CHAPTER 1: KEYNOTE PRESENTATIONS

Contribution of Industrial Research in Transformation of Developing Countries

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ABSTRACT

All developmental taxonomies point to the fact that the level of a country's development correlates to its level of industrialization, technology use, as well as maintenance of a healthful environment. Statistical rankings, such as UNDP's Human Development Index or World Bank's country per capita GDP, always tend to mirror the pecking order of other classifications such as *"first, second and third world"* or *"developed, developing, and underdeveloped."* There is another categorization that is becoming more fashionable, lately, dubbed *"countries in transition."* To these countries, like China, the sweet smell of socio-economic transformation is within reach. This paper seeks to reiterate the correspondence between these development indexes and industrial research activities. An attempt is also made to define what is meant by industrial research, as opposed to other research activities, and to make this distinction while expounding on the relationship between basic research, applied research, and development as in R&D. A historic perspective of industrial research, and associated milestones, is also discussed. Since it is no longer a matter of debate that industrial research is sine-qua-non to socio-economic transformation of a developing country, or a country in transition, this paper also engages in the discussion of impediments to R&D and proposes ways in which these obstacles can be overcome.

Keywords: Developing Countries; Development; Industrial Research; R&D

1.0 HISTORICAL PERSPECTIVE ON R&D

An article in the Canadian Encyclopaedia on Industrial Research and Development opens thus, "Technological innovation is essential for economic growth and for the improvement of the quality of life. Industrial Research and Development (R&D) is at the heart of the innovative process." The article goes on to articulate the fact that World War II marked the turning point from Canadian dependency on imported technology, with just a few indigenous innovations by individual inventors, to a more systematic, planned research and development. Like its neighbour, United States of America, Canada's manufacturing industry grew spectacularly and the R&D to support such growth was also remarkably enhanced, so much so that, "Canada emerged from the war with the fourth largest manufacturing output, exceeded only by the US, UK and USSR"(Canadian Encyplopedia, 2010).

This Canadian experience with WWII was by no means unique. In general R&D as a formal activity may have gained currency in the second half of the 19th century, but it grew very rapidly in the twentieth. "*The quickening pace of industrialization in such countries as Germany and the US and the increasing utility of science were important factors in its use*" (Enros). The 20th century has seen two world wars, a protracted cold war, and many more wars of attrition. This is not to suggest that R&D is necessarily a direct consequence of war and socio-economic strife, but rather that such catastrophic events tend to reveal the inadequacies of a system as well as consequences of human failures, and to demand urgent action to make repairs and amends, and strive to create fail-safe systems. Even the current brisk pace of China's development trajectory

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can be traced back to the debilitating "*Cultural Revolution*" of 1967 to 1978. The country's industrial epiphany is routed in the fact that that very unfortunate chapter in China's history, ushered in a dire need for mass employment, infrastructural improvement, and socio-economic reforms. In short, China needed a complete make-over. For China to meet these urgent needs, it had to engage heavily in technology transfer as well as home-grown industrial research. Even the level of reverse engineering that China is famous for, albeit scoffed at by the developed world, would not be possible without a concerted effort in industrial research. Their approach may be Machiavellian but it has so far worked for them.

In the context of historical link between war, industrial research, and inter-institutional, even international, collaboration the so-called Manhattan project probably has no equal, especially before collaborative space exploration. The project was led by the United States and included participation of United Kingdom and Canada. Even Stalin, the dictator of USSR, was kept in the loop. What started as a small research program (with an initial budget of a paltry \$6,000) to determine feasibility of using nuclear fission for wartime purposes would eventually expand into a gigantic research project employing more than 130,000 people and costing nearly USD 2bn by August 1945, an amount that is equivalent to over USD 22bn in today's dollars. As a result of this an atom bomb was developed and its impact on the war is well documented.

For United States, the Manhattan project and other wartime scientific successes, the era of "big science" had began (1945 to approx. 1980). This era was informed on the justifiable optimism that scientists and engineers, if afforded the requisite resources, would be able to develop products and provide services for the benefits of the economy. This would in turn help improve the standard of living of the population. Joint and or collaborative research between universities and corporations in America had indeed produced a string of breakthrough technologies as well as highly sought after products such as digital computers (1946), the transistor (1947), the CT scanner (1972), and atomic energy. All this frenzied and unprecedented cooperation was based on the "dominant intellectual belief of the immediate post-war period that science-driven research programs would ensure the development of an endless frontier of new products and processes. The development of the transistor at Bell labs gave strength to this view." Other corporate types were also doing their bit. As another example: in 1956 IBM established a research division devoted to world class basic research – obviously to stay ahead of the game in their field of endeavour. As they say that necessity is the mother of invention, competition will always arouse the genius in a corporation.

