cannot usually be published in scientific journals in the form of peer reviewed papers, and may not be classified as work that meets the university requirements for research and publication.

3. SUGGESTED SOLUTIONS

In order to move in the direction of the desired cooperation between Research and Industry, a number of solutions are presented below which address the barriers identified in the preceding section. It is however important to identify a third party whose efforts are essential in reaching the desired solutions. This party will be called the Official Side. In view of its importance, we will start with steps that can be taken by the Official Side.

3.1 Official-Side Solutions

To eliminate barriers, it is both important and necessary to have a third party play a leading role in mitigating the effect of existing barriers. This should be the role of an independent, non-profit organization having no special benefits of its own, and whose interest lies in having the interest of both sides coincide. Such an organization would act as the catalyst that causes the cooperation reaction to take place. Likely candidates to play such a role are the Ministry of Industry, Ministry of Higher Education and the Local Chambers of Commerce and Industry. By the nature of activities of the above-mentioned entities, their efforts would be acceptable to both sides. Activities that can be performed include, among others, the following:

- Prepare and conduct awareness programs aimed at removing the Lack of Awareness and Mistrust Barriers mentioned under Industry-Side Barriers. If these two barriers are eliminated, the Financial Barrier will be spontaneously reduced, and further on, eliminated.
- Establish and implement a continuous program of meetings, seminars, conferences and circular letters, the objective of which is to inform both Research and Industry on available opportunities on which both sides can cooperate, and from which both sides can benefit.
- Prepare and conduct a program of dialogue with responsible individuals at universities (Administrators, Deans and Department Heads) and Industry (Top Management and Technical Management) to discuss methods by which research conducted in cooperation between the two sides can be encouraged and given the recognition it deserves.

3.2 Research-Side Solutions

Faculties of engineering and sciences at universities can take a number of steps to promote the capabilities of faculty members, graduate students and university research centers and laboratories in providing solutions that meet Industry needs. Some of these steps are given below.

- In many industrially advanced countries, universities offer programs in which an important part of academic requirements for higher degrees are fulfilled through working at industrial institutions on industrial application projects. Work activities and results obtained are regularly reported to advisors at the universities for counseling and approval. Setting up such programs within faculties of engineering and sciences can lead to a closer cooperation between Research and Industry.
- Based on interaction with Industry, universities can create specialized courses at appropriate levels, the objective of which is to provide courses that are directly related to the needs of industrial development, and to conduct these courses in cooperation with and financing from Industry.

- Invite engineers from Industry to participate in teaching courses with high practical content. In that respect it is interesting to give two examples that point out to the importance of such a step. First, in a brochure [Munich University] directed at potential engineering students issued by Munich University of Technology, Germany, the brochure states “the university offers not only advanced and up-to-date training, but also its long tradition of scientific partnership and cooperation with Industry. The majority of our teaching staff has previously worked in industry. Their valuable industrial experience and connections are a further asset, in addition to their excellent international reputation in their field”. Second, in a number of recent issues of the IEEE spectrum magazine [Editorial, 2001], a number of universities have announced open academic positions. Among similar announcements by a number of universities, the University of Stuttgart, Germany, has announced an open position for the head of the department of Power Electronics, and the announcement stated that “the applicants are expected to have an excellent scientific and didactic skills, and industrial experience is especially welcome”. The above two examples point out to the high level of importance placed on industrial experience by engineering faculty members in a country, Germany, which is very well known for its high level of industrial productivity as well as its advanced and innovative technological capabilities.
- Form specialized committees within the faculties of engineering and sciences to contact Industry and make them aware of facilities and capabilities available to Research from which Industry can benefit.
- Research can issue special bulletins or a journal to be circulated to Industry indicating research projects undertaken and completed from which Industry has benefited.

3.3 Industry-Side Solutions

Industry can take a number of steps to improve and expand the cooperation base with Research. Some of these steps are listed below.

- The first and most important step for industry is to reach out to faculties of engineering and sciences, and to request proposals regarding possible solutions for any of its technical and operational problems. Such proposals can be discussed and evaluated jointly to determine their feasibility. This should be done before going out to outside suppliers for needed solutions. If Research responds in good time, and offers viable technical and operational solutions, then with time the Lack of Awareness barrier will be reduced and more confidence will be established between the two sides.
- To overcome the Mistrust barrier, Industry can request a non-disclosure and confidentiality agreement from Research when any cooperation is to take place. The individual faculty members who will be involved in the work, backed by the department or university to which they belong, can give such guarantees to provide full confidence to Industry.

- The Financial barrier is of a serious operational nature. In many countries, research conducted at universities is financed from multiple sources. By combining financing resources from industry, Research and the Official bodies mentioned above, it will be possible to overcome the Financial barrier and secure sufficient funds for continued research and development that can serve the needs of both Industry and Research.

4. GENERAL DISCUSSION

Although it may be viewed by some, that cooperation between Research and Industry offers a variety of benefits to both sides, it should not be assumed that both sides attach sufficient or equal value to such cooperation. The driving force behind each of the two sides is different in nature. While Research is driven by increased knowledge, scientific advancement and achievement, Industry is driven by increased productivity and profitability. For cooperation to reach its intended objective, it is necessary that the two driving forces be oriented in the same direction.

