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GENERAL ARTICLE

A policy for research in Sri Lanka*

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Abstract: This paper draws the attention of the reader on the importance of conducting quality research in a particular country and the need for a well-directed initiative to bolster the national research capability. It discusses the present Sri Lankan research scenario as revealed by S&T indicators developed through various national research and development (R&D) surveys. The paper then proposes a Goal-Oriented Strategy for the new era research effort inspired by the Millennium Development Goals which were identified at the Earth Summit at Johannesburg in 2003. All ten specific goals implicit in the Millennium Goals are inclusive in four national goals identified herein *viz.*, Goal I- Security in Food & Nutrition; Goal II- Security in Water & Energy; Goal III- Security in Health & Shelter and, Goal IV- Competitiveness in Trade & Industry. The main objective of this paper was to direct an intensive thrust to build an effective research capability in the country. It highlights several guiding objectives and suggestions to improve funding mechanisms for research in the country in the context of a suitable research policy for Sri Lanka.

Key words: Millennium development goals, national development goals, research and development, research capability, research policy, research strategy, Sri Lanka

INTRODUCTION

In 1953, two relatively unknown researchers working in Cambridge presented an epoch making paper elucidating the structure of DNA (deoxyribonucleic acid), which is a landmark event in the history of Science and indeed the world. The structure, which came to be referred to as the DNA-double helix, was unique in chemistry. The two scientists, James D. Watson and Francis H.C. Crick[1] wrote at the time:

... "*The structure has novel features which are of considerable biological interest. The specific pairing we have postulated immediately suggests a possible copying mechanism for genetic material.*"

Now fifty years later, Ronald W. Nichols, President and CEO of the National Academy of Science of New York says of the discovery:

"*For Science, for Society, and for Industry, this is one of the greatest foreshadowing of change in modern scientific history.*"

The above, however, underscores several important aspects of research. Research has a dimension where the results and impact is predictable. The difference between fundamental research and applied research is indeed the time that could elapse before the realization of the potential. The more fundamental the research it is more likely to have a larger impact.

The second aspect is that both Watson and Crick were products of a research culture and their achievement would never have been possible but for the work of those who preceded them. Frederick Sanger, who was a double Nobel laureate, first determined the arrangement of amino acids in the protein insulin. Lord Todd, also a Nobel Laureate, and later a Minister of Science in the UK, worked on nucleotides building the knowledge base. Dame Dorothy Crowfoot-Hodgkin, another Nobel Laureate, had done the pioneering work, in the X-ray crystallographic analysis or organic crystals and this discipline was ready for timely intervention by

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The Biennial Conferences on Science & Technology are mandated by the Science & Technology Act No. 11 of 1994, and are organized by the National Science & Technology Commission (NASTEC).

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Maurice Wilkins and Rosalind Franklin, on the DNA molecule. Besides, in the USA, Linus Pauling had laid the foundation of the theory in regard to chemical bonding, and had himself proposed models for the structure of DNA. These models were not in accord with the X-ray pictures of Rosalind Franklin. So a new model became necessary which was the double helix.

The third aspect is the necessity of trans-disciplinary work to capitalize on the discovery. It is the X-ray crystallographic work by Wilkins and Franklin that clinched the structure.

The case proves that for great discoveries to surface, a basic national capability is a prerequisite and in addition, collaborative work of the other disciplines is crucial. Much work has followed this discovery, as the potential was well recognized. Today it has led to a billion-dollar industry and much more.

The discovery of genes for specific diseases has led to development of therapeutic products based on biotechnology resulting in a revolution in disease control. The perceived benefits have caused the pharmaceutical industry to restructure and forensic science has been gifted with a new paradigm in the battle against crime.

The Biotech industry has generated many companies (in the US alone over 1300), with over 20 billion dollars in sales. There is in the world today an over ten billion dollar R&D investment in this field. Other benefits include new diagnostic techniques for intractable diseases, pre-natal genetic diseases, and development of the transgenic plants.

The example cited is indeed an extremely powerful one. Not every discovery is in this league and however, one may later cite a few others to underscore the salient issues involving the importance of research within a modern culture. In this context, let us now examine the Sri Lankan scenario.