Subsequent to the Second World War, the cold war between east and west was quickly taking shape. As the ideological differences between the two power centres replaced the embers of WWII, the rivalry became so intense. To fuel the ferocious competition, both camps had to make sure that scientific research was well funded. The military-industry complex of the west could only be matched by the centralised control of the east. Communism could stare capitalism eyeball-to-eyeball because both were engaged in committing serious resources to R&D as a means to fuel the arms race, develop industries, and also to keep the propaganda machines vibrant. There was serious fervour for staying ahead of the game and a zeal for dominance beyond their borders, as well as political grandstanding in their spheres of influence. Some sanity would begin to prevail again during the Reagan/Gorbachev era.

Looking at the shenanigans of the cold war more objectively, it was apparent that the west had the upper hand in terms of technological innovation in new product and service offerings. And private industry was recognised as the cause and consequence of this prowess. It is not by coincidence therefore that every regime nowadays extols the virtues of a "*private-sector led economy*." Even when the private sector has yet to exist!

Back to the historical perspective of industrial research: management and captains of industry, especially in the US, had by early 1970s began to lose faith in the science-driven view of industrial research and technological innovation. This was because few notable "*eye-catching*" products had come on the scene from the research that had been funded in the previous twenty or so years. Since the corporate leaders lived and breathed competition, and the fact that new products and processes were not in evidence, this led to a change in both organisation and strategy of R&D. Different models of operation and different approaches to setting funding priorities had to be considered.

By the 1980s and 90s a new model of organising research became apparent:

- 1. R&D came to be centralised inside large corporations themselves, with the aim to bring it closer to the users.
- 2. Many companies were beginning to look up to universities for much of their basic or fundamental research, maintaining close association with science and engineering departments.
- 3. Corporations started to forge alliances that involved R&D, manufacturing, and marketing in order to get products to the market quicker and to leverage off complementary assets already in use elsewhere.

The era of optimization of resources had truly come to the fore.

This paradigm shift of the 80s and 90s is still manifest, but with a twist. The new spirit of entrepreneurship has permeated all organisations and institutions, and is embraced even at individual level. There is new emphasis on *"value for money"* that has captivated all and sundry. The debut of venture capital and the attendant proliferation of start-ups have conspired to change the funding mechanisms for R&D, especially for SMEs. It however still remains more the exception than the rule that venture capital will invest in early stages of R&D as their sense of altruism doesn't go that far. At the same time competition for limited resources is fierce among public institutions, and has become as important as corporate concerns for the bottom line. In all this, however, industrial research is still regarded as the heart of innovation and that without innovation, corporations will not survive, nor will development and socio-economic transformation be realised by countries in transition, even for the developed world to maintain the lead.

2.0 HOW INDUSTRIAL RESEARCH CONTRIBUTES TO DEVELOPMENT

The transitory nature of man (and his lifestyle) has been part of him since his debut on this planet, both as an individual and as a member of a community. *"Modern"* man has followed and subscribed to the following stages of development (discounting the hunter/gatherer stage):

- subsistence farming
- mechanised agriculture
- industrialisation
- knowledge-based economy

In the Third World we still experience significant levels of subsistence farming while the First World has been decidedly transformed into the information age. Moving from one stage to another requires application and use of technology, which in turn is a direct result of innovation and invention. The genius that is responsible for such innovation is, in most cases, guided by R&D. Cases of invention through serendipity are few and far between. Otherwise it is through

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R&D that efficient and affordable tractors have been mass-produced and mechanised agriculture was possible. Here is an anecdote about tractors:

"After graduating from university of Wisconsin, Charles W Hunt and Charles H Parr developed a two-cylinder gasoline engine and set up their business in Charles City, Iowa. In 1903 the firm built fifteen "tractors". A term with Latin roots coined by Hart and Parr, and a combination of the words traction and power. The 14000 pound #3 is the oldest surviving internal combustion engine tractor in the United States and is on display at the Smithsonian Museum in Washington....The two-cylinder engine has a unique hit-and-miss firing cycle that produced 30 horsepower at the belt and 18 at the drawbar", Wikipedia.

Note: The first engine-powered farm tractors used steam and were introduced in 1868. The most popular steam tractor was the Garrett 4CD.

The steam engine, patented by Thomas Savery, an English military engineer in 1698, and eventually the computer (particularly the UNIVAC of 1951) have done a lot in realising the above transitory milestones.