Industry has much to gain by establishing cooperation with Research. Industry will gain the knowledge of faculty members, graduate and undergraduate students, research facilities and laboratories at a cost that is much less than if it were to have all these capabilities in house. Additionally, at times of economic difficulties, Industry is more sensitive to such difficulties than Research. This is due to Industry's profit sustaining nature, while Research will always get support due to its educational mission. By strengthening cooperation between Industry and Research, Industry can become more advanced, competitive and profitable, which is what it needs to survive during economic difficulties.

The recent worldwide developments governing international trade have given rise to a new emerging factor that necessitates the close cooperation between Research and Industry. The requirements for open markets and exchange of products will set new standards for product quality, productivity, competitiveness, innovativeness and other such measures. Developments in the structures of industrial and service providing companies worldwide, indicates that even large entities are consolidating and merging their efforts to achieve profitability and to maintain market position. One of the important reasons behind such mergers is to reduce the cost of research and development of quality products and services. This is an additional and important reason why Industry must cooperate with Research to meet the challenges ahead.

Cooperation between Research and Industry may not presently be at the appropriate level. However, there are indications that such cooperation is being seriously encouraged. Two examples are given in this regard. First, in a recent engineering related conference held at a university, representatives from the Saudi Electric Company (SEC) gave a presentation on future developments in the electric power utility. It was stated that by policy of SEC, a

predetermined part of SEC income would be spent on various research activities conducted at universities and research centers. Second, in a recent issue of the Bi-weekly Newsletter [Future, 2001] of the King Fahd University of Petroleum and Minerals, it was announced that the university signed an agreement with the oil services company Schlumberger for the establishment of a scientific research center at the university campus. Both examples above point out to the fact that serious and practical steps are being taken to encourage the cooperation between Industry and Research.

5. CONCLUDING REMARKS

In a series of recently published articles, a number of issues relating to the subject on hand have been discussed. Some of these issues are presented below.

The Editor in Chief of the IEEE transactions on Education (IEEE being one of the largest professional institutions in the world with over four hundred thousand members), and after more than forty years of mixed academic and industrial experience in the USA, David A. Conner said [Conner, 2002], “when I returned to academia, I began to develop questions about the relationship of engineering education and the practice of engineering in nonacademic settings”. One of the points he raised is that a number of university professors had no significant industrial experience, and thus cannot teach students “how to be practicing engineers in industry”. Another point is that “many faculty members viewed the primary role of engineers to be the development of new knowledge rather than the application of known knowledge to solve problems”. On this he continues that it is necessary to know “how to research new knowledge and how to apply known information in the solution of problems, whereas the general view in industry was just the opposite”. The last point is that “as many faculty members progressed in their research, their view of the future was based upon their past activities in their field of technical specialization and not necessarily based on the dynamics of the market place”.

The above statements point out to the fact that some of the Research-Side barriers mentioned above exist not only in developing countries, but are also present, in one way or another, in one of the most technically advanced countries, namely the USA.

On the Industry-Side barriers, in one of the articles it was stated that [Paton, 2002] “The most important issue facing engineers and educators is how to keep up in a technical world that changes, seemingly in nanoseconds. We must find ways for industry and engineers to overcome the traditional roadblocks to continuing education by proposing a new type of partnership between industry and academic organizations”. The article goes on to say “Traditionally, managers who send engineers to classes or conferences have very little interest in understanding what value the program had for the engineer or the business that paid for it. Even worse, too many managers believe that if they lack a particular talent in their group, they

can simply go hire the talent they need and expect their problems to be resolved immediately”.

The above statements points out to the fact that some of the Industry-Side barriers mentioned above are also present, in one way or another, in one of the most technically advanced countries, namely the USA.

Finally, general ideas and concepts covering the subject on hand were presented. The author recognizes that the discussion above must be based on a wider and more varied review at a number of universities, and a larger segment of Industry. It is necessary that field surveys be conducted to achieve a more in depth understanding of the issues involved. Surveys must cover universities having faculties of engineering and sciences on one hand, and on the other hand, a representative and varied sample of Industry of different sizes, geographical locations and product types. Surveys must be based on clearly structured questionnaires permitting a thorough understanding of the interests and expectations of both sides. It is necessary to determine methodologies to be followed that would satisfy both parties to the desired cooperation. The results of such surveys will offer better insight into the elimination of barriers and the development of effective and viable solutions.

REFERENCES

1. Arthur E. Paton, 2002 “What Industry Needs From Universities for Engineering Continuing Education”, IEEE Transaction on Education, February, Volume 45, pp. 7.
2. “Classified Employment Opportunities Open Academic Positions”, 2001, IEEE SPECTRUM October, pp. 76.
3. David A. Conner, 2002, IEEE Transaction on Education, February 2002, Volume 45, pp.
4. “KFUPM & Schlumberger Research Sign an Agreement for Establishing a Research Center at the University Campus in Dhahran”, Future Bi-weekly November 25, 2001, pp. 2. Published by the Department of Public Relations & Information of KFUPM.
5. “Master of Science (MSc) in Communications Engineering”, Brochure on the International Graduate Program, Department of Electrical Engineering and Information Technology, Munich University of Technology