2. The Sri Lankan research scenario

This paper gives a very brief insight which is based on three surveys conducted by the National Science Foundation, Colombo; in 1996 [2], in 2000 [3] and in 2004 [4]. The three surveys cover the period from 1966 to 2004. Some of the findings from these surveys are revealing.

The major contributor to research expenditure has throughout been the government R & D institutes (Figure 1) followed by higher education sector organizations.

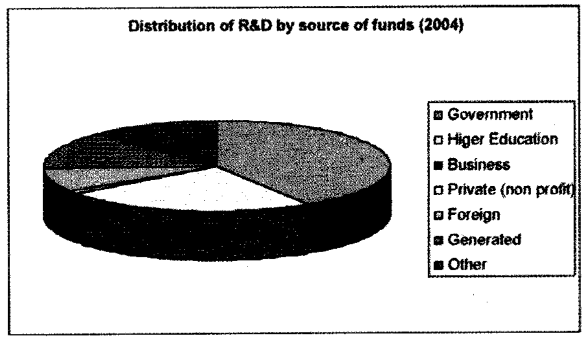

Figure 1: Distribution of R & D by source of funds (2004)
Source: Science & Technology Policy Research Division, National Science Foundation, Sri Lanka.

The Government expenditure on R&D or GERD expressed as a percentage of the national GDP after 1984 has been below the 0.2% level (Table 1) when, the level recommended by UNESCO for countries such as ours is a minimum of 1%.

Table 1: Government expenditure on R&D or GERD expressed as a national GDP

Year	GERD % GDP
1966	0.3
1975	0.2
1984	0.18
1993	0.13
1996	0.18
2000	0.14
2004	0.16

Source: National R&D Surveys in Sri Lanka; 1996, 2000, & 2004. National Science Foundation, Sri Lanka.

According to the national Research and Development Survey of 2004 conducted by the Science and Technology Policy Research Division of the National Science Foundation, Sri Lanka. the "head count" of **'scientists'** (including engineers) in Sri Lanka at present is 9,319. When this count is computed as "Full Time Equivalent" (or FTE) researchers, it decreases to 2679. However, if postgraduate students are added, the FTE count then becomes 2941 which accounts for about two per ten thousand of the population The distribution of **researchers** among subject areas is as summarized in Table 2.

About 25% of the researchers are at the post doctoral level and about 40% are over the age of forty. The Natural Sciences and Engineering fields appear to be better served. However this is way below the optimum level. The total requirement of scientific research personnel for a country with the size and population of

Table 2: Distribution of researchers among subject areas - 2004

Field	Number of researchers	Percentage (%)
Agricultural Sciences	555	20.7
Natural Sciences	711	26.6
Engineering/Technology	756	28.2
Health Sciences	226	8.4
Social Sciences & Humanities	330	12.3
Other	101	3.8
Total	2679	100.0

Source: Science & Technology Policy Research Division, National Science Foundation, Sri Lanka.

Sri Lanka would be more than double this number for significant Science and Technology contribution to the socio economic development of the country.

The NSF survey 2004 also examined the factors such as the research publications, citations and patents. The relevant figures are reproduced below (Tables 3 & 4; Figures 2 & 3)

The number of research publications by the local scientific community is well below a satisfactory level. Since publication of research will lead to formal professionalism of the Sri Lankan scientific community, it is important that the local scientists publish the results of their research findings. Also it must be mentioned that publication in a local journal has its merits in respect of dissemination of knowledge in the local scenario.

It is interesting to note that the number of resident patents per year has been increasing since 2002 indicating the progress of technology development in the country.

The inescapable inference arising from the above S&T indicators is that the national R&D effort has remained at best at a standstill. The tragic truth is that over a period of three decades or more, there has been no strengthening or no discernible improvement in the national capability for research. This issue is further underscored when one examines the results of research published in the sessions of local professional bodies such as the Sri Lanka Association for the Advancement of Science (SLAAS), and the Institutes of Chemistry and Engineering in Sri Lanka. The research performance reflected is low, and the absence of a mature leadership in the research area has become evident.