Over time "industrial research and development has been performed with the expectation that it will contribute to economic growth, by improving products and processes or developing new ones." (Enros). This is also the way that enterprises and countries can stay competitive.





Figure 1: The development cycle

The above development cycle (Figure 1) is a value chain of sorts which begins, and ends, with R&D and as the saying goes, "A chain is as strong as its weakest link." Therefore for this "chain" to stay viable and deliver the intended contribution to development, every aspect of it must be strong and must be attended to.

For R&D to deliver to its potential and become a true linchpin of the development cycle we need to understand the circumstances and the context in which it should be carried out. All stakeholders need to come to terms with the fact that industrial research is the activity in which the confluence of scientific and engineering knowledge is used to create and bring to market new products, processes, and services. Its component parts and its genesis include:

Basic research, which is aimed at the creation of new knowledge or verification of new and old paradigms and theories. The main purpose of basic research is to create new understanding of new or old phenomena and to provide a platform for new and upcoming researchers to hone their skills and develop confidence in what they do. It is the ultimate proving ground for choices in career paths and future professional pursuits. Basic research is the foundation upon which further R&D activities are built.

Applied research, on the other hand, is not beholden to acquiring more knowledge for knowledge's sake but rather is geared towards finding practical solutions to real and particular questions. Although it usually builds on basic research, applied research has practicality and utility as the goal. Generally, applied research focuses on *"practical problems"* and is a precursor to designing and prototyping stages of a product or process. The development phase crowns it all by honing and modifying the product or process for commercial application. Hence R&D is the logical progression of applied research that leads to the development and commercial application of a product or process.

This is the starting point of industrialization, which is an agglomeration of production facilities that eventually lead to wealth creation. With wealth comes a higher standard of living and better quality of life and, ultimately, the proverbial development of a nation.

3.0 ALAS! PROGRESS IS SLOW

All country development indicators continue to paint a bleak picture for most of the third world countries. The gap between the rich and poor nations continues to widen; in fact some of the latter are sinking ever deeper in the abyss that a new category, the so-called "fourth world" is beginning to emerge. There are even some that are so much on the fringe that they are now being declared "failed states".

Global concerns over the fate of some of the world's citizens have led to the adoption, in the year 2000, of the Millennium Development Goals (MDGs) that are to be achieved in 2015. A cursory look at the MDGs reveals the magnitude of the developmental debacles of some in our contemporary world and a sad commentary on humanity in general that things are really this bad. Let us take a look at the MDGs that countries like Uganda are struggling to meet. They include:

- Eradicate extreme poverty and hunger
- Achieve universal primary education
- Promote gender equality and empower women
- Reduce child mortality
- Improve maternal health
- Combat HIV/AIDS, malaria and other diseases
- Ensure environmental sustainability
- Develop a global partnership for development

To drive the point home, reference is made to a short video titled, "The UN Millennium Declaration" (<u>http://www.undp.org/mdg/basics.shtml</u>). The former UN Secretary General, Kofi Annan, gives it all an impassioned spin.

Specific ways in which industrial research can address the development needs of third world countries include:

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- ✓ Accelerated pace of developing and deploying technologies for value addition. Value addition is one sure way to increase incomes and reduce poverty for the subsistence farmers and artisans. Lest we forget, more than 80% of our population depend on some form of agricultural activity.
- ✓ Complementary to technology development should be research activities aimed at product and process development which will in turn assure the optimal utilisation and exploitation of our natural resources that poor countries have plenty of.
- ✓ Concerted efforts should be made by industrial researchers as they apply their competences in addressing the relevant components of the industrialisation process within their purview, namely, technology and human capital. It is only through matching appropriate technology, skilled manpower, and adequate financial capital that industry can flourish and satisfy market demands. This package will not be complete if entrepreneurship is not part of the puzzle. A representative schematic follows in Figure 2.



Figure 2: A schematic showing the components of entrepreneurship

4.0 CONCLUSIVE REMARKS

Industrial research may not be a panacea for the world's developmental woes, but it can and has always been depended upon to deliver technologies, products, and services that together have enabled countries, communities and enterprises to develop. The quality of life has been directly affected by the level of technology use.

There is ample and empirical evidence that investment in R&D (as a percentage of GDP) has a direct correlation to the quality of life of the citizenry. Needless to say, such investment must be made in the context of a well thought out development plan. Such a meticulous plan is expected to be based on thorough needs analysis, assimilation of baseline information, as well as practical evaluation of options and priorities.

5.0 REFERENCES

Enros, Philip C., Scientific Research and Development. The Canadian encyclopaedia (2010)