PUBLICLY FUNDED RESEARCH INSTITUTIONS AND THE LEGACY OF SIR SHANTI SWARUP BHATNAGAR

Society for Advancement of Chemical Sciences and Education

Indira Gandhi Centre for Atomic Research, Kalpakkam

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SHANTI SWARUP BHATNAGAR: A BRIDGE BETWEEN CULTURE AND ERAS

- **Confluence of excellence in science, arts, languages, poetry and literature**
- **Bridge between colonialism and nationalism**
- **Bridge between scientists, scientific peers and political leadership**

LIFE AND TIMES OF SIR SS BHATNAGAR

- **1894 :Born in Lahore on 21 February to Parameshwari Sahai; father dies when the child is eight months old; raised by maternal grandfather, Munshi Pyarelal**
- **1911 : Publishes the first scientific work as a letters to the editor of 'The Leader" on how to make carbon electrodes for batteries using molasses and carbonaceous matter under heat and pressure.**
- **1913: Joins Forman Christian College**
- **1915: Fails in chemistry because he wrote that X Rays can be reflected, refracted and polarized just as ordinary light , something the text book of the day did not mention !**
- **1915 : Marries Lajwanti, his wife for 31 years**
- **1916: Graduates with B.Sc in Physics !**
- **1919: Obtains a M.Sc in Chemistry as a private student while working as a demonstrator in Dyal Singh College**

LIFE AND TIMES OF SIR SS BHATNAGAR

- **1921: D.Sc from the University of London working with Professor Donnan, FRS on a scholarship awarded by Dyal Singh Trust and DSIR, UK; the title of his thesis is " solubility of bi- and trivalent salts of higher fatty acids in oils and their effect on surface tension of oils"**
- **Thesis defense committee chaired by Sir William Bragg**
- **His contemporaries in the department : J. C. Ghosh, J. N. Mukherjee and Megnad Saha**
- **1921 : joins Benaras Hindu University as a Professor at the invitation of Pandit Madan Mohan Malaviya ; pens the University Song for BHU**
- **1924: Moves to University Chemical Laboratory, Lahore as Director**
- **1940: Director, Scientific and Industrial Research, Calcutta**
- **1941: Knighted by the British Crown**

LIFE AND TIMES OF SIR SS BHATNAGAR

- **1942: Director, The Autonomous Council of Scientific and Industrial Research(CSIR), New Delhi**
- **1943 : Elected Fellow of the Royal Society**
- **1946: Sets up the Atomic Research Committee under the Chairmanship of Dr Homi Bhabha**
- **1946-47 : Lays the foundation for the first of the five National Laboratories, namely, Central Glass and Ceramic Research Institute, Calcutta, Central Fuel Research Station, Dhanbad, National Metallurgical Laboratory, Jamshedpur, National Physical Laboratory, Delhi and National Chemical Laboratory, Poona**
- **1948 : Secretary, Ministry of Education**
- **1951 : Secretary, Ministry of Natural Resources**
- **1952: Secretary, Atomic Energy Commission**

LIFE AND TIMES OF SIR SS BHATNAGAR

- **1952 : Chairman , University Grants Commission**
- **1953-55 : Establishes National Research and Development Corporation and Indian Rare Earths Limited as public sector companies; creation of co-operative research institutions (Indian Jute Manufacturers Research Association, Calcutta, Indian Rubber Manufacturers Research Association, Bombay and Textile Research Association, Bombay); negotiated with global oil companies to set up petroleum refineries in India**
- **1954 : Conferred Padma Vibhushan**
- **1955 : January 1 passes away in harness**

"I have always been associated with many prominent figures eminent in other ways, but Dr. Bhatnagar was a special combination of many things, added to which was a tremendous energy with an enthusiasm to achieve things. The result was he left a record of achievement which was truly remarkable. I can truly say that but for Dr. Bhatnagar you could not have seen today the chain of national laboratories".

Pandit Jawaharlal Nehru, 3 January 1955

PERSONAL EVOLUTION OF SHANTI SWARUP BHATNAGAR

- **University Professor and Teacher : 1921- 35**
- **Practitioner of Applied Industrial Chemistry: 1936-45**
- **Science Administrator and Institution Builder: 1945-55**

BHATNAGAR'S CONTRIBUTIONS TO FUNDAMENTAL SCIENCE

- **Physical chemistry of emulsions: The first to define the effect of electrolytes on the stability of colloidal solutions; enunciated simple rules govening colloid stability. His hypothesis that all emulsifying agent with an excess of negative ions will yield water in oil emulsions and emulsifying agents with an excess of positive ions will result in water in oil emulsions is widely used even today !**

- **Magneto chemistry : Used magnetic suceptability measurements to explore properties of organic compounds, solutions, films and colloids. Established the structure of oxide film on the surface of copper produced by oxidation. He proved the existence of ionic miscelles by the study of magnetic rotations of solutions of salts of higher fatty acids in water and alcohols. Wrote a definitive text which was widely acclaimed titled"Physical Principles and Applications of Magneto Chemistry published by MacMillan and Co Ltd in 1935**

Access to Dr Bhatnagar's list of scientific papers : Repository of Publications of Fellows, The Indian Academy of Science, Bangalore and Biographical Memoirs of Fellows of the Royal Society, UK by T.R.Seshadri

“On turning over the pages of Nature my eyes chanced upon an advertisement of Macmillan’s in which I find your book at last advertised. That the book is of a high standard is indicated by the most excellent review in Current Science by Professor Stoner, who is competent to judge. As far as I know Meghnad’s is the only text book in physical sciences which has been adopted by foreign universities; and it gladdens my heart that another work in physical science is likely to occupy a similar place. My days are practically numbered; and my great consolation is that you, in chemistry, are raising the reputation, abroad, of Indian workers".

Acharya P.C.Ray, on Bhatnagar’s book “ Physical Principles and Applications of Magneto Chemistry”, 1935

FORAYS INTO INDUSTRIAL RESEARCH

“ It was in 1933 that Dr Bhatnagar demonstrated that the very first requirement of an industrial chemist is a very thorough grasp of the fundamentals. The Attock Oil Company of Lahore was faced with a problem, of the coagulation of muds in their drilling operations when they encountered salt deposits. Upon discussion with the Company’s chemists, Dr Bhatnagar insisted that it was a simple problem in colloid chemistry. He suggested that a method for protecting the colloid that made up the drilling mud so that salt could not coagulate the clay”.

P. Carter Speers, J. Scientific and Industrial Research, April 1943

As a compensation for his services, the company (Steel Brothers, UK) offered Dr Bhatnagar a sum of Rs 1,50,000 for research work on any subject related to petroleum. Dr Bhatnagar, In turn, turned the money over to the University for the establishment of six research scholarships. This sum was later enhanced to Rs Four Lakhs

"You have hereby raised the status of the university teachers in the estimation of public, not to speak of the benefit conferred on your Alma Mater. India does not lack in men earning in millions; but if a few of these millionaires were guided by the fine example of a comparatively poor teacher like yourself her scientific and social progress would have been more rapid".

Professor Megnad Saha, 1934

AN EYE FOR THE DETAIL : THE IP CLAUSE

"The patents issued will be jointly in the name of Steel Brothers and Company Limited and Professor Bhatnagar and, or his chemists and any profits would be shared equally between the company on the one hand and the partied concerned on the other"

Agreement between Steel Brothers, Dr Bhatnagar and the University

Twenty nine patents issued to Shanti Swarup Bhatnagar and assigned to CSIR between 1941 and 1959

EXAMPLES OF APPLIED SCIENCE UNDER THE DIRECTION OF DR BHATNAGAR

- **A varnish to make gas masks impervious to gases**
- **A special lubricating oil for bronze bearings**
- **A petroleum derived preservative for wood**
- **A method for purifying sulfur**
- **Making fuels and lubricating oil from vegetable oils**
- **Jute and Shellac derived containers for storng hydrocarbons**
- **Resins from bagasse and jute**
- **Enamels and lacquers from Bhilawan nut**
- **A stove, the size of a matchbox which gives off intense heat using a solid fuel**
- **Cotton cloth with a heat insulating property of wool**
- **Rendering textile fabrics non flammable and water resistant**

Our troops have greatly been aided by the invention of unbreakable containers in which even liquids can be dropped from airplanes on hard ground without being shattered. These inventions are the work of Professor S.S.Bhatnagar of BSIR.

New Republic of USA, 18 September 1943

PURE AND APPLIED SCIENCE

“Rigorous research in pure science is the only possible basis for applied science in the cause of industry. Any attempt to avoid pure chemistry and begin with applied chemistry is like erecting a fortress on a foundation of sand”.

Lecture, Pure and Applied Chemistry, Indian Chemical Society, Calcutta, 1941

PURE AND APPLIED CHEMISTRY

“ Since my association with industry and some of the rapidly advancing departments of Industrial Chemistry in India, I have come in contact with large number of non descript men of our profession for whom I have acquired a great admiration and respect. I remember the days when we used to consider greasy, fatty, oily, cement, leather, textile, coal tar, paint and varnish chemists as something far removed from the realm of real chemistry, to be looked down upon by Pundits of Chemistry, who arrogated to themselves the self styled title of pure chemists, almost implying that all others not of this kind are impure. In this age even the pure chemist must soil his hands, although the spoils of academic reputation may be the privilege of the pure scientist”

Lecture at Indian Chemical Society, Calcutta,1941

THE PURPOSE OF RESEARCH

"Scientific and industrial research thrives best when it is applied to material benefits of human kind and to existing industries and agricultural enterprises"

A VISION FOR THE FUTURE

There are hardly any new lands which Indian can hope to exploit. The only new lands on which we may have our eyes must lie in the domain of mind and have to be created in the research laboratory. It is on these sources which will emerge from the national laboratories that we may have to depend now and in the future for the means to maintain and raise our standard of living and to keep abreast amongst the best nations of the world.