Here we may pause to define what is meant by a National Capability for Research (NCR). In broad terms it would be the nation's continuing capability to do good endogenous research in a range of subject areas relevant to its needs. Such a capability will depend on several factors such as:

Table 3: Number of research articles published in the NSF Journals* from 1998-2005

	1998	1999	2000	2001	2002	2003	2004	2005
Biological Sc.	5	9	6	5	4	17	5	11
Health/ Med.	1	-	-	-	-	-	-	-
Agricultural	2	4	8	2	4	3	2	1
Social Sc.	8	7	4	3	3	15	5	5
Science Edu.	1	-	-	-	-	-	-	1
Physical Sc.	3	7	12	7	7	5	8	15
Earth Sc.	-	1	-	-	-	-	-	2
Engn.	-	-	-	-	-	-	-	2

Source: Science & Technology Policy Research Division, National Science Foundation, Sri Lanka.
* Journal of the National Science Foundation of Sri Lanka; Sri Lanka Journal of Social Sciences

Table 4: R&D outputs by the scientific community for the years 2001-2004

	Higher Education		State		Private & NGO	
	National	International	National	International	National	International
Patents acquired	60	1	15	5	8	2
Science and Technological publications done	2270	897	1154	422	163	38
Meetings, Seminars, Symposiums, Workshops attended	4193	975	2585	774	926	173
High technology products / processes & innovations	60	11	4031	27	41	18
Number of consultancies undertaken	187	34	1121	68	428	27
Number of special awards & achievements	142	31	48	2	32	1
Number of visiting fellowships offered	177	101	26	56	4	17
Number. of postgraduate students	585	34	5	–	–	–
Other R&D Outputs	37	0	46	19	175	14

Source : Science and Technology Policy Research Division. National Science Foundation, Sri Lanka.

- The quality and quantity of the researchers
- The institutional infrastructure available to researchers
- Access to information on leading edge research
- The quantum of funding and the flexibility for its use
- Perquisites afforded to scientific community to continually attract good research scientists.
- Smooth interaction with global and regional science
- A vibrant interactive local atmosphere where research is recognized

It may here be recorded that the previous meetings BICOST I & BICOST II (the first and the second Biennial Conference on Science & Technology held in Sri Lanka) organized by the National Science and Technology Commission (NASTEC), revealed the absence of any of these factors, to a degree of adequacy, and hence the conclusion that R&D in this country is at a standstill in regard to scientific research is an obvious one. This is tragic in the present milieu. More so, because other countries, and mostly our neighbours, and far eastern regional countries, have passed us by in terms of national scientific capability. One need not here labour the point why all countries and particularly an island such as ours should have its indigenous scientific capability. This is well documented. And one can indeed plead in addition: *"The situation is so dire; it is too late to debate."*

The investment in R&D in our case is appallingly low and there are several remedial measures that have been recommended in the BICOST I, and II. What is

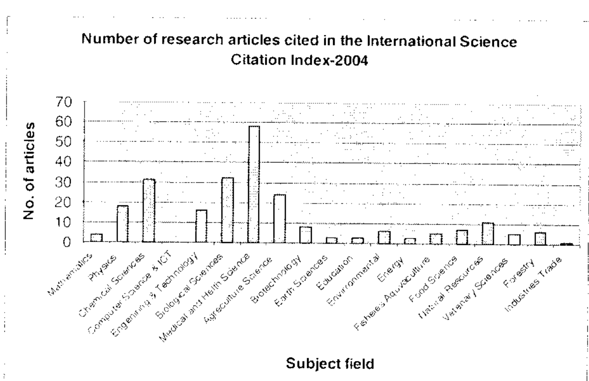

Figure 2: Number of research articles cited in the ISCI for the year 2004

Source : Science & Technology Policy Research Division, National Science Foundation, Sri Lanka.

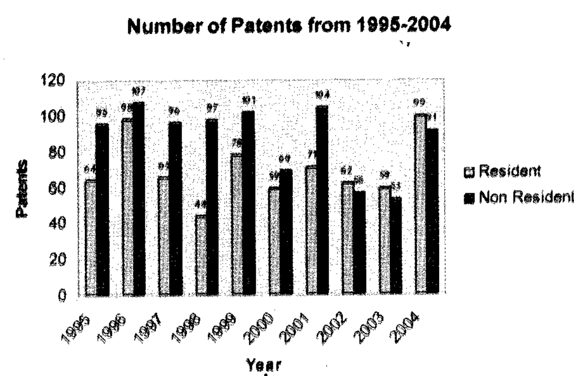

Figure 3: Patents granted during 1995 – 2004 (resident nd non resident)

Source : Science & Technology Policy ResearchDivision, National Science Foundation, Sri Lanka.

intended here is to propose an acceptable strategy that would help to resuscitate the R&D effort and to build a new generation of scientists and technologists able to lift the national research capability upwards. Time is a needed factor in the exercise in addition to new measures and strategies.

