

Why should we grow and harness the National System of Innovation?

By
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INCOSE SA Chapters
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You can't build a reputation on
what you're going to do.

Henry Ford

Overview

- Understanding the evolving global knowledge-driven societies and their key drivers
- The importance of Innovation and Innovation Systems that work
 - The impact on competitiveness
- The role and importance of engineers to facilitate innovation processes
- Observations of the current status of South Africa's National System of Innovation

Changing National priorities

- 1945: post WWII reconstruction
- 50/60's+: Resource beneficiation industries
- 70/80's+: Security, defense, import replacement
- 1990's : Global re-integration
- 2000's : Strategic differentiation & capacity
- 2010+ : Socio-economic and knowledge economy

The Knowledge Economy

- **The Knowledge Economy**
 - Knowledge is the ‘product’ and/or a productive asset
 - An extension of the “Information Society”
 - The rules and practices that determine success in the industrial economy need rewriting in a interconnected, globalised economy where knowledge resources such as know-how and expertise are as critical as other economic resources
- **The Knowledge –based Economy**
 - Knowledge is a ‘tool’
 - Multi-disciplinary in nature
 - Using knowledge to produce economic benefit as well as job creation

Courtesy: Wikipedia

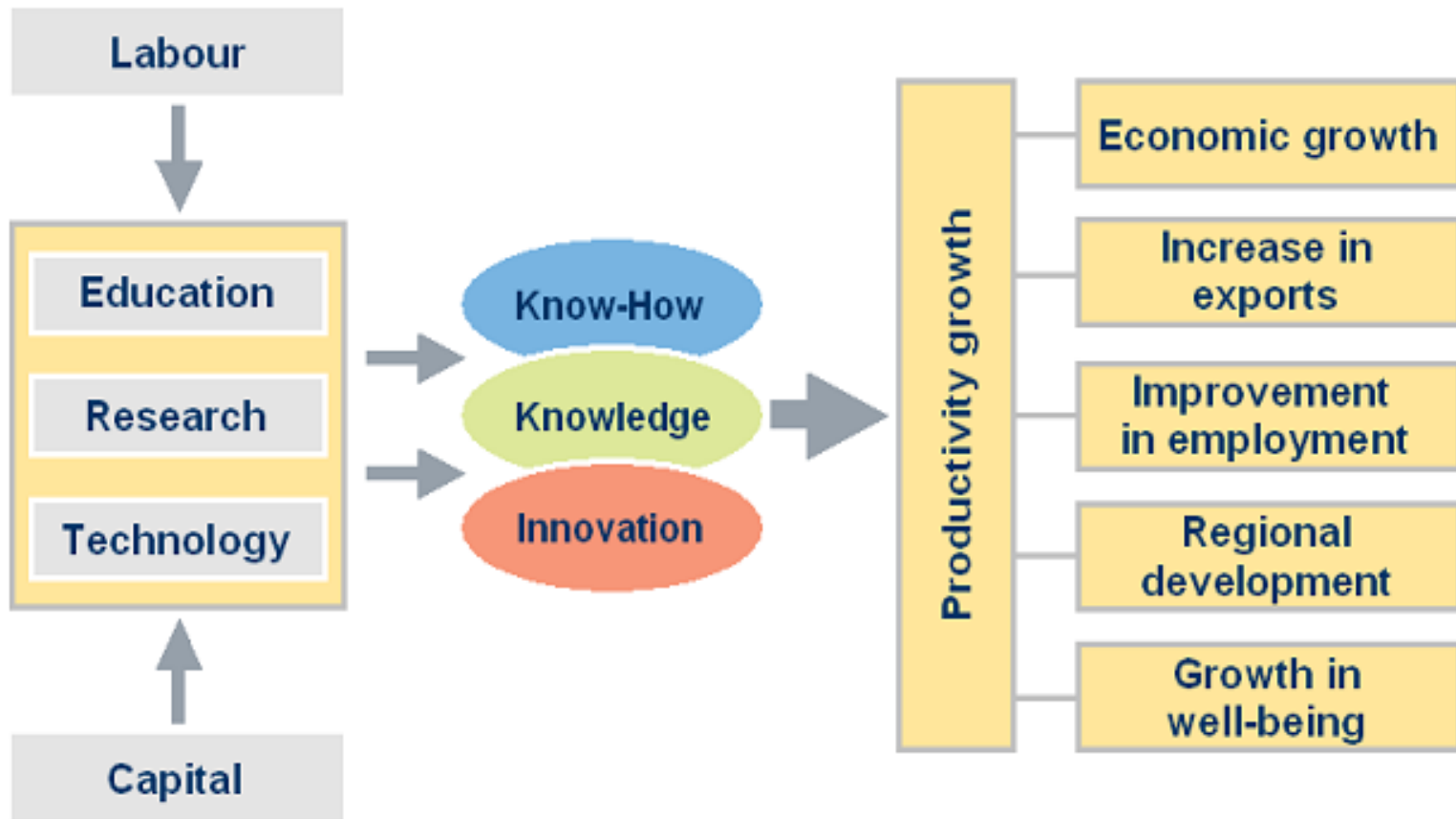
Characteristics/Differences

between the Knowledge and Industrial Economies

- The economics are not of scarcity, but rather abundance
 - Knowledge resources do not become depleted by use, and information and knowledge can be shared
- The effect of location is either:
 - Diminished by using virtual marketplaces that offer speed, agility, round the clock operation and global reach
 - Reinforced , by the creation of business clusters around centres of knowledge, such as Universities and Research institutions
- Knowledge-enhanced products achieve premium prices
- Knowledge is 'transportable' 'in people' s heads and can leave.
- Human capital becomes critical as a component of any knowledge-based business
- Communication is fundamental to knowledge flows. Social structures are important.

Courtesy: Wikipedia

New economic growth model – sources of economic growth



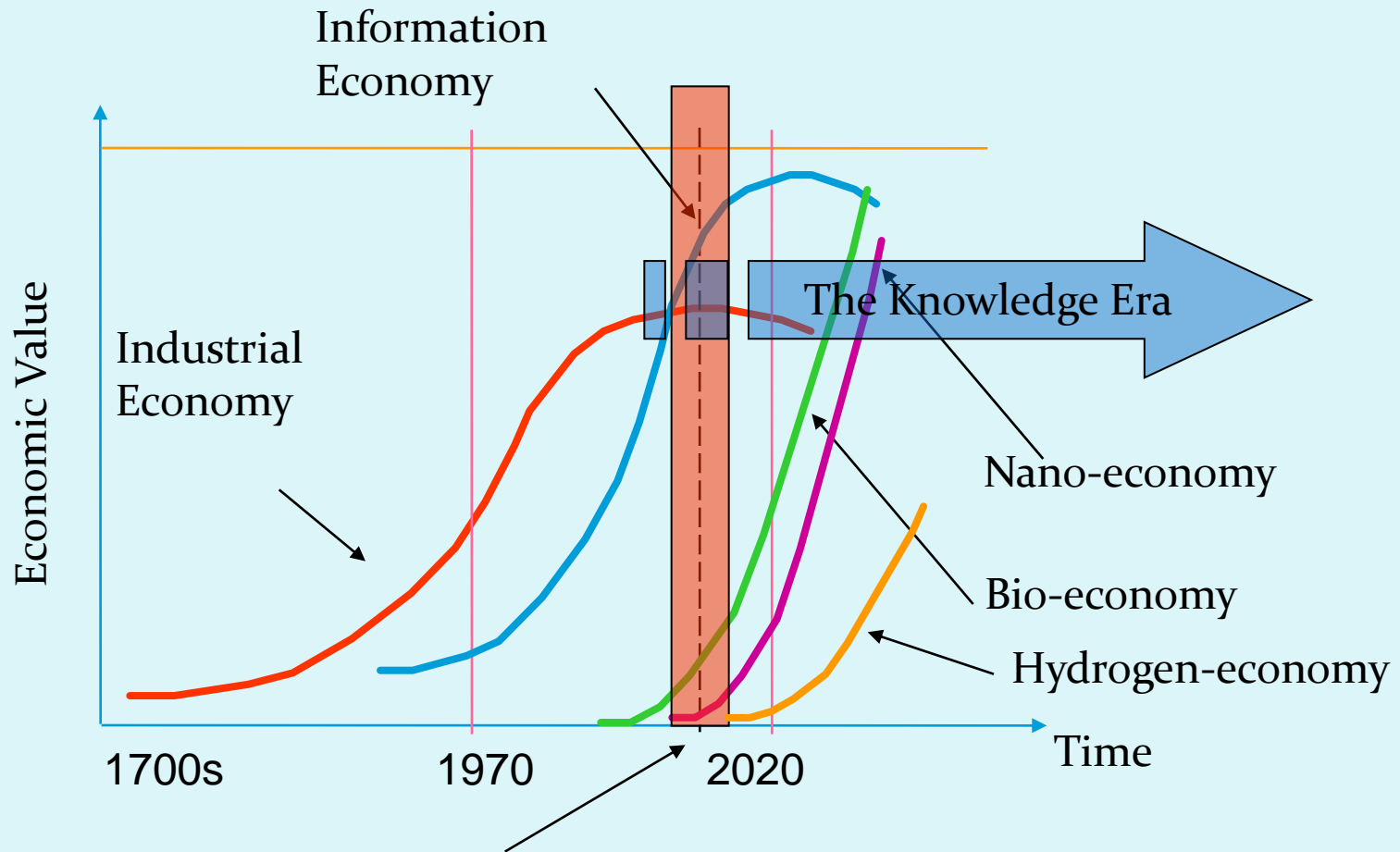
According to the new growth model, economic growth is rooted in education, research and technology.