S.S. Bhatnagar
6th April 1947

THE BIRTH OF AN IDEA

It was as early as September 1941 that I submitted my proposals to the Government of India regarding the desirability of *establishing in India a National Chemical Laboratory*. The proposal was finally accepted by the Government of India and the Board of Scientific and Industrial Research under the Chairmanship of Sir A. Ramaswamy Mudaliar in their tenth meeting held in July 1943 and proceeded to appoint a planning committee for the National Chemical Laboratory

Shanti Swarup Bhatnagar

“It is science alone…. that can solve the problem of hunger and poverty.. of vast resources running to waste, of a rich country inhabited by starving people”

Jawaharlal Nehru

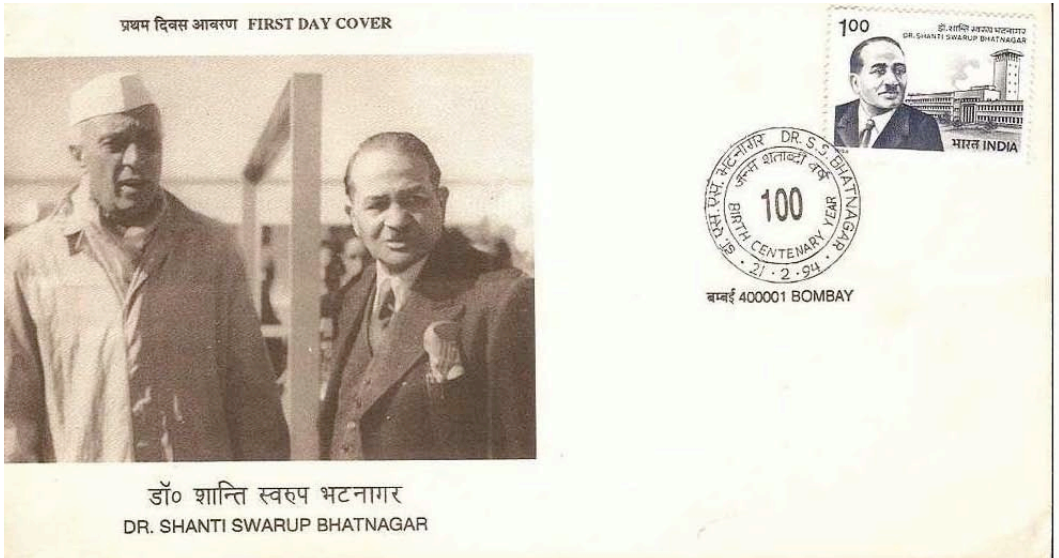
“There is talent in our country. But the question is how to tap that talent and give opportunities to the young men and women of India, who had the requisite ability. I hope that so far as these laboratories are concerned they would help to some extent at least in opening the doors to a large numbers of young men and women and give them opportunity to do good work for the country in the cause of science and in application of science for the public good”

Jawaharlal Nehru, January 3, 1950

A DREAM FOR INDIA

When in 1941 I was asked by the Viceroy to take up the Directorship of the Board, I was convinced that I must leave the university for a larger field to help in building India's scientific research, training her young scientists and inspiring her young men to take up research as a career. In that hour when I decided to take up the office, *I dreamt of a chain of National Laboratories, of large teams of scientists working on the development of India and the creation of scientific outlook on life amongst India's masses.*

S.S. Bhatnagar, 1950



ORGANIZED SCIENCE AND NATIONAL DEVELOPMENT

- **Summer of 1920 and 1921 : Visited leading laboratories in France and Germany; Influenced by the visit to Kaiser Wilhelm Institute (laboratories of Fritz Haber) and Walter Nernst at Berlin**
- **1944-45 : Visited UK, US and Canada to study post war development of science and technology; Observed first hand events associated with the discovery of Penicillin, DDT, developments in metallurgy, aviation and communication technologies; visited great industrial laboratories of ICI, Shell, Vickers (in UK) and Bell Labs, General Electric, DuPont, American Cyanamid, Eastman Kodak, and several Petroleum Companies (In US) in addition to visitng MIT, Caltech, Carnegie Mellon University**

"The tale of Tennessee Valley is the romance of a wandering and inconstant river tamed by human ingenuity, creating electrical energy which has been America's Alladins Lamp. I dream of the Tennessee Valley that may happen to any river valley in India, from Damodar, to Ganges, to Sutlej and Narmada, if the people and the Government just give science a chance "

CSIR : TIME LINES IN HISTORY

1938 - At the behest of Dr Meghnad Saha, Subash Chandra Bose, the then President of the Indian National Congress creates a National Planning Committee for Scientific Research under the Chairmanship of Pandit Jawaharlal Nehru

1939 - Bureau of Scientific Research set up

1940 - Creation of the Board of Scientific and Industrial Research (BSIR) with a budgetary allocation of Rs 5.00 lakhs

1941- Lord Linlithgow, the Viceroy of India invites Sir Shanti Swarup Bhatnagar to become the first Director of the Board

14 November 1941- A Resolution for the creation of CSIR prepared by the Commerce department and moved by Sir Arcot Ramaswamy Mudaliar passed in the Legislative Assembly

21 March 1942- BSIR reconstituted as the Council of Scientific and Industrial research (CSIR); Registered as a Society under the Societies Registration Act XXI, 1860

26 September 1942- CSIR is born as an Autonomous Body

CHARTER OF CSIR
RESOLUTION DATED 14 NOVEMBER 1941

- **The promotion, guidance and coordination of scientific and industrial research in India including the institution and financing of specific researches;**
- **The establishment and award of research studentships and fellowships;**
- **The utilization of the results of the researches conducted under the auspices of the Council towards the development of industries and the payment of a share of royalties arising out of the development of the results of researchers to those who are considered as having contributed towards the pursuit of such researches;**
- **The establishment, maintenance and management of Laboratories to further scientific and industrial research and to utilize and exploit for purposes of experiment or otherwise any discovery or invention likely to be of use;**
- **The collection and dissemination of information in regard not only to research but to industrial matters generally;**
- **Publication of scientific papers and a journal of industrial research and development**

FUNCTIONS AND OBJECTIVES
(From the address of Sir S.S. Bhatnagar)

- **One of the most important functions of this Laboratory will be to bridge the serious gulf between scientific research and its industrial applications**
- **It will work out ways and means for the application of scientific knowledge to practical problems of human welfare**
- **NCL will stand or fall according to the quality of its scientific staff. It must achieve national and ultimately international recognition**
- **The Laboratory will try to improve old processes in the light of new scientific knowledge and discover new processes**
- **In short, the National Chemical Laboratory will be a living and vital link with the universities, scientific institutes and industry**

Contd…..

FUNCTIONS AND OBJECTIVES

- **Another principal objectives of this Laboratory will be to undertake fundamental research to extend the frontiers of knowledge. Fundamental research has always had a stimulating influence upon research workers and has attracted to the laboratory men who worked for ideals and whose motto is "it is better to have wisdom than gold"**

Sir S.S. Bhatnagar

January 3, 1950

PURPOSE OF NCL (1945)

- **Embrace all applications of chemistry with due attention to the advancement of the fundamental science**
- **To serve as a link between university, the state, the scientific institutions and industry**
- **To undertake fundamental research directed towards the acquisition of knowledge which is likely to help overall industrial development**
- **Applied and development work will be concerned with improvement of existing processes, efficient utilization of raw material resources and the discovery of new processes and products**

UNIVERSITIES AND NATIONAL LABORATORIES

“ I would like to take this opportunity of dispelling any misconceptions and of reemphasizing that universities and national laboratories have complementary functions to perform. National Laboratories are not intended to supplant, but, to supplement the work of individual or collective industrial concerns and universities in respect of research; generally speaking universities are concerned mainly with fundamental research while the activities of national laboratories lie essentially in the domain of applied research, though these laboratories are not precluded from taking up investigations of a fundamental character”