3. The role and utility of identified national research goals

Scientific and Technological Research brings economic rewards to society. However discovery for the most part is unpredictable, yet research is essential. Failure to maintain a robust investment in research cripples a country's ability to be competitive. In this era, knowledge is a wellspring, and it is research that generates this knowledge. To be able to capitalize on the knowledge of the world a country must also have the ability to interpret that knowledge. A creative research facility is crucial in this exercise too.

How then may we set about boosting our research in this country? Here, the approach should be incentive driven, rather than the command and control approach. The incentive approach must be such that each scientist within a research team must feel that he or she is part of a collective effort. Hence the importance of a goal oriented strategy for the country.

Indeed the problems faced require cross-disciplinary analysis and cross-sectorial action. As a nation we are not organized that way, in government, in the corporate sector or in the academia. Therefore, one has to have a plan that would encourage cohesive planning and implementation with respect to research.

Finding a way to mould a national consensus on something as complex as scientific research is a daunting task. Yet it is critically important. We are a divisive nation. Everything about us is divisive, and not cohesive. We possess little resources and these should be utilized optimally.

Accordingly we may propose a ***Goal-Oriented Strategy*** for our new era research effort. Every piece of research whether sponsored by government, the corporate sector, external assistance, or private enterprise, should in effect be directed towards well-marked Goals. The goals that are here proposed have been inspired by the Millennium Development Goals

goal 1 : Security in Food & Nutrition
goal 2 : Security in Water & Energy
goal 3 : Security in Health & Shelter
goal 4 : Competitiveness in Trade & Industry

Figure 4: Mega Development Goals

identified by the Earth Summit at Johannesburg in 2003. They have also been influenced by some insights into the new research approach in Europe and even in the United Kingdom, which have also, one feels, been considerably inspired by the Millennium Development Goals of the Johannesburg Summit. The broad goals or in otherwords Mega Goals quoted are as follows, and they encompass the essentials of life as further indicated in the Figure 4.

All ten specific goals implicit in the Millennium Development Goals are inclusive in the four Mega Goals above. It is hoped that all national research is directed towards these mega goals with immediate goals which are of two types *viz.*, a) goals pertinent to research at institution level, and b) goals pertinent to research at national level. The question arising with the latter is to what level the national problems should be addressed. However, the major objective of this exercise will be to direct an intensive thrust to build a research capability. The following will be the guiding objectives:

- Increase the working population of researchers
- Direct all research to be responsive to the major goals – from fundamental to applied.
- Enhance the national R&D investment, with Government and Corporate sector in partnership.
- Develop means to motivate scientists, and attract people to scientific careers
- Identify gaps in present range of research and commission research in these areas
- Judiciously utilize external resources
- Utilize the expatriate assistance
- Build an international level capability for S&T in the nation, using both the regional and global dimension.

Food Security in ***Goal I*** represents the security in food, in its widest sense, from a country standpoint as well as the standpoint of the home. Within it researchers may address issues at village level, urban level, the level of poor communities within a town, the food of school children, take-away foods, maternal diets and a variety of such specific categories. There could be research on matters of nutrition, food composition safety and contaminant issues. The subject categories would range from agriculture, plantation crops, animal husbandry, human nutrition, chemistry, biochemistry, microbiology, analytical chemistry, design engineering, preservation engineering, post-harvest technology and a host of others. Food will also encompass grain, livestock, fish (ocean and fresh water), fruits and vegetables, pulses, spices as well as others. The range will serve every discipline and research along the continuum from the fundamental to the very applied. The importance of strengthening research on our own foods cannot be overstressed.