Drivers in the Knowledge Economy

- Market and products are more global
- Information technology produces three effects:
 - Over 70% of workers in developed economies are knowledge /information workers relying on information and know-how
 - The wide production and distribution of knowledge results in ‘**collective intelligence**’. Much easier to access and utilize.
 - Time to market does not allow long development periods for new products and services
 - The internet allows for the concept of a ‘global village’.

Courtesy: Wikipedia

The Future holds New Technology Challenges



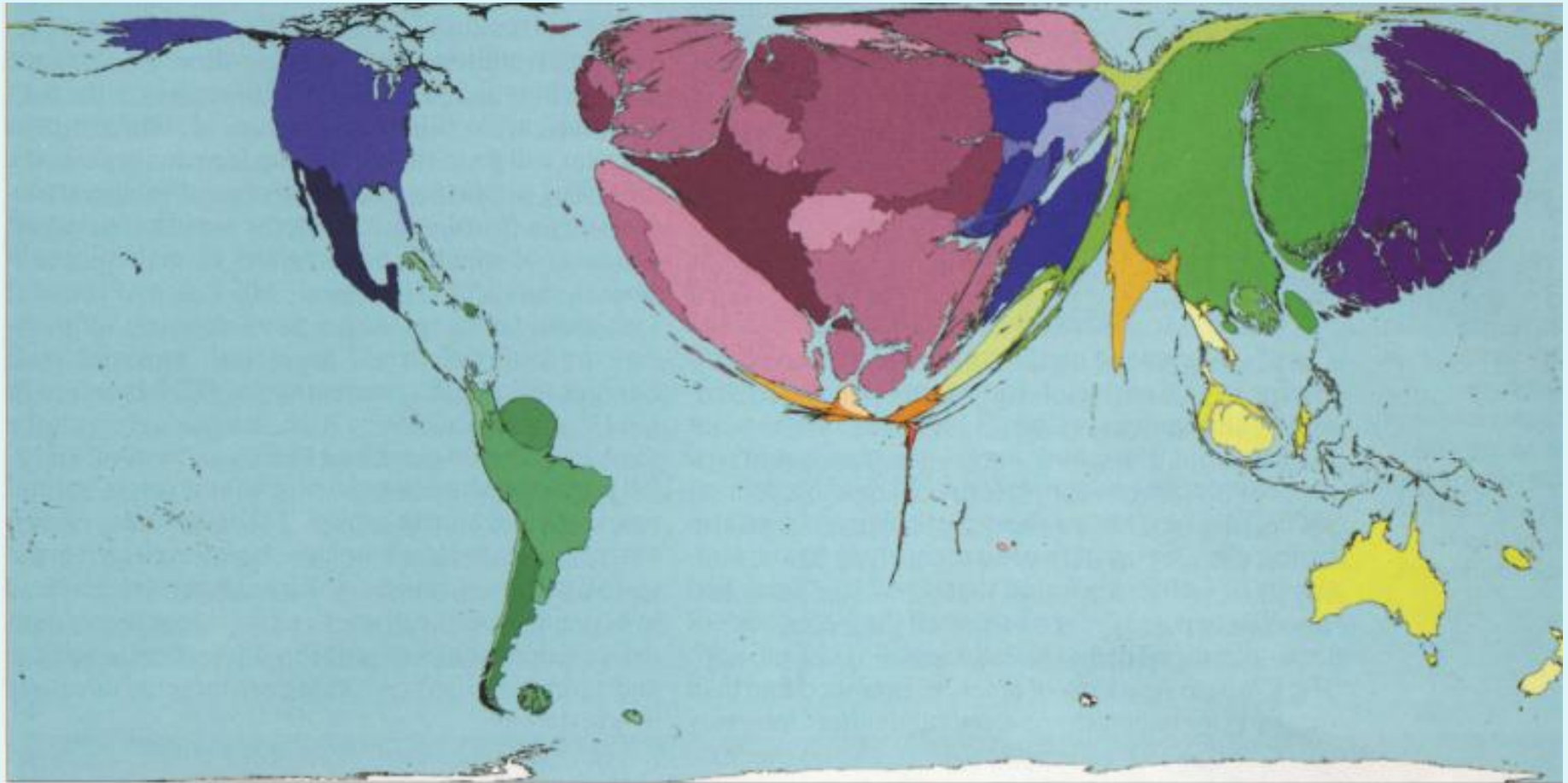
"We are now challenged by all four economic futures"



But –

How much new knowledge do
we generate in SA?

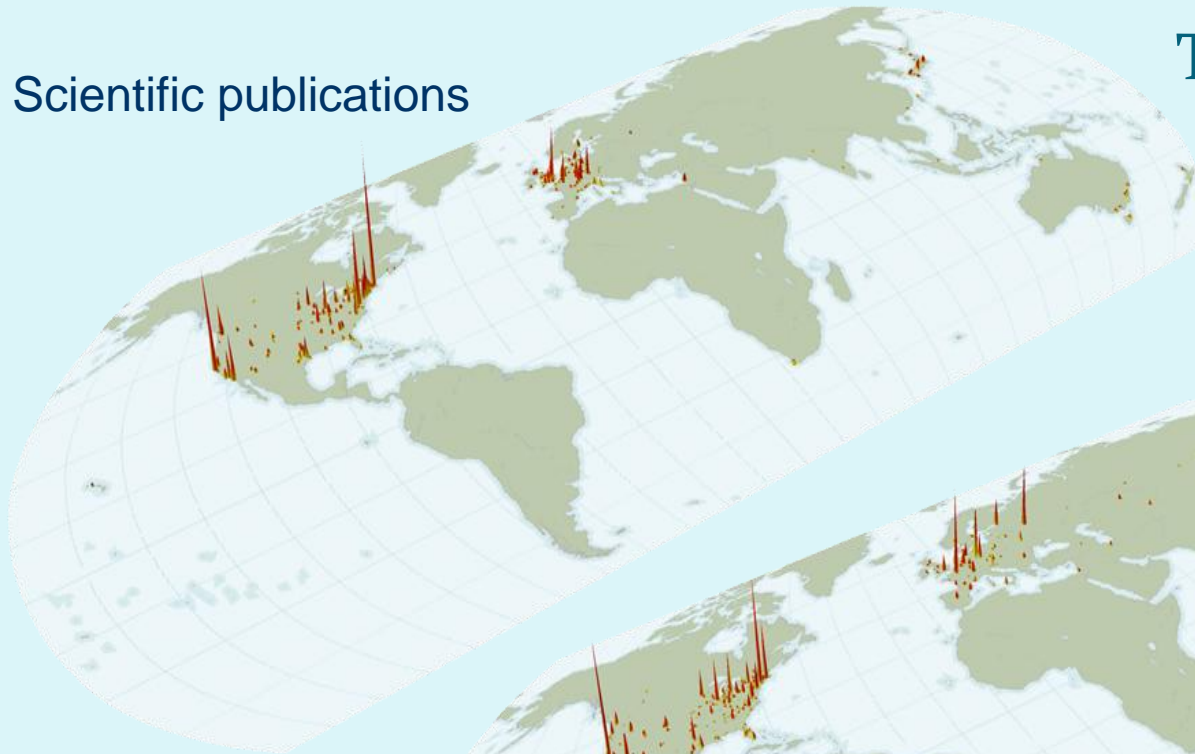
A map of the world with the areas of countries reshaped in proportion to their scientific growth