Convocation Address, M.S University of Baroda, 10 October 1953

A PRESCIENT CALL FOR PRESERVING THE AUTONOMY OF UNIVERSITIES

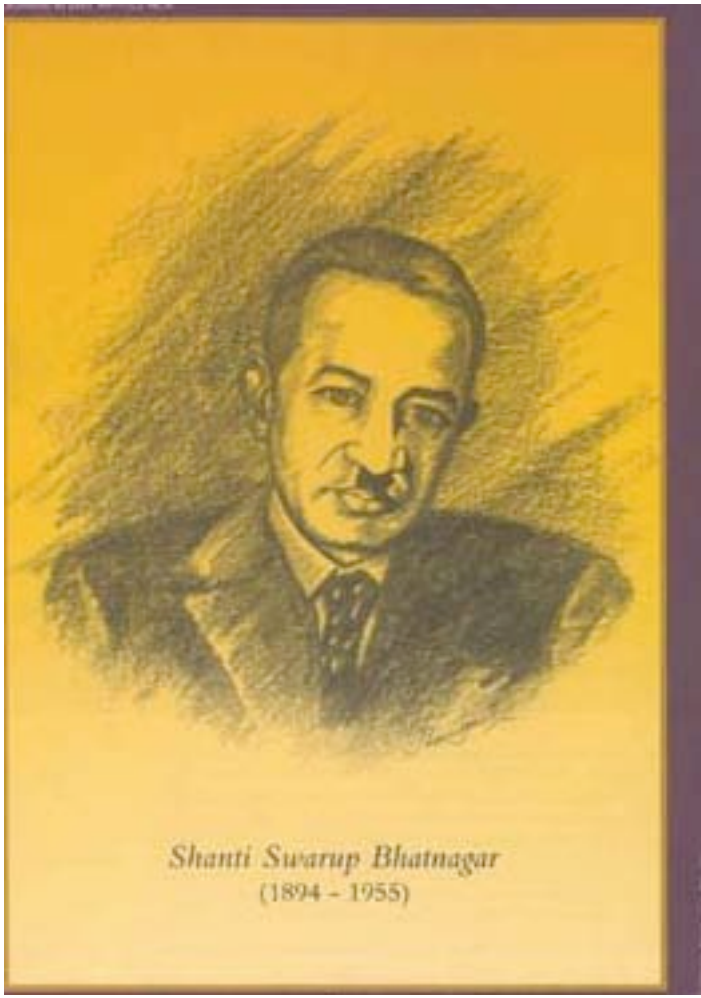
"I take this opportunity of drawing attention of those who love their country to see that our universities are kept as free as possible from narrow communalism and politics. Since politics has begun to play a part in the selection of Vice Chancellors, the university standards have tended to deteriorate. If these evils are not looked into, these institutions will cease to be real seats of learning and will turn into areas of political ambitions"

Presidential Address, Indian Science Congress, 1945

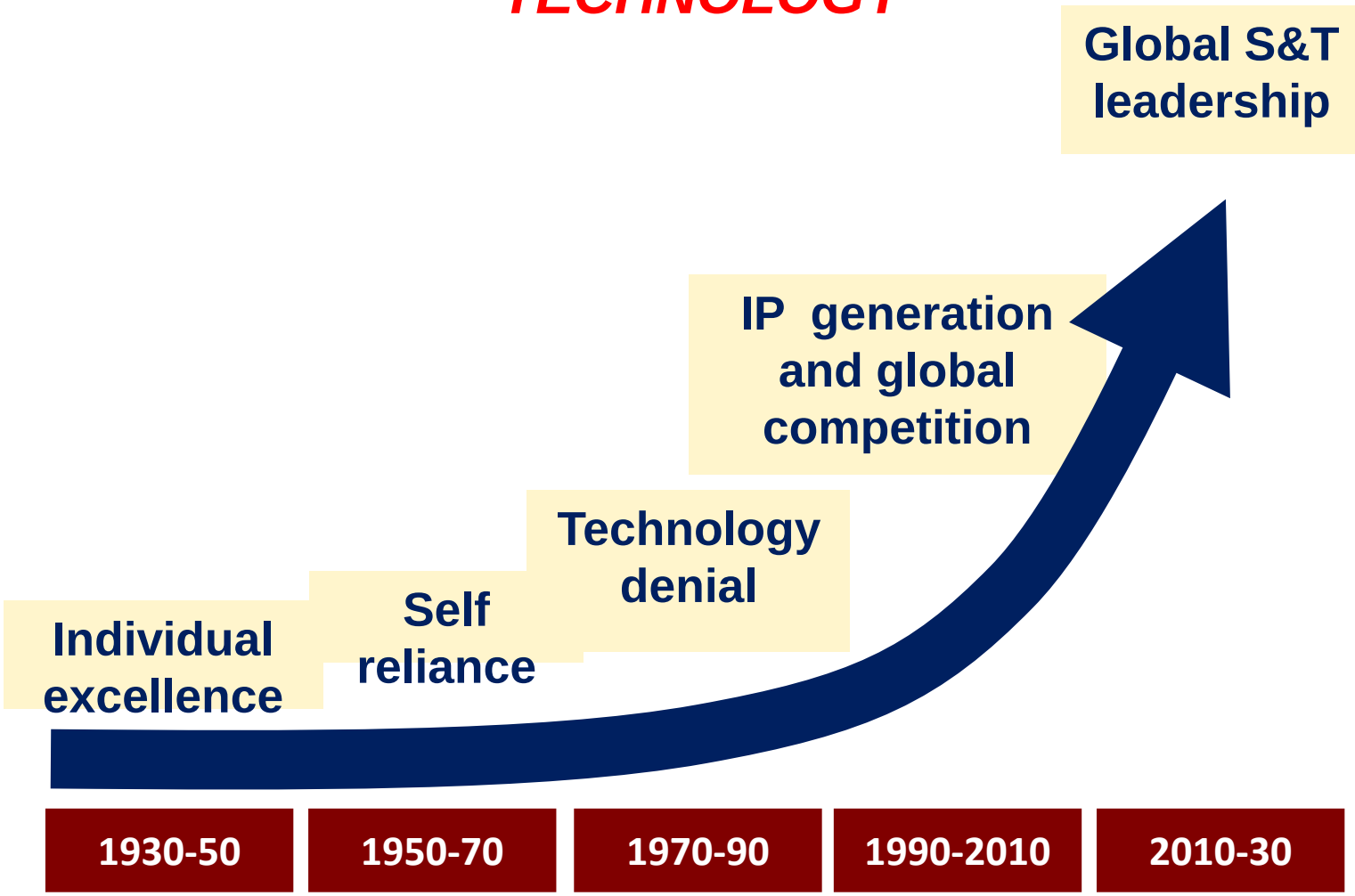
THE ANGUISH OF A HUMANIST

"These are the days of decision for India and if she is to take, as she must, her rightful and honoured place amongst nations of the world she will have to grow strong and great industrially….vast are the fields to conquer, plenty the harvest to reap. It is only the divisions among our people that are holding us back from a leaping march. Here science can intercede with its message of concordance in truth and unity in endevour. The realm of science is bound finally to establish itself. Convinced of the inevitable, we must sink our differences and march ahead in unity"

Speech at the Foundation Stone Laying Ceremony of NPL, New Delhi, 4 January 1947



ONE HUNDRED YEARS OF INDIAN SCIENCE AND TECHNOLOGY



PUBLICLY FUNDED RESEARCH INSTITUTIONS : ARE THEY STILL RELEVANT ?

- **Publicly funded R&D organizations have existed for over seventy years in India**

- **Many of them serve the strategic sectors of the economy, such as , defense, space, atomic energy, food and agriculture, public health etc where public funding of S&T is essential (Public Goods and Services)**

- **CSIR was originally created for the purpose of serving the non strategic sectors of the economy, namely, industry, consumers, making Indian products global competitive (Private Goods and Services)**

PUBLICLY FUNDED RESEARCH INSTITUTIONS : ARE THEY STILL RELEVANT ?

- **industrial research in India is slowly, but steadily maturing. This is bound to alter the relationship of CSIR with industry. Drugs and Pharma as well as automotive industry are two examples where industry is well on its way to maturity in terms of new product development and R&D efficiency.**

- **So where does CSIR position itself in the coming years? What aspects of research and development will be still relevant for CSIR ?**

- **A deep introspection is called for if CSIR has to remain within the folds of public funding**

PUBLICLY FUNDED RESEARCH INSTITUTIONS : ARE THEY STILL RELEVANT ?

- **Several options are available to us**

- **CSIR can become a simple contract research organization for industry or a hand maiden for the strategic sector R&D, especially defence, space and atomic energy. There is no rationale for public funding to the former ; if we pursue the latter option CSIR will stand the risk of losing its identity**

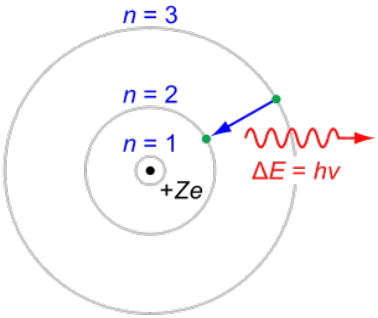
- **The imperative for CSIR is to therefore search for a unique space for itself, based on its core strength, namely, outstanding human capital, innovation potentials, as a center for advanced education in S&T and outstanding infrastructure for research (land, buildings and facilities)**

PUBLICLY FUNDED RESEARCH INSTITUTIONS : SOME QUESTIONS

- **What are our metrics for measurement of effectiveness ?**
- **Have we established a brand for ourselves ?**
- **Should CSIR be a sub-contractor for the strategic sector ?**
- **What component of our research should be market facing?**
- **How do we create wealth in the society through innovation ?**

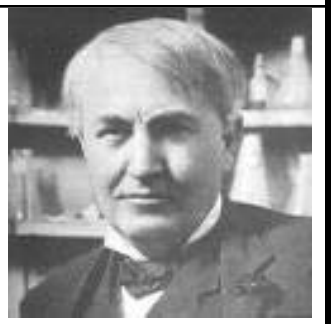
Pasteur's Quadrant

Bohr



Pasteur

Average
Academic
and
Industrial
R & D



Edison

Fundamental Research

Use Inspired Research

SCIENCE IN THE 21st CENTURY

- **Blue skies vs Directed or Organized Science**
- **Small vs Big Science**
- **Individual vs Team Science**
- **Curiosity driven vs Grand Challenges or Utilitarian Science**
- **Open access vs Intellectual Property**

RESEARCH ENTERPRISE : COMPLEXITIES

- **Individual or solo research**
- **Collaborative research**
- **Mission driven research**
- **Research leading to IP**
- **Research leading to products and prototypes**
- **Research aimed at societal needs**
- **Teaching , mentoring and communication**