Security in Water and Energy have been included together in ***Goal 2.*** Together they are considered to be crucial in addressing the problems of poverty, hunger and the quality of life. At the BICOST I and II meetings, the subject of the increasingly prohibitive cost of fossil fuels was addressed.[5-6] It is also well known that soon the energy costs are expected to escalate even further. That is when the so-called "Hubbert's Peak" is reached (this is when one half of the recoverable oil reserves on the planet have been used up).

There is, therefore, an urgent case for the use of renewable energy, which could be an important component of energy security for a country like Sri Lanka. Research on small-scale energy generation would contribute towards:

- Poverty reduction
- Equitable distribution of energy
- Rural electrification
- Rural industry

These small-scale renewable units should be flexible, and adaptable and suited to areas which big grids powered by fossil fuels cannot be reached. Renewable energy research can be wide and varied and include wood, biomass, solar, wind and geothermal and tidal wave energy. It is a commendable area for research initiatives.

In the words of Brazil's Minister of Science & Technology, Jose Goldenberg:

"In time renewable will dominate the world's energy system.Governments and Institutions should switch subsidies and investments in favour of renewable energy systems. This includes situation specific research. The G8 nations are already moving towards this".

Renewable energy is known to be competitive as against fossil fuels. It is particularly so, in rural communities. In the Sagar Island, 6 km off the coast of West Bengal, solar energy is used in small-scale grids.

Nine stand-alone photovoltaic power plants have been set up to provide electricity 6 hours a day to the grids. The cost per unit is competitive with diesel generators. In Rajasthan, the Barefoot College has supplied solar powered generators to over 15,000 people in 130 villages. They are used for lighting, cooking, in schools and even to operate computers. They also have solar powered spinning wheels giving employment to over 200 women.

As Andrew Simms, Policy Director, New Economics Foundation, London has observed:

"The renewable-route will lead to clean and cost-effective energy. The fossil fuels route to high economic costs, conflict and global warming".

The subject of water received high priority as highlighted by Gunawardene[7] at BICOST II. The recommendations regarding research are still valid and cover a very wide area. Access to water is indeed a human right. Vandana Shiva[8] in her treatise "Water Wars" says that "*Without water food production is not possible. That is why drought and water scarcity translate into decline in food production and an increase in hunger. Traditionally, food cultures evolved in response to water possibilities surrounding them. Water prudent crops emerged in water-scarce regions and water demanding ones evolved in water-rich regions.*"

These traditional patterns have changed as new research developed crops with new attributes. The opportunities of research are vast and should be appropriate to the country's needs. It is everyone's right to have access to water and energy to lead peaceful and profitable lives. For research to ensure that, the country must invest in appropriate research.

Health and Shelter included in ***goal 3*** is as crucial as security in food, water & energy. In this goal the stakeholders include the entire population. There is a common bond between the two widely separated subject areas, and this is due to the indigenous dimension. In both health care as well as in the methods the people provided shelter for themselves, the country is rich in indigenous knowledge and technology. While the traditional auto-centric model of research in these two areas is commendably valid, the thrust should also be directed towards the indigenous methodologies. In healthcare we have our *Ayurvedic* system; which is a composite of the other ancient systems as well as our own *deshiya* system, which demands research attention. There are many facets to the research possibilities and in the light the attention received by herbal therapeutic agents in the west at the present time, it would appear ridiculous not to pursue research in Sri Lanka in this important area as documented by NASTEC.[9]

In regard to shelter, the methodology of building and construction could borrow something from the methods and materials used in the construction of the ancient structures in the country. Here too, the building industry would be a stakeholder in respect of this area of research and it *offers* challenges and opportunities to researchers ranging from the fundamental to the applied. The approach in respect of this research area too should be to achieve national security in regard to shelter. This means that there would ideally be nobody without access to a decent roof over his or her head. Since the majority of the local people are poor, low cost, easily erectable housing systems will be preferred in order of priority. The Tsunami disaster has added a dimension of emergency to this mega goal. On the other hand, health and shelter circumscribes the science and technologies of waste management and disaster management. Our country is subject to periodic floods and landslides, which bring avoidable casualties and hardships. The Tsunami experience was the recent extreme case.

And finally, the management of the environment, which issue even if included here, actually pervades all the other goals and must be accepted as such.