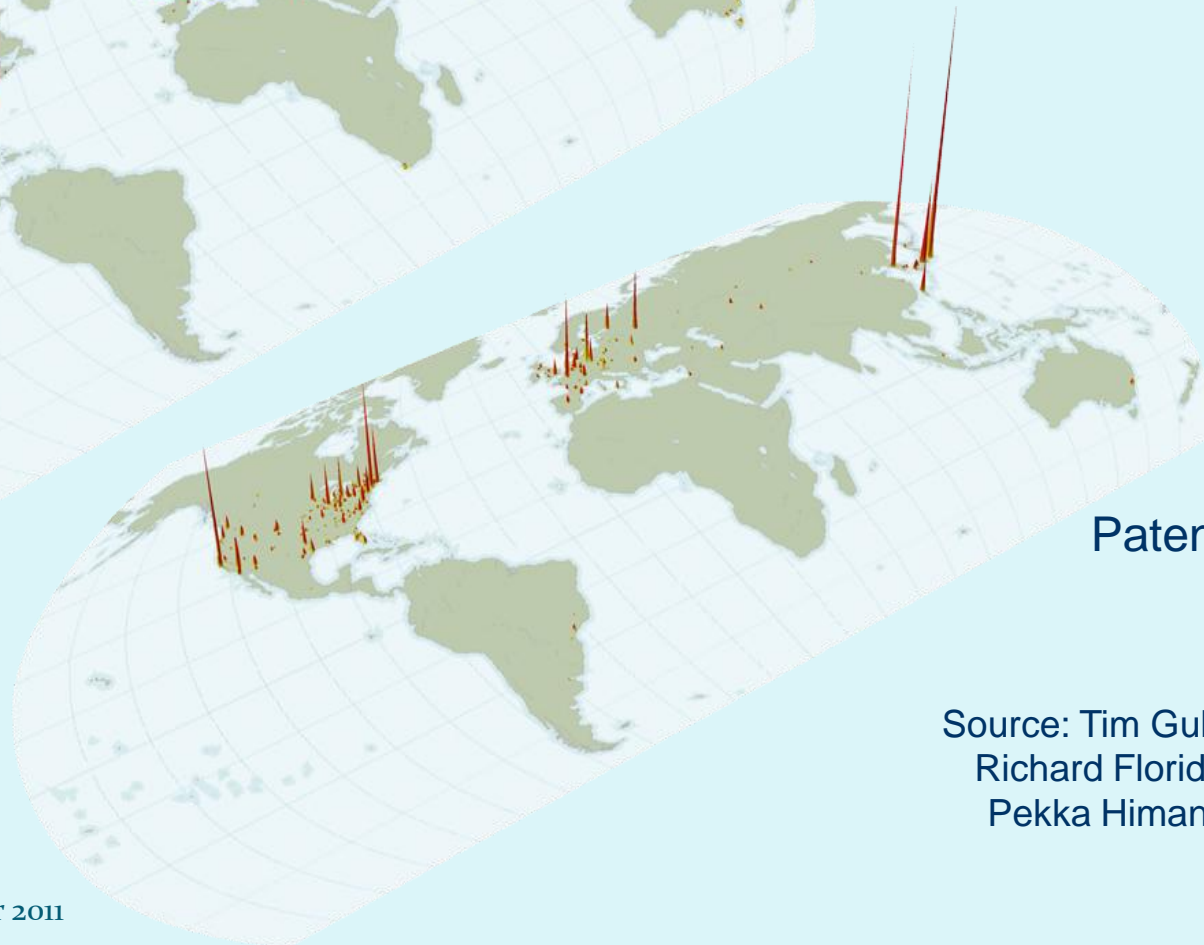
The World is Flat...

The World is Spiky...

Scientific publications



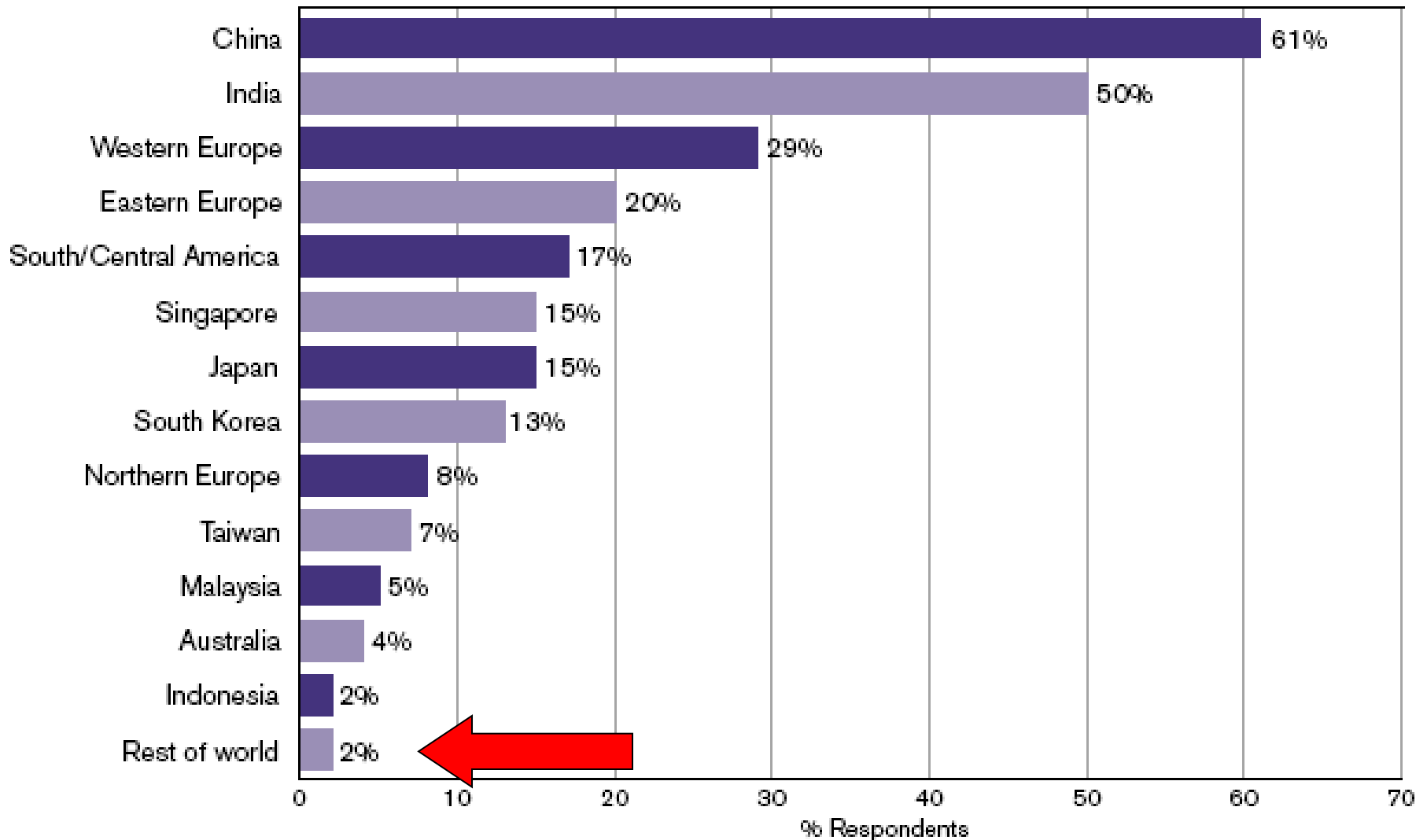
Patents



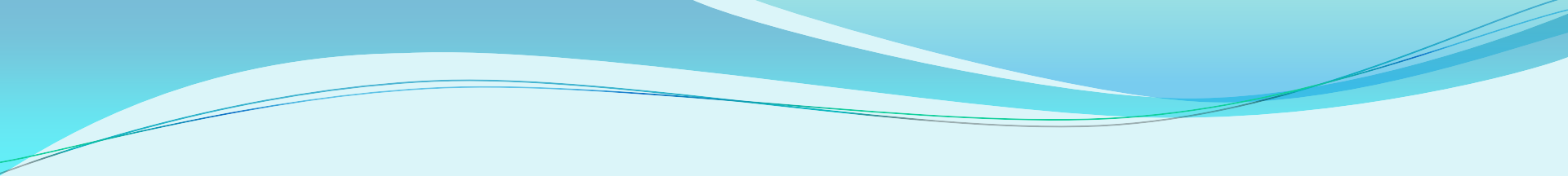
Source: Tim Gulden, UMD,
Richard Florida, U of T,
Pekka Himanen, HIIT

Status Quo : Africa is not even on the map!

Where are you investing in R&D facilities?



Source: R&D Magazine, Battelle, OECD



What is “Innovation”

Innovation is not negotiable !!