STRUCTURE OF SCIENCE

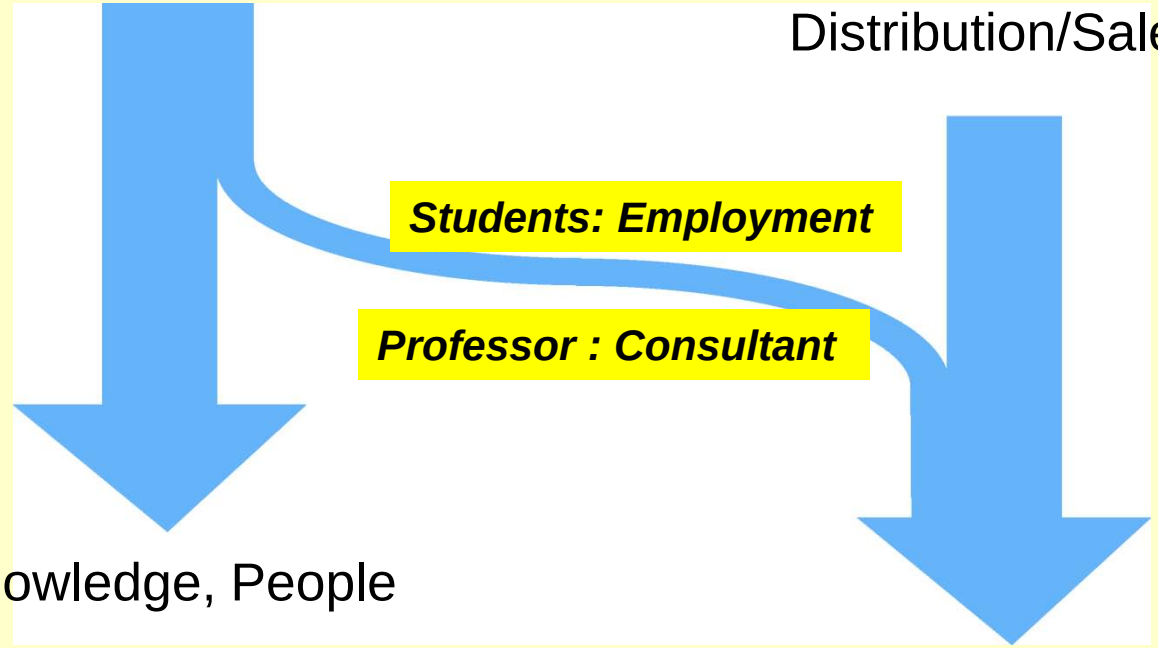
Money

University **Government** Laws, Regulation

Industry

("Liebig" Model:
Professor/Student/Problem/Thesis)

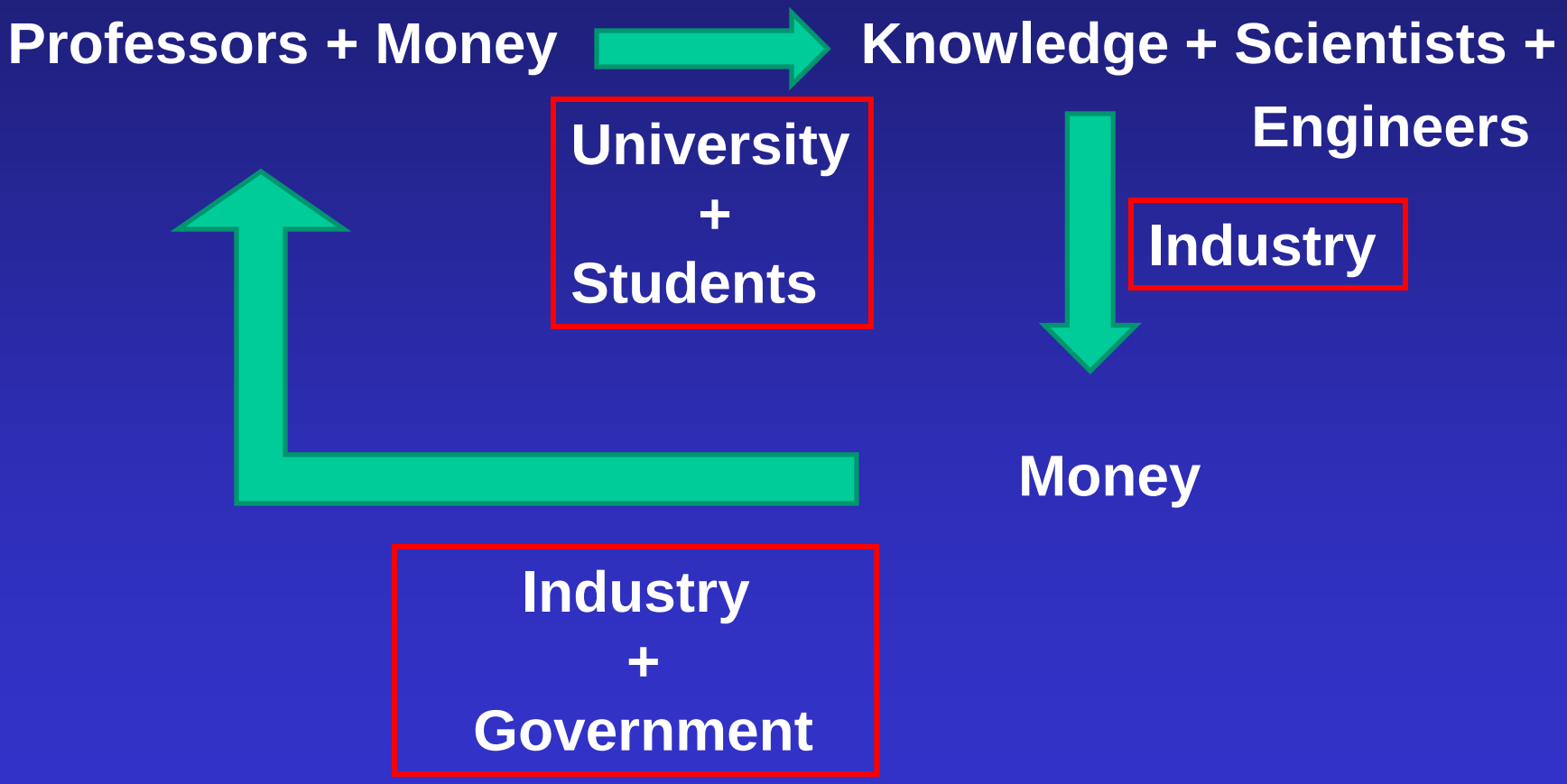
(Development, Manufacturing,
Distribution/Sales)



Knowledge, People

Products/Solutions for Problems

LIEBIG'S MODEL



LEIBIG MODEL OF RESEARCH TRAINING

Professor assigns a problem to a student

The student solves the problem , gets his Ph D; the professor becomes famous

The student goes on to become a professor and repeats the process all over again

EXAMINE THE MODELS

- **Is the “Liebig Model” obsolete?**
- **Is the current model of the university (“a collection of semi-isolated experts”) still workable?**
- **Can curiosity-driven basic research survive?**
- **Should research be driven by large missions ?**
- **Should translational research be funded by the state or should be left to industry ?**

THE GREAT AMERICAN UNIVERSITIES

J. R. COLE, PUBLIC AFFAIRS, NY 2009

- **Academia and industry : Fundamentally different goals and value systems**
- **Academic values: Universalism, organized skepticism, creation of new knowledge, free and open communication of ideas, disinterestedness, free inquiry and academic freedom, international communities, peer review systems, loose governance, vitality to the community**
- **Basic leading to applied leading to development leading to production and markets : A linear model attributed to Vannevar Bush, Science - The Endless Frontier**
- **The Bayh Dole Act of 1980 changed the paradigm. University ownership of Intellectual property changed the rules of the game**

Stanford University's contribution to Research and Innovation

- Since 1930s, faculty, alumni & staff were the source of:
  - **332,000 patents**
  - **2.2 million publications** (4% of all publications!)
- **39,900 active companies** have roots in Stanford
  - **5.4m jobs**
  - **$2.7Tr in revenues**
- **29% of alumni founded an organization**
- 12 companies with market value >$10B (2011)
- **50% of alumni-founded companies moderately or highly innovative**

THE NON LINEAR PROCESS : SEAMLESS INTEGRATION OF RESEARCH AND INNOVATION

- **Research : ideas, concepts, principles, techniques, theories (*Discover)***

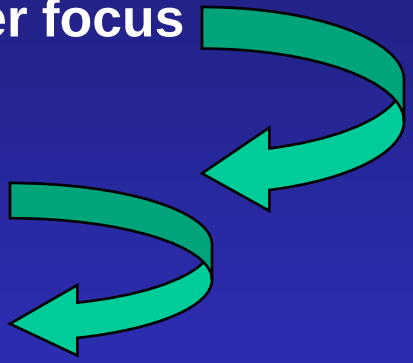
- **Translation : proof of concept, connecting solutions with needs, validation *(Develop*)**

- **Defining the customer and his needs (met or unmet) and cost –performance targets, prototype or pilot plant development, customer acceptance, business plan, investment and economics *(Demonstrate)***

