The University-Industry Gap and its Effect on Research and Development in Developing Countries

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Abstract - In both developed and developing countries a gap exists between universities and industry. In developed and industrialized countries universities are in the process of forsaking their ivory towers and forging strong links with industry, mainly through sponsored research and continuing education. In developing countries the gap is very wide indeed. How can it be bridged? This paper analyses the university-industry gap syndrome and suggests means by which the gap can be reduced. Since research plays a very important role in promoting university-industry ties, the role of R&D as a linkage between universities and industry is also discussed.

The University – Industry Gap

The majority of countries that are today referred to as developing or third world countries were, in not too distant past, the colonies or protectorates of colonial powers and as such their educational systems were modeled after those of the ‘parent’ countries. However, the educational systems of these parent countries were based essentially on the particular socio-cultural characteristics and historical evolution of each country rather than on actual industrial requirements (universities preceded industry by several centuries). This has led, over the years, to the establishment of a widening gap between universities and industry. The developed and highly industrialized countries realized (albeit fairly recently) that if this gap is not narrowed and bridged, the result would be detrimental to both sides and hence to the nation as a whole.

Perhaps the first country to realize the importance of bridging the gap and successfully do so is the United States, more than three decades ago. This is primarily due to its free-market-economy based industry and its non-centralized higher education system. In Europe and the UK serious efforts to establish closer links between industry and academe are much more recent – a little over a decade ago. In developing countries on the other hand, the ‘alien’ education systems coupled with the very large inertia inherent in any educational system, has reduced these systems to a state of quasi-static lethargy. In spite of the growth of industry, the universities have remained confined in their ivory towers with unfortunately little or no effort made to bridge the ever-widening university – industry gap. There are several reasons for this:

• Faculty staff have completed their college education, undergraduate or graduate or both, at universities in advanced countries. For reasons of prestige and recognition, curricula are modeled after those at such universities without any regard for local requirements. Liaison with any existing industries is completely ignored, since their requirements are considered to be well below the capabilities of universities: a question of who sets the standards, almost a matter of honor!
• In developing countries, industry is in its infancy – public utilities and corporations as well as service industries – look up in awe at engineering colleges and are under the delusion that the graduating engineers will be capable of solving all their problems.
• In some developing countries, where graduates are ‘assigned’ permanent jobs, the bureaucracy of the socio-political system is such as to make it almost impossible to establish any meaningful ties between universities and industry.
• With very heavy teaching loads and promotion-oriented research work, faculty staff find very little time for promoting any of the university-industry interaction which is necessary for broadening professional experience and exposure.

In order to have a better perception of the university-industry gap syndrome, we have listed in Table 1 the principal factors contributing to this gap and in Table 2 the reasons why the gap needs to be bridged. The left-hand side of each table lists the factors from the university point of view and the right hand side lists those from the point of view of industry.

To narrow the university-industry gap it is necessary that industry should:
• Carry out a needs analysis: where is it going and what are the human resources it needs to get there.
• Provide support for student projects
• Sponsor long-term research.
• Hold periodic seminars in collaboration with universities.
• Provide support for and participate in continuing education programs in specific areas.
• Encourage consulting.
• Share equipment and facilities with universities.

The rate of scientific and technical information growth almost doubles every three to four years so that both managers and engineers will have to work with rapidly
changing technologies. A university engineering education cannot provide undergraduates, in some 130-140 credit hours, with the knowledge which will serve them throughout their careers. Universities can provide them with basis and industry must allow and encourage them to participate in continuing education programs—today a lifelong learning process.

Industries which, due to scarce cash resources, cannot themselves organize continuing education programs, will benefit greatly by investing primarily in such programs offered by universities. The programs are a good source of income for the universities but their development requires close cooperation with industry.

From their side, universities should:

• Recognize that the needs of the industry have changed considerably and undertake to provide the quality of education that it requires. Today knowledge of technology alone is not sufficient: in addition to the formal engineering skills, industry requires people with communication skills and with knowledge of how technology relates to economics and the commercial world.

• Invite industry to participate in the planning and periodic reviewing of curricula and course contents at both the undergraduate and graduate levels. Perhaps the most important single factor which contributes to a strong and lasting bond between industry and university is the field of research and development.

Research and Development as a Linkage between Industry and Universities

Today, the two words Research and Development are inextricably linked together. This has not been always so.

In the past Research was the ‘monopoly’ of universities, whilst Development was the ‘monopoly’ of industries. Research implied ‘pure’ or ‘disinterested’ research almost totally dedicated towards finding out how nature works; its objective was to serve world science irrespective of economical and industrial considerations. Development on the other hand implied the improvement of existing technologies.