“the disturbing regularity with which industrial leaders follow their core technologies into obsolescence and obscurity” [Utterbeck](#)

Because they

- Just do not see the benefits
- Vested interests and investments
- Resistance to change
- Complacency

Radical Innovation often comes from ‘outsiders’ and industry leadership changes hands

[Summarized by Prof Callie Pistorius \(Former Chairperson of NACI\)](#)

What is Innovation?

- It is not ‘invention’
- ‘Innovation’ is the process of taking ideas right through **to the market**
 - It must have customers and markets
 - It must demonstrate an economic output or a social impact
- In the current era, innovations are often associated with new technology developments
 - The ‘**linear models of innovation**’ are no longer accepted
 - Basic research ➔ Applied Research ➔ Commercialisation, etc., etc., etc.

Some other definitions

- **INNOVATION:** It is the process whereby ideas for new (or improved) products, processes or services are developed and commercialised in the marketplace. **The process of innovation affects the whole business** - not just specific products, services or technologies.

For the Business World

INVENTION:

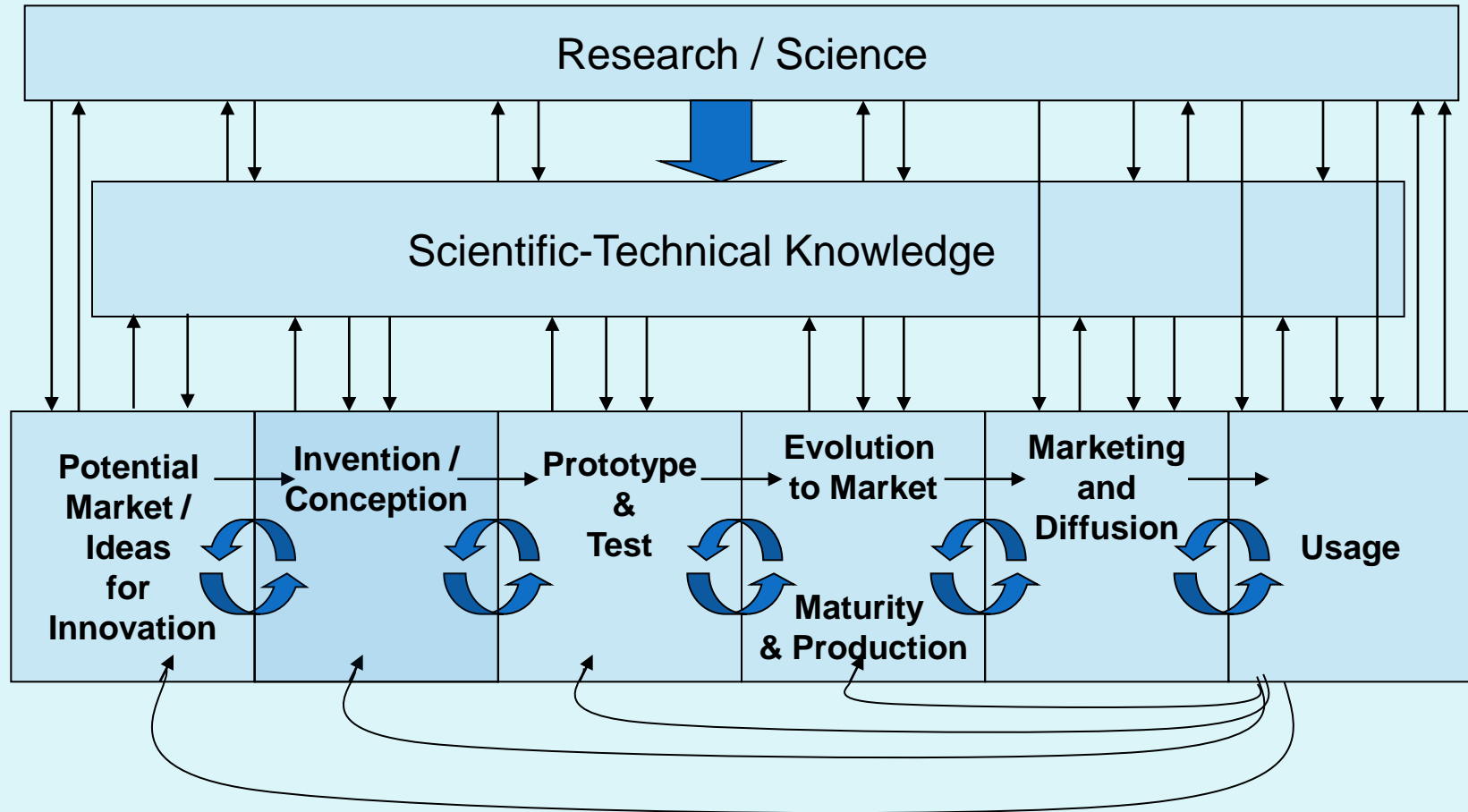
**PUTTING MONEY IN TO GET KNOWLEDGE
OUT**

INNOVATION:

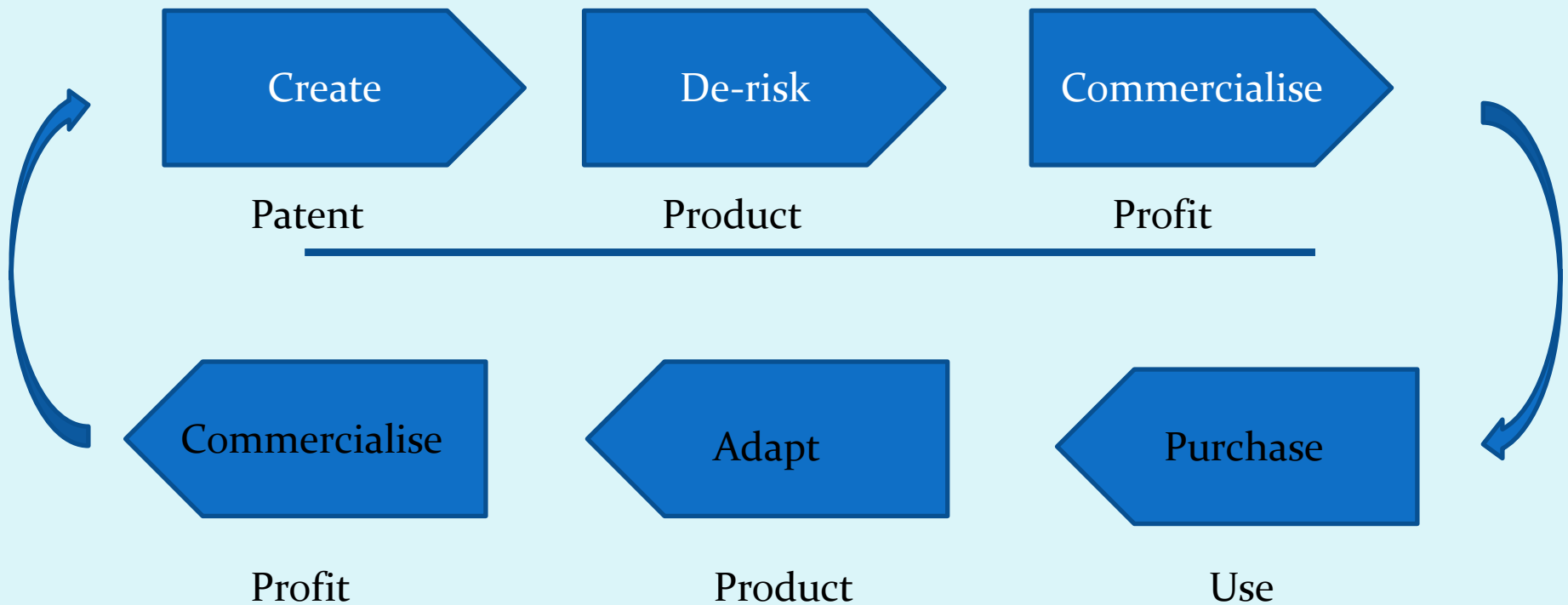
**PUTTING KNOWLEDGE IN TO GET MONEY
OUT**

Tapani Saarinen – Turku Science Park (Finland)

Knowledge / Technology Driven Innovation



Two sides of Innovation



Key Elements of an 'Innovation Society'

- Goals:
 - To enhance the number of people innovating
 - To have appropriate knowledge and to use it for value creation purposes
 - Allow others to be knowledge generators
 - Use innovations occurring elsewhere in the world
- **Constraining ourselves to only use ideas we generate hampers an innovation society.**
- Focusing on just a knowledge-based economy will limit us
- An innovation society cultivates '**collective creativity**'

Evolving Innovation Drivers

- **Open Innovation**

- If the knowledge or a solution is not readily available, research may be too late
- Linking with the world's leading “problem solvers”

- **Crowdsourcing**

- Gaining ideas from society on their needs and requirements
- An example was the “Open Innovation Workshop” by Nokia in Kenya held in November 2010.