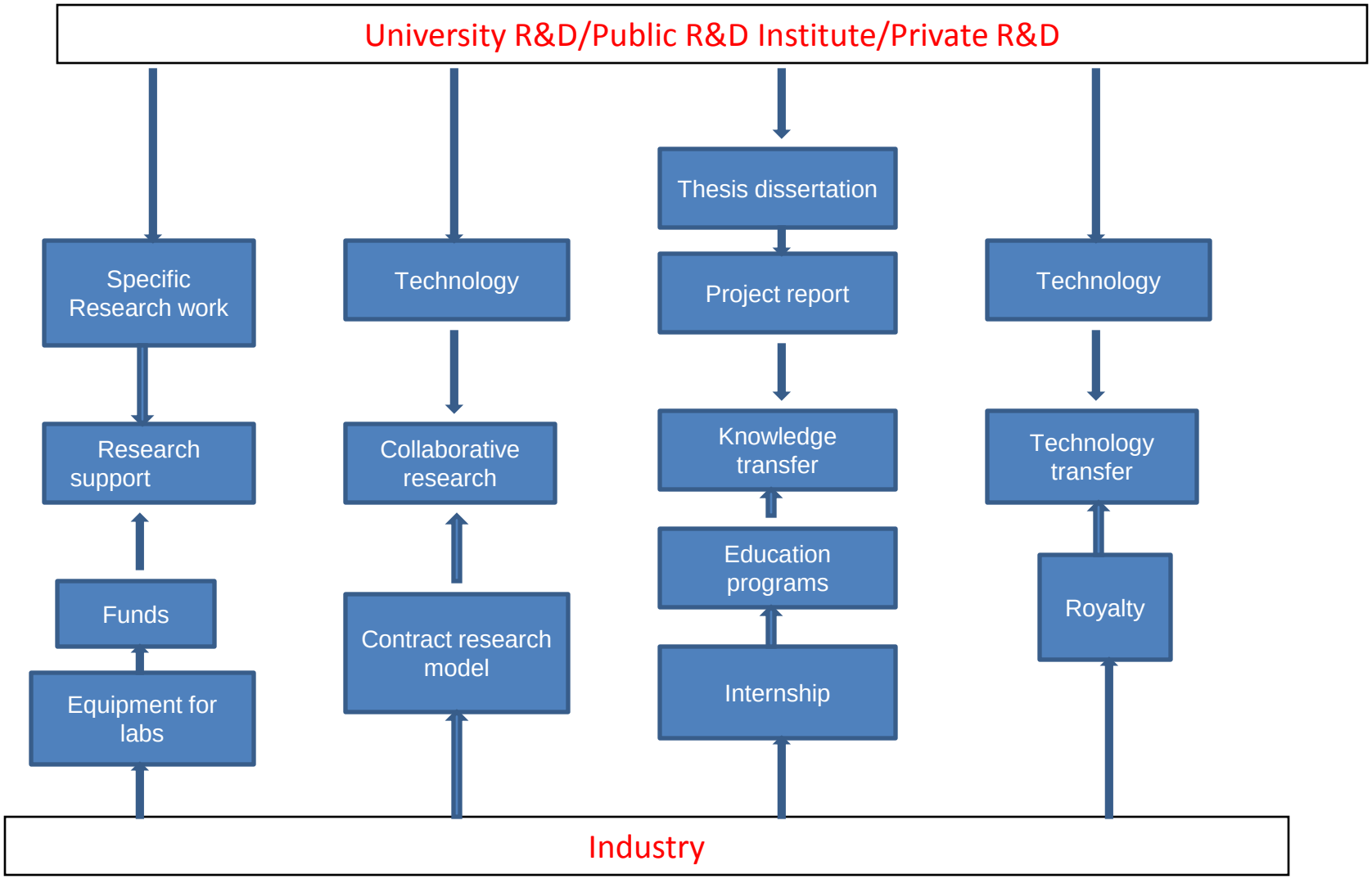
- **Marketable Product *(Deploy)***

CSIR-STAKEHOLDER INTERACTIONS : TOWARDS EVOLUTION OF NEW MODELS

- **The transactional model : Little or no stakeholder focus**
- **The relationship model : stakeholder satisfaction**
- **The partnership model : stakeholder success**



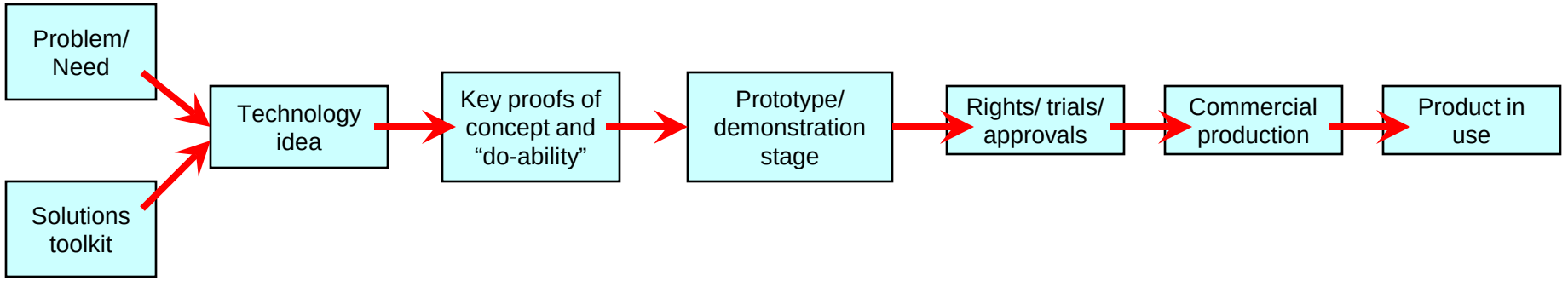
MODELS OF CO-OPERATION



TRANSLATIONAL SCIENCE

- **A new term increasingly used in biology and medical science**
- **Develop, design, engineer and produce/ commercialize: This was the prerogative of industry**
- **With industry stepping back , Government through public funding is increasingly stepping in to fill the vacuum, especially in high risk R&D**
- **Success of translational efforts using public funds still not proven**
- **Government picking technology winners is best with great dangers and risks**