Competitiveness in Trade and Industry is placed in ***Goal 4.*** In itself, it is wide and encompasses the industrial utilization of all our natural resources. Research in this area is bound to give results in terms of quicker economic returns. The direct stakeholders in regard to this goal are evident. They are all our major export industries such as Plantation Crops, Spices, Textiles & Clothing, Engineering & Electronics Industries and those that could easily, with research attention, be developed in the shorter term. The stakeholders from the supply side will include all our major research institutes, the universities, and government departments associated with science and technology services. For instance, a strong analytical services capability would be a boon in respect of industrial competitiveness. A microbiological analytical capability will enhance the tourist and hotel industries and make them competitive and internationally acceptable. There is scope for research inputs in several of our already established industries such as: processed rubber, molded products, plastics, adhesives, packaging materials, and agro products. Services such as industrial waste management and pollution control can also be considerably enriched if perhaps an additional 0.2% government contribution towards the RP component as well. Another 0.4% from the corporate sector, as a contribution towards the RP component, would make the total scientific and technology budget at least 0.8°% of GDP. If external assistance is forthcoming at least to the extent of 0.2% GDP, we may even be able to reach the 1.0% GDP recommended for the country by UNESCO and other agencies. This at present appears as a Himalayan Summit.

5. Concluding remarks

In this contribution we have drawn brief attention to the need for a well-directed initiative to bolster the national research capability, which at present seems to be at a standstill.

Four main National Research Goals have been proposed to guide the research initiative. Clear objectives have also been defined. A method of funding is proposed which will constitute a paradigm change from the obsolete treasury-centered methodology, which has so far jeopardized scientific and technological growth in the country. The above will call for a carefully designed method of management for the national research effort. One model to examine is that used in the UK and in Europe where the recipient researchers who benefit from the central research fund are linked together as a Network of Collaborating Centres. Such a network assists in cross-disciplinary research, besides making the individual scientists and the participating teams the proud members contributing towards a national research effort. The Network then constitutes an "invisible college" - a group of institutions or sections of institutions, bound to the common national research goal. A suitable management structure should be designed to generate durable interactions between partners.

Discipline oriented professional bodies will also have a pivotal role to play in the spread of scientific and technological excellence relevant to their respective interests. They would assist in the dissemination of information among scientists and stakeholders who are outside the immediate core of participating centers.

Sri Lanka being a poor country has no means to counter the loss due to the celebrated phenomenon of scientific migration or the Brain Drain as well as what has been now identified as "quitting scientists", meaning those leaving the possibility of a scientific career options.[11] The effect of these can soon come to the proportions of a deluge as industrialised countries make moves to draw the best from the third world. In the case of the United Kingdom where they lament the loss of their brilliant scientists to the United States and Europe, they comfort themselves with the fact that equally or more versatile substitutes from the third world are available. In Sri Lanka no such substitutes will be available. Hence we shall have to benefit from our own expatriate scientists who would be willing to come over and share their skills and experience with us. We should also not hesitate to enrich our human resource through the use of our regional neighbours. There are some outstanding scientists in these countries who may be willing to share research experience with us. Such enrichment is common in the history of science. Most of all we should stress the importance and need for research in our research institutions and Universities. To take just two examples that are poignant here:

1. The Australian Research Council[12] advertises for *"Federation Fellowships"* These are then described as Innovative and highly prestigious awards designed to attract outstanding researchers and build and strengthen world-class research capability in Australia. Early to mid career researchers are invited. *"Who will play a leading role* in *building Australia's internationally competitive research capability?"* This opportunity is open to non-nationals as well.

2. A *"Chair in Chemistry"* has been advertised by a Commonwealth University, which stipulates the requirements as follows: *The person appointed will be highly motivated with an outstanding internationally leading research profile in the subject. The person will collaborate through leadership to the teaching and research excellence of the school. The principle objective is to appoint a candidate of the very highest research caliber who will maintain the international profile, and enhance the wide ranging research portfolio of this research-led school"*

The emphasis on Research is significant. It is quality personnel who can motivate quality material. Therefore, we as a nation must try to retain our quality material, not sacrifice them. Research is needed to develop new technology, to adapt transferred technology to our needs and to interpret and understand global developments in technology. Research is also needed to safeguard our country from the risk factors in the global technological developments, which are now at merchandise level. Research is needed for national security and to propel industry. Indeed, research is the chassis on which the modern development process moves.

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