Open Innovation: the “new imperative”

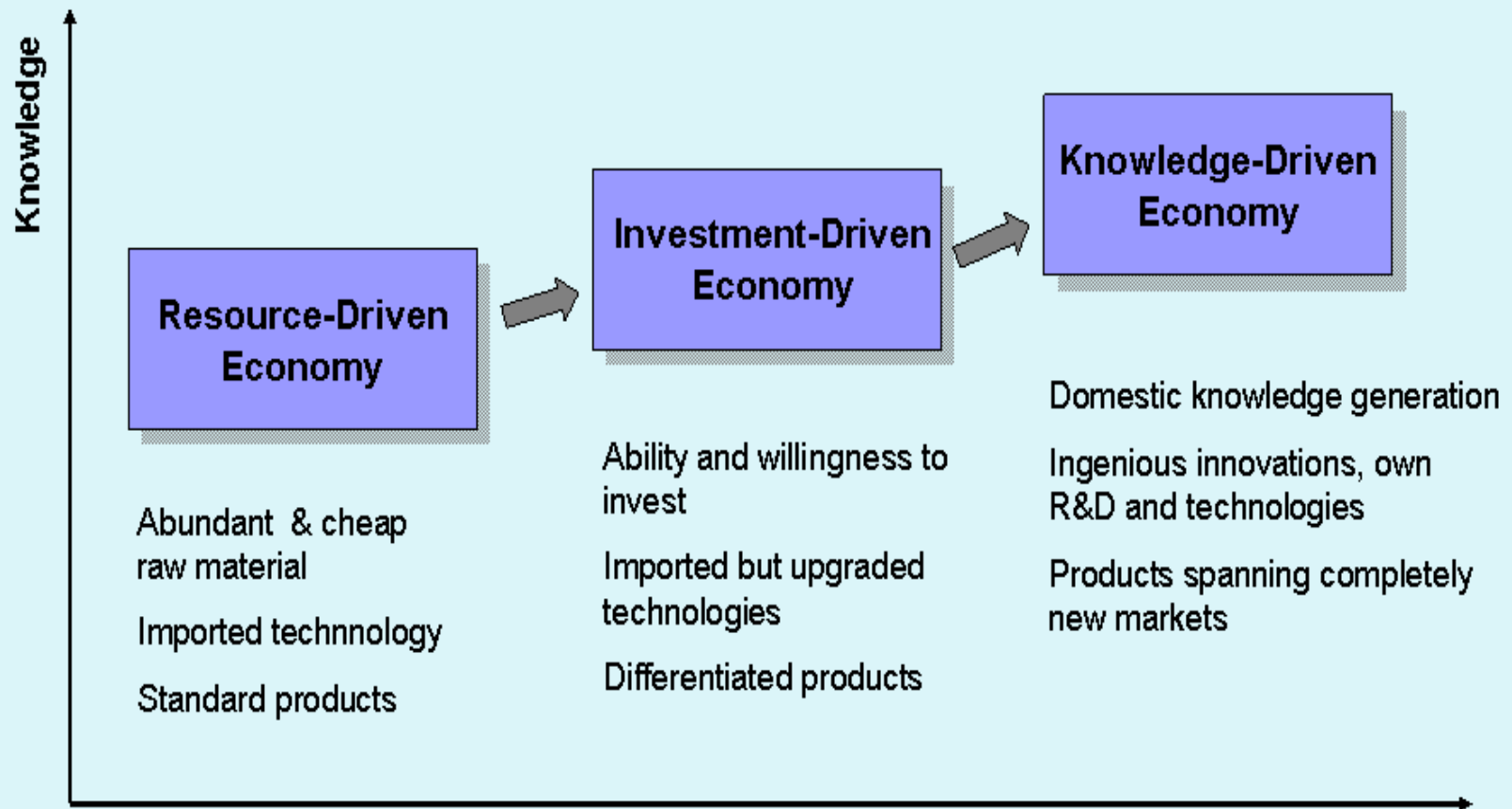
Closed	Open
Smart people in the field work for us	Connect with external smart people in the field
To benefit from R&D, we must discover and own it	External R&D creates value; our R&D can grow the cake
If we discover, we can get to market first	We do not have to originate research to benefit from it
First to market innovation wins	Best model is better than getting to market first
Creating the best and most ideas will make us win	Using the best internal and external ideas will make us win
We must control our IP to lock competitors out	More benefit if others use our IP, and we buy theirs if it advances our business model

(Henry Chesbrough)

Realities of the World in which we live

- Competitiveness
- Increasing our understanding of new concepts

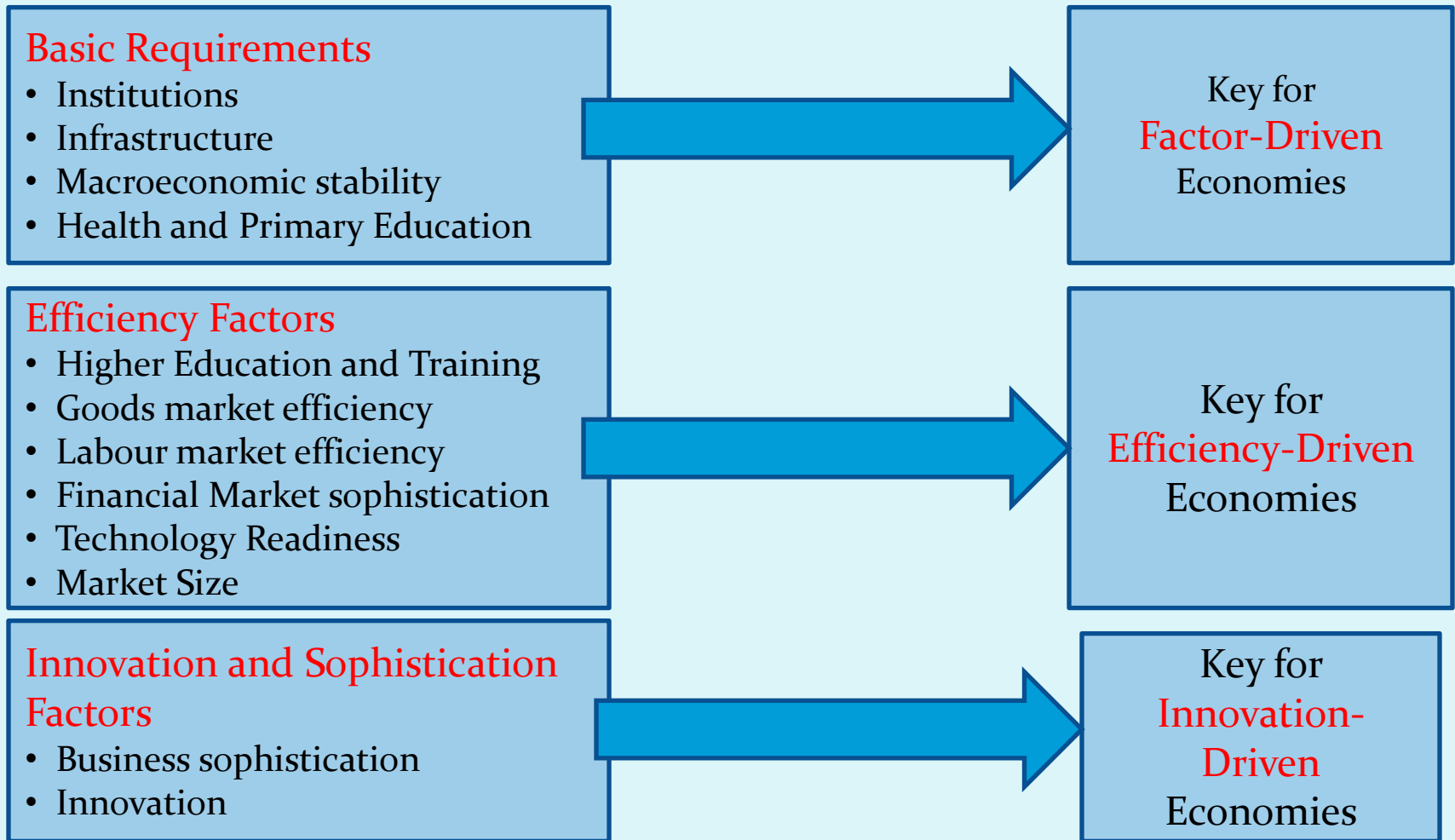
Stages of Industrial and Economic Development