Technology Innovation: A simplistic model



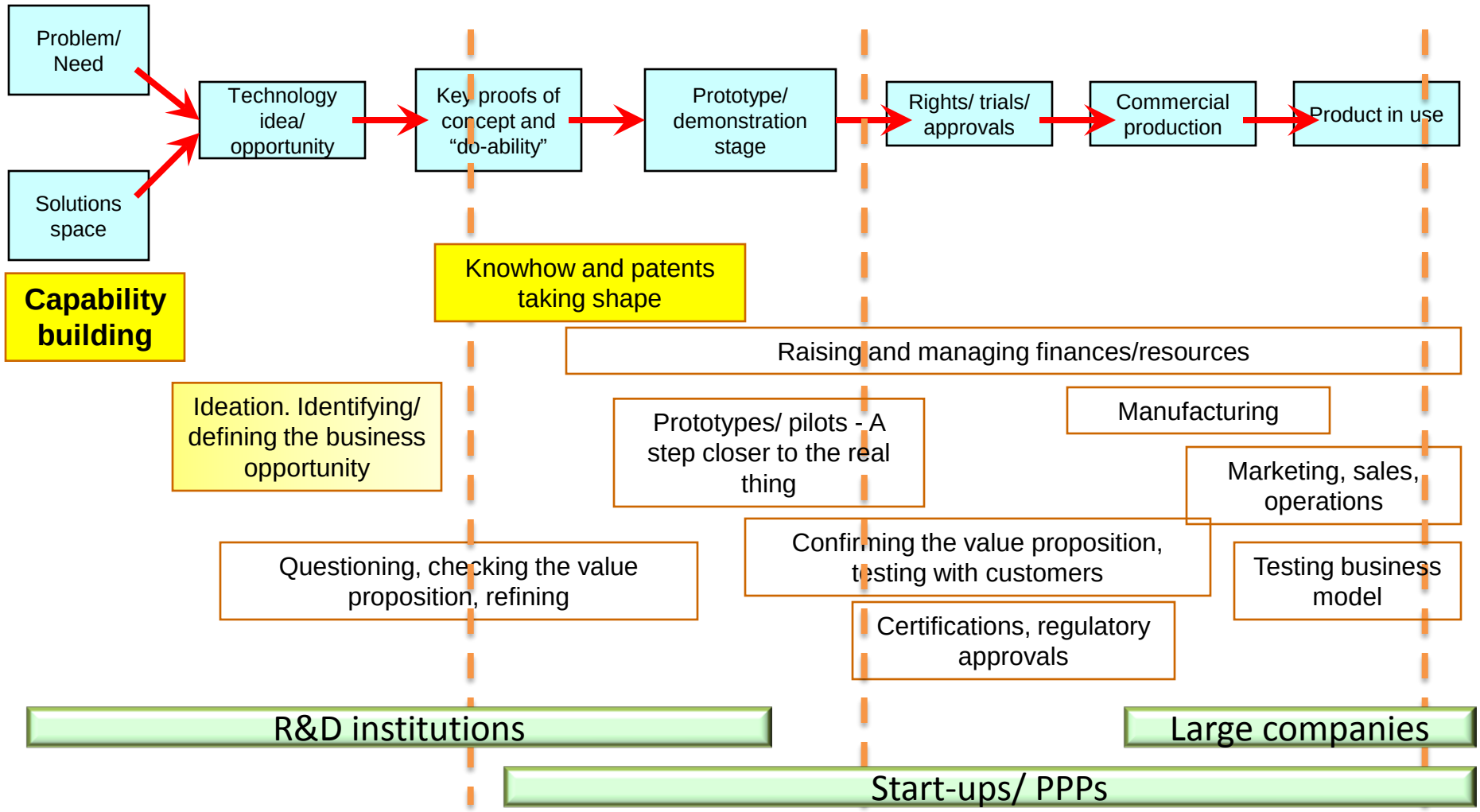
Invention

80% of work, time, investment

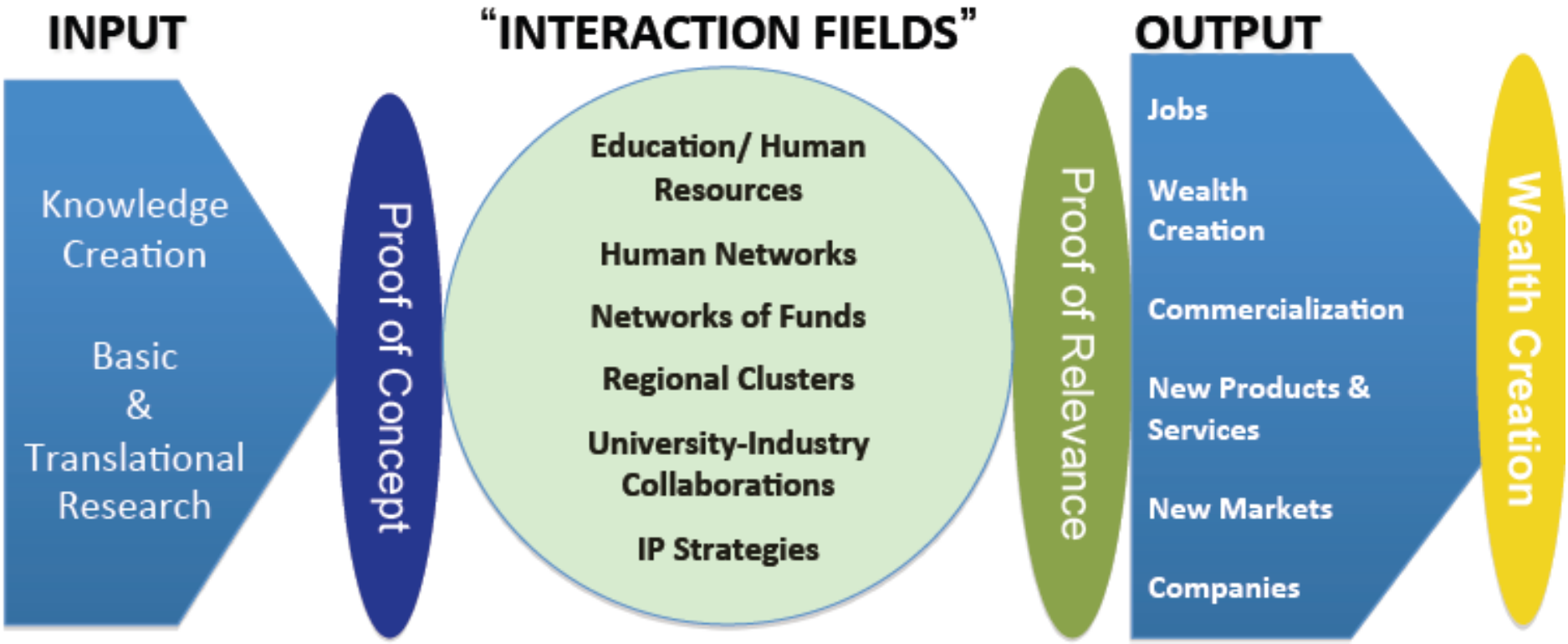
All the inventions that are remembered have successfully navigated this process!

Innovation is 80 % perspiration, 20 % inspiration !

TECH COMMERCIALIZATION – THE JOURNEY

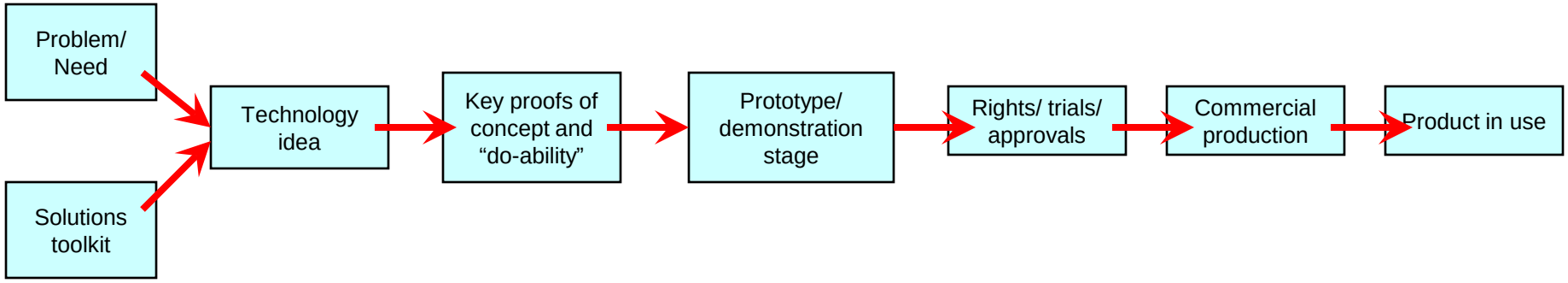


INNOVATION ECOSYSTEM



The concept of the **Innovation Ecosystem** stresses that the flow of technology and information among people, enterprises and institutions is key to a vibrant innovation process.

TECHNOLOGY DEVELOPMENT & TRANSFER: NEW EQUATIONS



CSIR : Then and Now

Before	Now
First "Solutions/toolkit", then "Problems/Need"	Increasing focus on "Problem/Need"
We built competencies; Others came with problems	Build competencies + Seek problems in parallel
Processes	Processes + Products
Small but important parts of large, multi-faceted technology	Stand-alone technologies; Less need for complementary technologies / investments

INDUSTRY – ACADEMIA LINKAGE: INDIAN SCENE

- **Weak and rare**
- **Socio – cultural as well as economic reason**
- **The competitive advantage of companies in India not dependent on technological innovations but on process innovations**
- **Few large companies with traditions of research**
- **The western world moved from agrarian to industrial and then on to service based enterprises over two hundred years. The work force had the time to accept and manage the change through skill up-gradation and education**
- **The industrial revolution laid the foundation of industrial R&D; Large corporate research facilities became the visible symbols of successful enterprises. They hired large number of highly educated professionals and provided them an ambience to create and innovate.**

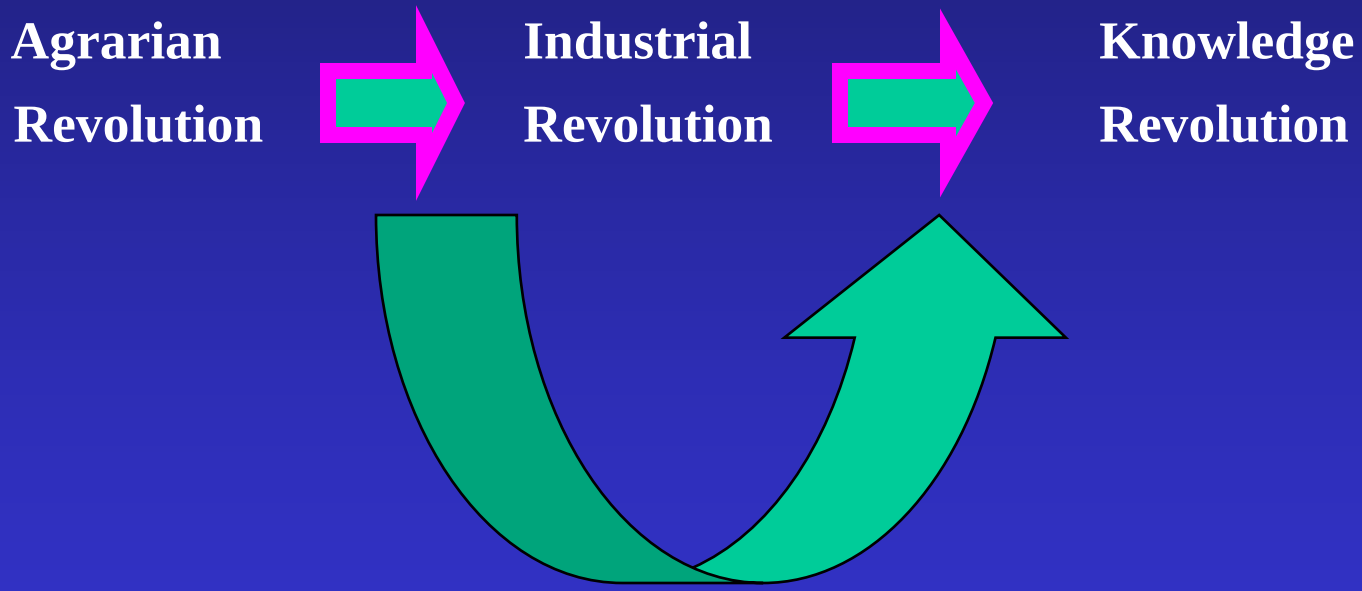
INDUSTRY – ACADEMIA LINKAGE: INDIAN SCENE

- **However, in India we missed the beneficial aspects of the manufacturing revolution. India began to industrialize in the early fifties, but before this process reached maturity, India migrated to a service economy**
- **R&D in industrial enterprises never became institutionalized. There was no established innovation processes in majority of the Indian companies, barring a few honorable exceptions.**
- **Service industry does not require process or product innovations, but only innovations in delivery and cost management.**

INDUSTRY – ACADEMIA LINKAGE: INDIAN SCENE

- **In India, even R&D began to assume a service model, largely due to the cost arbitrage. A large proportion of R&D that is conducted in India by companies are for customers outside India, both by global MNC's and by Indian companies, especially in the pharma sector. The outsourced R&D model never gave Indian organizations an opportunity to take a concept to the market, completing the full innovation chain. Instead they were only deployed to do those things where they had some competence**

WILL INDIA MISS A FULL BLOWN INDUSTRIAL REVOLUTION?