Table 1. Factors Contributing to the University-Industry Gap

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<th>University Point of View</th>
<th>Industry Point of View</th>
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<td>- Academic institutions are “non-profit” institutions, which exist primarily to teach and educate students, and undertake pure and fundamental research.</td>
<td>- Industry’s almost sole objective is to make a profit by producing a marketable product or rendering a useful service.</td>
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<td>- Academic research is an open activity where staff are valued by their publication record: their research is motivated by promotion and tenure and hence require maximum publicity. The motto for survival is “publish or perish”.</td>
<td>- To safeguard investment, research is closed activity and new developments require protection mainly through patents. Thus communication and publication are restricted. You publish only when competitors learn little from discovery.</td>
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<td>- Research is mainly to look for and extend new knowledge in an absolute way. Acquisition of knowledge itself is valuable.</td>
<td>- Knowledge is valuable only if it can be exploited in products. Likewise research is pointless unless investment in it can be justified by turning discoveries into products. R&amp;D is a form of industrial investment leading to wealth creation.</td>
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<td>- For faculty and staff research is a part time activity.</td>
<td>- In an industrial research laboratory research is a full time activity.</td>
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<td>- There is no emphasis on urgency: research workers are more relaxed and more scholarly.</td>
<td>- Industry’s goals are usually short-term. In technological development the overriding consideration is time.</td>
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<td>- The main objective of university education is to develop the students’ self-confidence, mental capacities and latent capabilities to produce creative individuals capable of independent thinking and mature judgement. It is not the function of universities to give professional training.</td>
<td>- University faculty lack professional experience. There is thus a mismatch between industry’s expectations and the type of education provided by the university.</td>
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<td>- University faculty tend to be patronizing.</td>
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Table 2. Why the Gap Needs to be Bridged

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<th>University Point of View</th>
<th>Industry Point of View</th>
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<td>- An urgent need for financial support particularly where government support is not forth-</td>
<td>- Industry is the most direct beneficiary of engineering programs. Over 90% of graduates</td>
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<td>coming.</td>
<td>are ultimately employed by industry and by government or private utilities. This calls</td>
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<td>- Make use of sophisticated and expensive industrial equipment and facilities.</td>
<td>for the strengthening ties with universities.</td>
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<td>- Industry can provide valuable cooperation and guidance for courses and student projects</td>
<td>- Any company’s most important asset is its staff. Engineers and scientists must be kept</td>
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<td>which are relevant to industry e.g. design and implementation of technology.</td>
<td>abreast of the rapid advances in science and technology and the best way of doing this</td>
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<td>- Liaison with industry provides an excellent opportunity for faculty to acquire some</td>
<td>is through sponsoring their staff for continuing education or professional advancement</td>
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<td>first-hand industrial experience.</td>
<td>courses.</td>
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<td>- Liaison with industry can help identify problems that can either develop into sponsored</td>
<td>- Utilize university talent and facilities at a maximum benefit to cost ratio. Thus</td>
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<td>research projects, joint projects or consulting opportunities.</td>
<td>consulting is an excellent way for faculty to have a close relationship with industry.</td>
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<td>- Attract graduates from industry and government by developing a strong continuing</td>
<td>- Universities are best suited to carry out long-term research on problems which</td>
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<td>education program which is practically oriented (Diploma courses) and in which</td>
<td>require a high degree of sophisticated theoretical knowledge in specific fields.</td>
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<td>experts from industry and government can cooperate with faculty and staff in specific</td>
<td>- Interaction with universities provides industry with a window into leading-edge</td>
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<td>topics.</td>
<td>scientific research.</td>
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However, as a consequence of the staggering rate of advance of both science and technology, research became very detailed, specialized and expensive. Progress was accompanied by a continuous dissociation into particular problems resulting in ‘pulverization’ of research – scientists knew more and more about less and less. This has led to the urgent need for persons with the specialized ability for integration and for making use of this integrated scientific knowledge in practical applications. When science is so used for practical purposes it normally becomes a technology and as such requires development. It was thus imperative that scientific research and technological development join forces to achieve the goals of wealth creation (building industries, creating employment, increase exports, etc.) and improvement in the quality of life.

Taking a wide-angle view of research it is possible to define four categories of research:

- **Undirected research**: this is the so-called pure or disinterested or “blue sky” research. It is research pursuing exciting new speculative ideas in which no immediate pay-off is perceived.

- **Fundamental research**: this is research directed towards identified gaps in knowledge. It is a major component of the type of research that industry looks to universities to perform.

- **Directed or strategic research**: this is research having a direct bearing on local conditions and long-range aims connected with economic and/or industrial potential of the country.

- **Applied or ad hoc research**: this is multidisciplinary research. It seeks solutions of identified industrial problems which use the already known facts of science. It is thus strongly associated with the development of technology and usually involves meeting the timescales needed for product development.

What is the position of developing countries vis-à-vis research and development as a linkage between industry and university? It would appear that any link between the two hardly exists.