“Feedback is the Food of Champions”

- WEF “Global Competitiveness Index 2011-2012”
 - Survey of 142 countries
 - Analysis of:
 - Basic Essentials
 - Efficiency Enhancers
 - Innovation and Sophistication Factors
 - Countries assessed in terms of:
 - where they are in “The Development Cycle” (3 Stages above)
 - **South Africa, Namibia and Tunisia only countries in Africa assessed to have reached Stage 2 .**

12 Pillars of Competitiveness



Global Competitiveness Index 2011-2012 Rankings

- Tunisia 40 Down 8
- South Africa 50 Up 4
- Mauritius 54 Up 1

From Rankings 95 – 142 : 24 of 48 countries from Africa

- Malaysia 21
- Indonesia 46
- Brazil 53
- India 56

Looking at the Factors more closely

- Rankings for **Basic Elements**

- Tunisia 42
- Mauritius 48
- **South Africa 79** (Low on “Primary Education” 125 , and “Health” – Rank 129)

-
- Malaysia 25
 - Indonesia 53
 - Brazil 83
 - India 91

Looking at the Factors more closely (2)

● Efficiency Enhancers

- South Africa 42
- Tunisia 50
- Mauritius 66

-
- Malaysia 20
 - Indonesia 56
 - India 37
 - Brazil 41

Perceptions why South Africa is 42nd?

- Market Size 24
- Technology Readiness 76
 - Availability of latest technologies 39
 - Firm-level technology absorption 30
 - FDI and technology transfer 41
 - Internet users/Internet bandwidth 102/112
- Higher Education 73
 - Tertiary enrolment 97
 - Quality of educational system 133
 - Quality of Maths and Science 138
 - Local availability of research and training 47

Innovation and Business Sophistication Factors

Ranking

• South Africa	39	(Innovation 41)
• Tunisia	43	(Innovation 37)
• Mauritius	60	(Innovation 89)

• Malaysia	22	(Innovation 24)
• Brazil	35	(Innovation 44)
• India	40	(Innovation 38)
• Indonesia	41	(Innovation 36)

Why is SA's Innovation Ranking at 41?

- Capacity for Innovation 46
- University-Industry Collaboration in R&D 26
- Availability of Scientists and Engineers 111
- Quality of Scientific Research Institutions 30
- Company spending on R&D 36
- Gov't procurement of advanced tech products 103
- Utility patents per million of population 42



Systems of Innovation

Innovation, Innovation System

- Today, successful innovation is considered as the result of a **process of interaction and exchange of knowledge** involving a large diversity of actors in situations of interdependence.
- Recent social network theories of innovation lay emphasis on the **strategic importance of relationships** rather than technical tools, and on knowledge rather than technological networks.
- Knowledge-based innovation requires not one **but many kinds of knowledge**.
- Furthermore, it requires the convergence of many kinds of knowledge retained by different categories of actors. These new criteria require **a new organizational and functional paradigm where the performance of innovators depends on the relations and cooperation between actors in the system**.

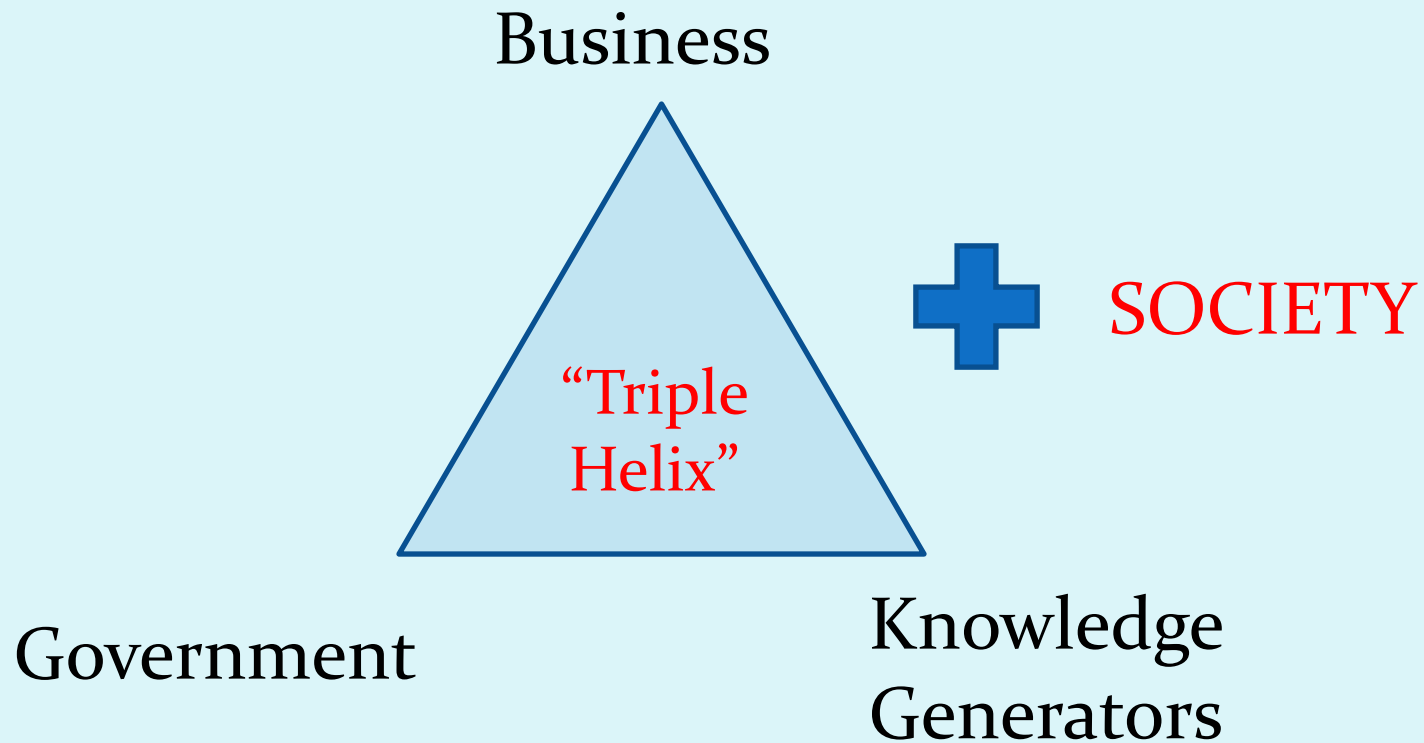
IDRC - Canada

National Systems of innovation

➤ OECD definitions:

- Networked institutions in public and private sectors whose activities and interactions initiate, import, modify & diffuse new technologies. (Freeman, 1987)
- Elements and relationships interacting in production, diffusion and use of new, economically useful, knowledge and are either located within or rooted inside the borders of a nation state. (Lundvall, 1992)
- A set of institutions whose interactions determine the innovative performance of national firms. (Nelson, 1993)
- National institutions, their incentive structures and competencies, that determine the rate and direction of technological learning (or the volume and composition of change generating activities) in a country. (Patel & Pavitt, 1994)
- Set of distinct institutions who jointly & individually contribute to development and diffusion of new technologies and provide frameworks within which governments form and implement policies to influence innovation processes. It is a system of interconnected institutions that create, store & transfer knowledge, skills and artefacts which define new technologies. (Metcalf, 1995)