NATURE OF RESEARCH

- PI driven funda-mental research
- Problems tend to be narrowly defined
- Education is the primary goal
- Teaching and mentoring is a core activity of faculty

- Team driven multi-disciplinary research
- Problems need to be large and difficult
- Larger degree of application focus
- Long term needs of industry and society
- Education is an associate goal

- Team driven multi-disciplinary research
- Objectives business driven
- Focus – short and medium term

Purpose of a University

- Teach to educate
- Perform research to train
- Exploit Knowledge for public good

  - *License IP*

  - *Create new enterprises (spin off companies)*

Universities are good at discovery and creation of new knowledge; they have poor skills in exploitation

Science : Is it for

- Pleasure ?
- Profit ?, or
- Pleasure and Profit ?

Does it benefit anybody ?
Is it worth the money spent on it ?
Is it directed at the right objectives ?
Is there too much or too little?
Is it too pure or applied ?
What are the rewards of research ?

As the world attains prosperity, science is taken for granted and is increasingly being questioned

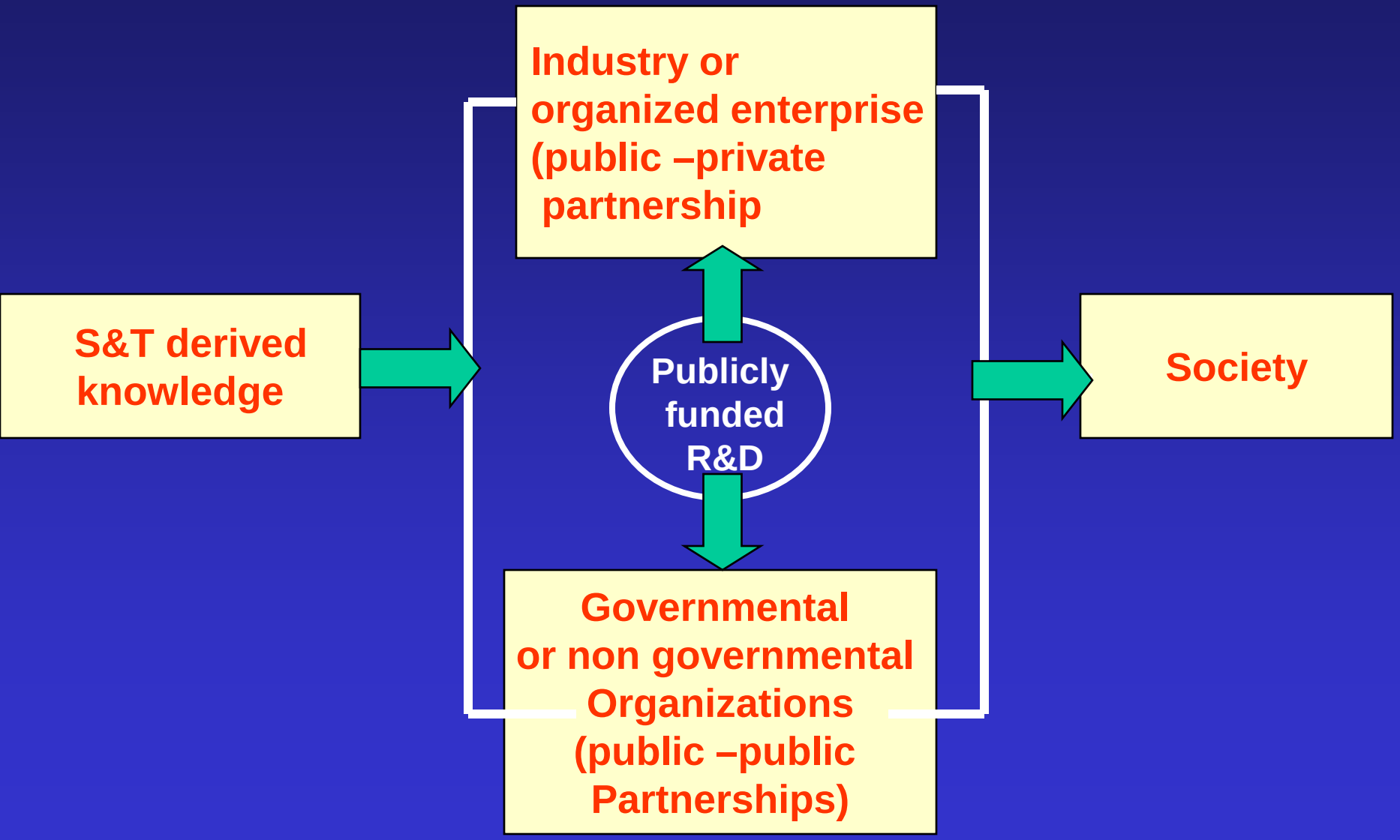
Issues in exploitation of academic research

- Public pays twice for the same invention; taxes support university research that yields the invention and the high monopoly prices charged by the provider when the invention reaches the market

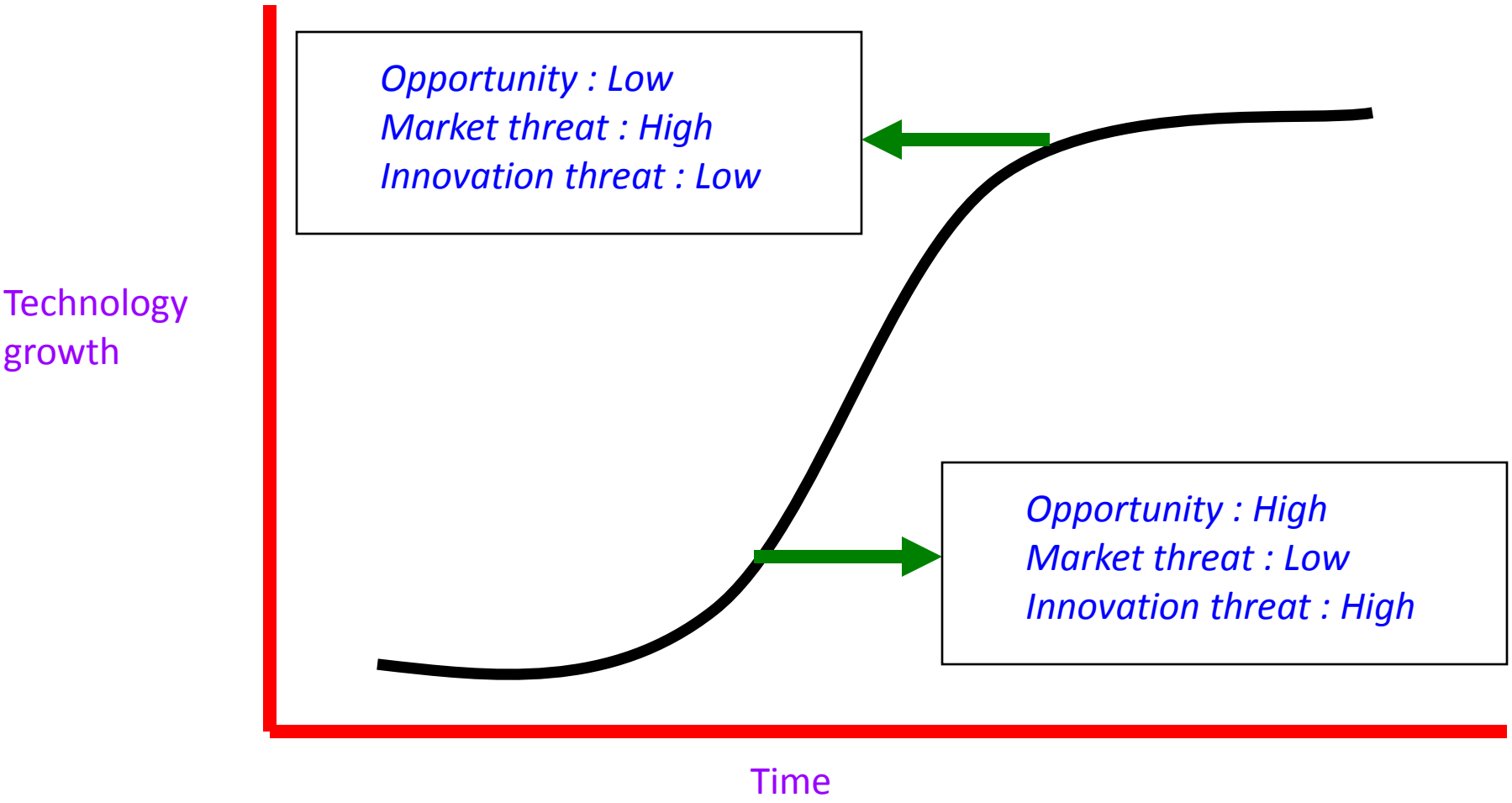
- Bayh- Dole Act in USA led to more IP licensing than spin offs

- Academic departments must avoid redirecting research purely for commercial outcomes; commercial opportunities should be considered as welcome by products
- One extreme view is that academic research and commercial considerations of results do not mix
- Commercial considerations of research do create conflict in academia between the need to disseminate knowledge and limit access to knowledge