Whereas in advanced countries universities have forsaken their ivory towers and are working with industry and governments partners in the research and development drive, in developing countries the universities still exist in “splendid isolation” as far as links with industry are concerned. There are several reasons for this:

- Lack of funds.
- Lack of any industrial experience and hence awareness, amongst academics results in failure to direct engineering research towards industrial applications.
- Choice of research topics is made almost exclusively by
  the different supervisors, each according to his own
  inclination.
- The main objective and incentive for the research is to
  obtain promotion via publications.
- Research laboratories and support facilities are virtually
  non-existent or have been allowed to age without
  renewal.
- Lack of equipment and facilities has forced research
  work to be almost totally computer generated. Some of
  it could be termed “virtual research”!

In spite of this there is some excellent research work
being done in developing countries. The problem is that
either this research does not meet industry’s needs or
industry is unaware of its existence; also universities and
research centers are not good at marketing their products. In
developing countries many universities have overcome this
point by developing their own Technology transfer Centers.

The low efficiency of research and development
programs in developing countries is mainly due to the lack
of a national R&D policy either in the public or private
sectors of industry. Moreover, the all-important interface
between industry and university is non-existent.

For universities to participate in and make positive
contributions to research and development programs there
has to be an effective industrial/academic interface such as
the federal agencies in the US (NASA, DOD, AEC, HEW),
the Universities grant Commission and SERC (Scientific
and Engineering Research Council) in the UK, the CNRS in
France, etc. Such an interface would be specialized agency
acting as intermediary between government, industry and
university. Government interest in research would entirely
be of the directed or strategic type e.g. environmental issues,
public health, defense requirements etc. Industry’s interests
are mainly in applied research whilst the traditional forte of
universities is in fundamental and undirected research. Both
government and industry should submit their problems and
research needs to the agency which will then choose the
most suitable place where research can be best carried out:
research center or university, and if there are several which
one of them. To be effective the agency must be competent
to make the right choice of research workers (a
comprehensive and continuously updated national
specialization-based ‘who’s who’ in science and technology
is a must), efficient in the follow-ups but most important for
ultimate success is proper coordination. Government and
industry must be prepared to provide the necessary funds for
their projects via the specialized agency. Universities will
submit their own research proposals directly to the agency.
They may very well match existing industry needs; if not
alternatives can be negotiated but the eternal problem of
funding will inevitably raise its hoary head.

In order to ensure a cross-flow between industrial and
academic communities, it is important that both
industrialists and academics be equally represented in
research council committees.

The establishment of specialized national research
centers can also serve as very valuable links between
universities and industry. In developing countries most of
their future growth will come from the small and medium-
sized industries, and it is these industries that stand to gain
the most from such research centers. Research centers
would:

- Make available to industry (and thus avoid duplication)
  expensive research equipment and test facilities.
- Have available highly qualified personnel with
  exceptional skills and a high degree of expertise in their
  fields of activity.
- Realize considerable savings in time and money by
  providing solutions to technological problems which
  may be common to several industries
- Collaborate as partners with universities pursuing
  strategic research.
- Develop highly qualified human resources in their
  fields of activity.
- Act as centers for the transfer of technology

It is a fact that most developing countries have
immense socio-economic problems which makes them
consider that any expenditure on research and development
is a luxury. On the other hand the rich developing countries,
which have abundant sources of natural wealth, do not feel
either the urgency or the necessity for wealth generation so
that R&D is given a very low priority. However all
developing countries must realize that any R&D program,
however modest, will provide excellent returns if effectively
orientated and efficiently administered. They have to draw
up their own model, one that is adapted to their own needs
and particularities. By identifying suitable means, limited
resources could be harnessed to benefit all. Of the many
questions which they will have to answer the following are
perhaps the most important:

- What is the size of commitment to research?
- What is the size of commitment to development?
- Which sciences and technologies should they
  concentrate on?
- Will they duplicate the work of others?
- How can their research and technology capabilities be
  best transmitted into wealth-creating business
  activities?

There can be no doubt that science without industry
(technology) will not lead to wealth creation or improve the
quality of life, nor will industry without continuous research
and development. Thus government, industry and
universities must all be convinced that a close partnership
between them is vital in today’s world if ferocious
competitiveness. The question of course is who within these
organizations must be convinced and how can such
convincing best be done – through professional institutions
perhaps? The answer is beyond the scope of this paper but is
certainly a topic for discussion. However it is industry and
its investors that must ultimately shoulder the burden of
wealth creation. Without research and development the long-term effect would be wealth depletion.

Summary

A narrowing of the university/industry gap in developing countries can be achieved:

(a) On the university side by:

• revising the course curricula and degree plans to meet the various requirements of the different industries.
• inviting industry to participate in the planning and reviewing of undergraduate and graduate curricula.
• encouraging academic staff to carry out consulting work and cooperate with industry via the university and not via private offices.
• reducing its “time constant” by responding more quickly to changes.
• improving the experimental capabilities of university graduates through better laboratory training.

(b) On the industry side by:

• sponsoring staff for continuing education or professional advancement courses.
• funding research projects in areas of common interest.
• encouraging cooperation between university and industry through joint projects or consulting opportunities.
• sponsoring undergraduate design projects.

• assisting universities in updating laboratories and equipment.

Selected References