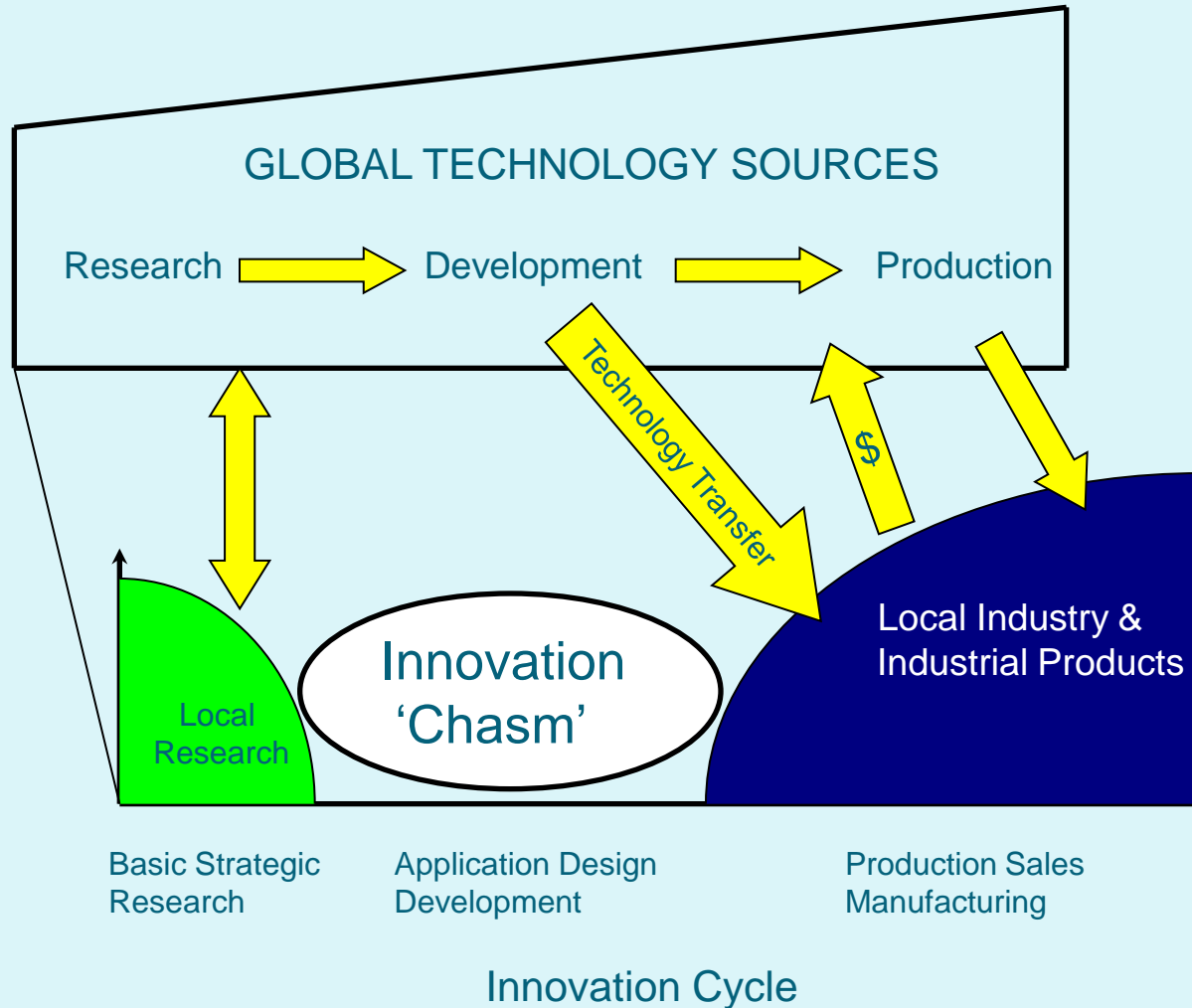
Key “Actors” in an Innovation System



Innovation is a 'cultural' issue

- Overcoming many of the challenges has very little to do with hard science or engineering, more R&D or technology
- We need to discover ways of creating new environments where:
 - The multi-helix and collaborative philosophy is the norm
 - Innovation is an expectation and an objective
 - Business, research and government can all play their appropriate roles together to mutual benefit
 - We can create showcases of knowledge economy development to enhance our image with foreign investors
 - Society sees progress
- Do we have such activities in South Africa?
 - Do we need new leaders to drive

But instead we have defined an 'Innovation Chasm'



Reference: South Africa's National R&D Strategy 2002

The Three Main Levels of a National Innovation System

Macro level

- Defining Innovation Policy
- Setting Regulatory Framework

Meso Level

- Turning Policy into Practice

Micro Level

- Beneficiaries of public innovation support schemes
- Provide Innovations
- Install Innovation Support Organisations and use it

Merging the Different Groups of Interest within a National Innovation System

Policy

- Create jobs
- Good investment of tax money – tax income
- Increased standards of living

- Innovation Programmes
- Innovation Support Institutions

Science

- High, international scientific reputation
- Exploration of new scientific paths
- Low involvement of industry
- International research activities

Industry

- Good framework conditions for innovation
 - Skilled labour
 - Inventive, suitable research centres
 - Finance for investment

Innovation and Entrepreneurship

- Entrepreneurship is the ‘role of continuing on a creative idea’ to become an innovation



Carries the
‘risk-taking perspective’

- Encouraging “Productive Enterprises”
 - Rewards available (and secure) and proportionate to ‘value-contribution’
 - Remove impediments to starting enterprises
 - Reduce monitoring and reporting burden

Courtesy : Ross Emmett

Critique of NSI's

- Pro's
 - Looks for connections between institutions and innovation 'actors'
 - Moves away from the "Strategy of Picking Winners"
 - Does not seek which technologies will succeed.
- Con's
 - Tends to make one think that the NSI is where the innovation should occur
 - **Everything is NOT inside your nation**
 - Users and consumers (society) are not given enough of a role
 - Can tend to focus on incremental innovation
 - NSI looks like a corporate R&D process
 - NSI makes the nation a 'company'.
 - The trend is to optimize the system, rather than creating conditions for innovation

The role and importance of Engineers to facilitate Innovation Processes

Based on the research and conclusions of:

Prof. Martin Bell

SPRU – Science and Technology Research Unit

University of Sussex

2010

Design and Engineering

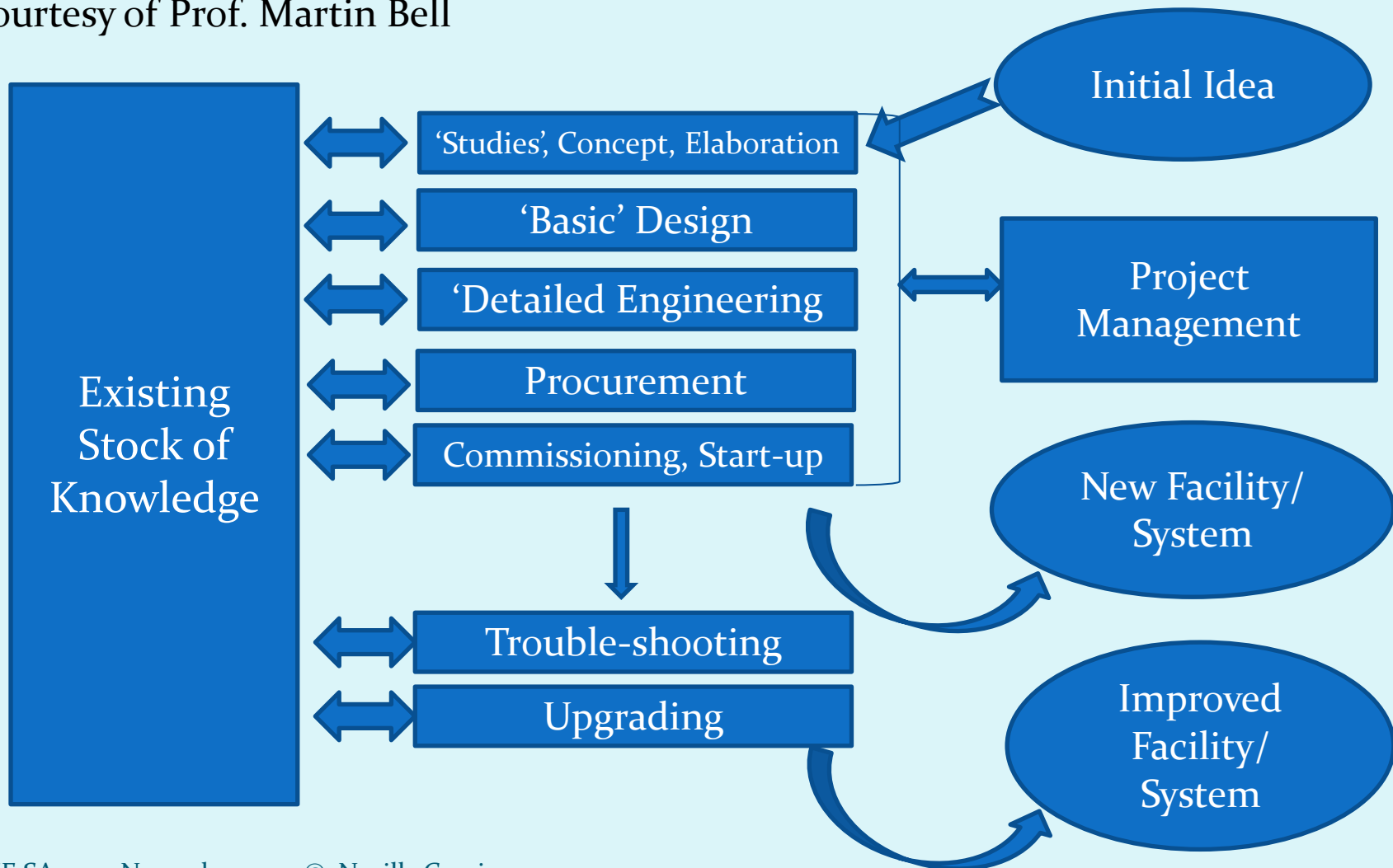
- Design – setting the specifications of:
 - products, processes and production systems.
- Engineering
 - Realisation of the specifications in operational form:
 - Project management and procurement
 - Implementation and system integration
 - Testing
 - Initiation
 - Supervision