PARTNERSHIP IS ESSENTIAL FOR S&T TO REACH THE STAKEHOLDERS



The S Curve and Innovation

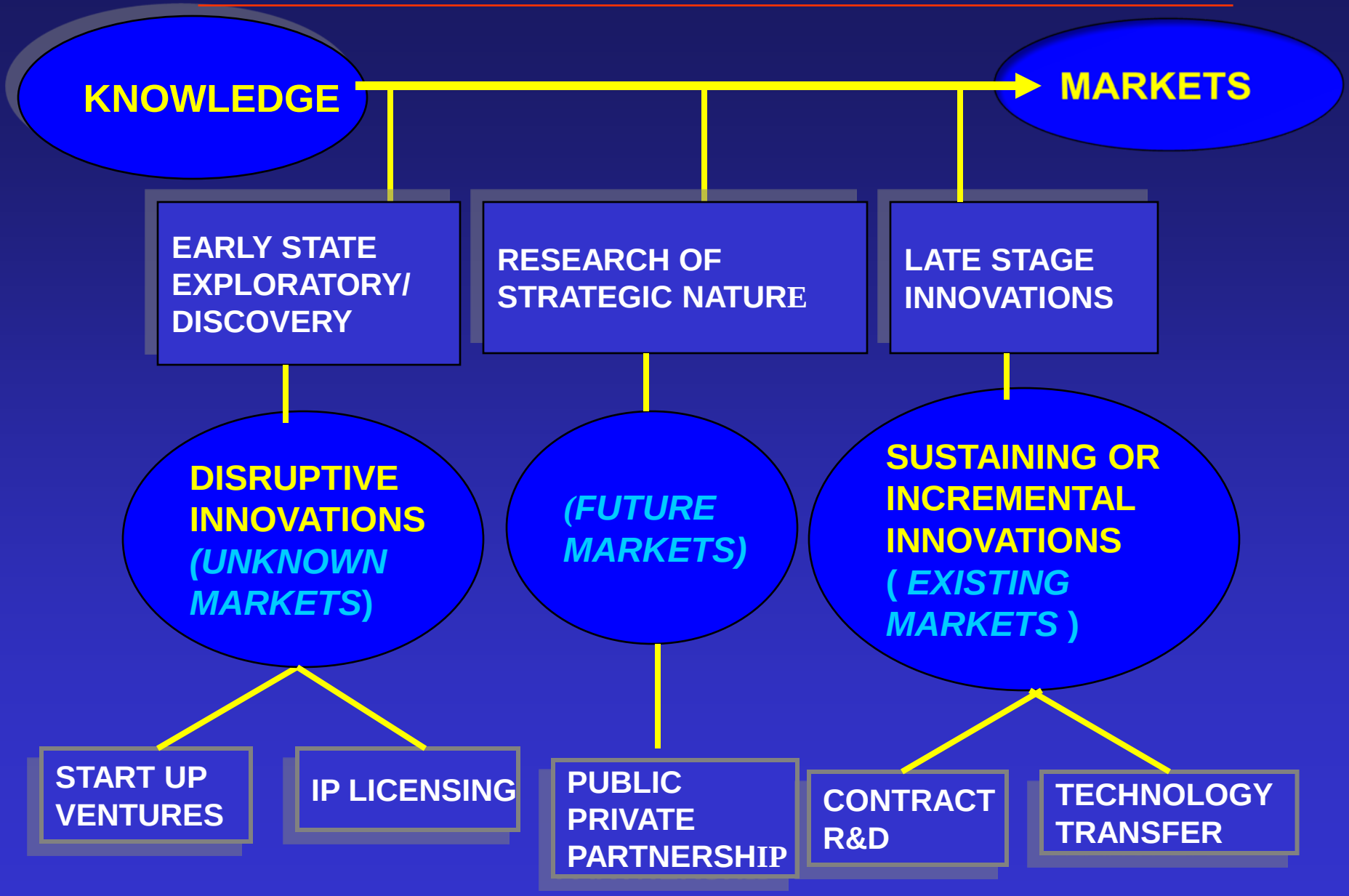


Health, nutrition and well being
Environment
Safety and Security
Information and communication
Transport and Mobility
Built Habitats
Energy and water

PUBLICLY FUNDED RESEARCH INSTITUTIONS FOR EXCELLENCE
(JANELIA FARM)

- **Put world class researchers in an environment that makes it easy to interact across disciplines**
- **Cultivation of a collaborative culture; Individual vs team science**
- **Pursue big science : High risk and high payoff, long term research, grand scientific challenges**
- **All institutions must eventually pass the “deletion” test; removing an institution from the future scientific landscape should reveal its vital importance**
- **Attributes for excellence : Small research groups facilitates communication and mentoring (max six persons); Group leaders are active scientists, not administrators or fund raisers; research funded from within, no need to chase grants; part of a community focused on a small group of problems**
- **Janelia Farm : Biological Imaging, Neural Circuits**

LINKING KNOWLEDGE TO MARKETS



MINDSET CHALLENGE

- **Puzzles versus problems**
- **Interesting versus important**

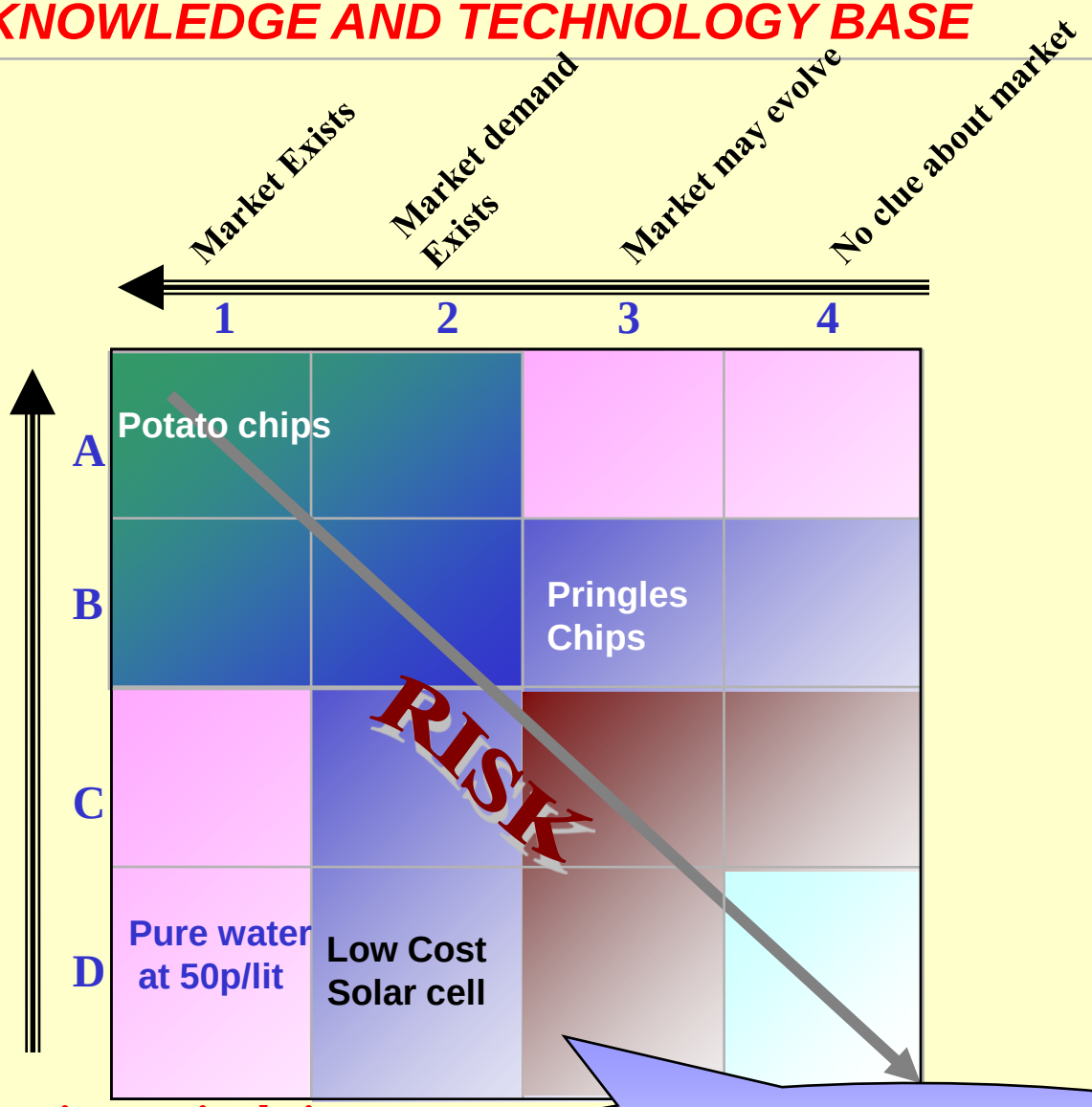
CSIR has to solve problems which are important

CSIR FOR S&T SYSTEM OF INDIA

- **Crossing Intellectual Barriers**
  - **This needs to be based on best global bench marks**
- **Serving National Agenda**
  - **This needs to be related to the National Agenda for a period**
- **Innovating for Industrial Competitiveness**
  - **This is a need of the time in global knowledge economies**
- **Redressing National Shortfalls**
  - **This makes an organization socially relevant**

Courtesy : T. Ramasami, Secretary, DST

PRE COMPETITIVE POSITIONING OF CSIR'S KNOWLEDGE AND TECHNOLOGY BASE



Knowledge exists, Technology exists

Knowledge exists, Technology needs to be developed

Knowledge exists, No clue about Technology

Problem exists, Knowledge needs to be developed

CSIR needs to operate increasingly in the lower half of this knowledge – market matrix

Designed microbes as Industrial worker
eg .Creating H_2 Fuel
eg. $CO_2 + H_2O$ to Glucose& Sucrose


THANK YOU