Courtesy of Prof Martin Bell

D&E –based Innovation Mode 1

(Incremental)

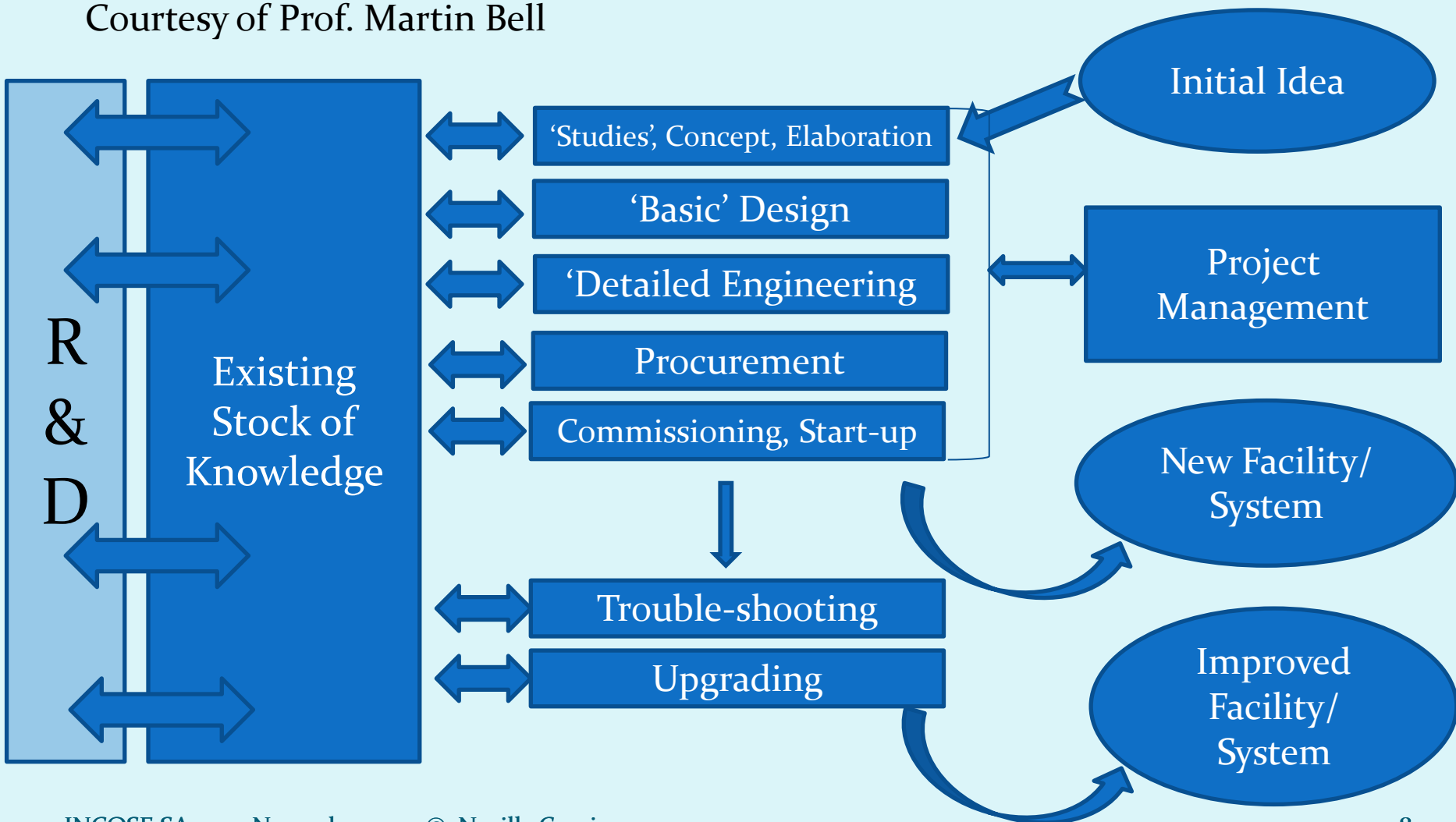
Courtesy of Prof. Martin Bell



D&E –based Innovation Mode 2

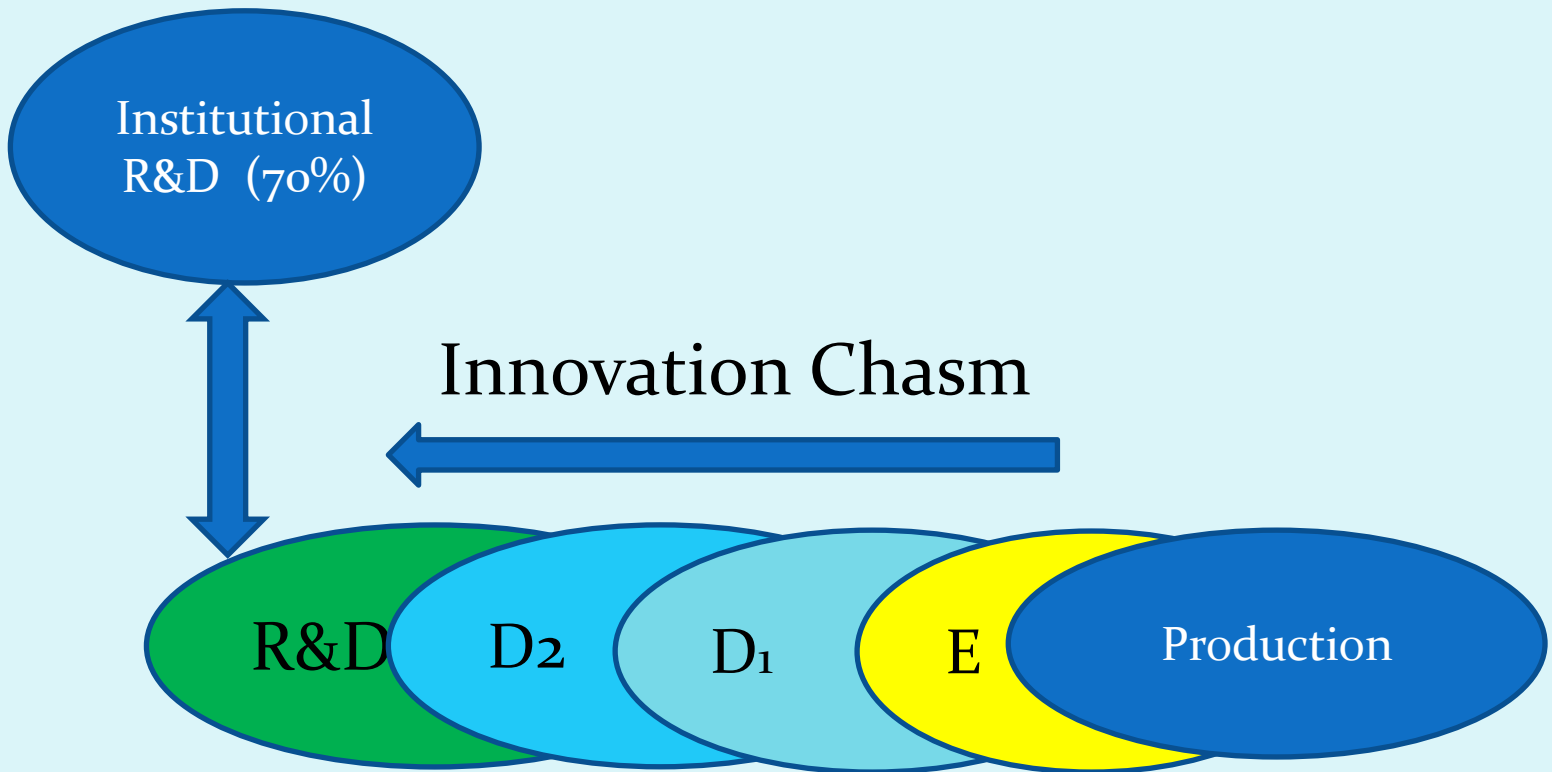
(More complex/novel/radical)

Courtesy of Prof. Martin Bell



D&E in Business mediating the 'Innovation Chasm' in Developing Economies

(Courtesy Prof Martin Bell)

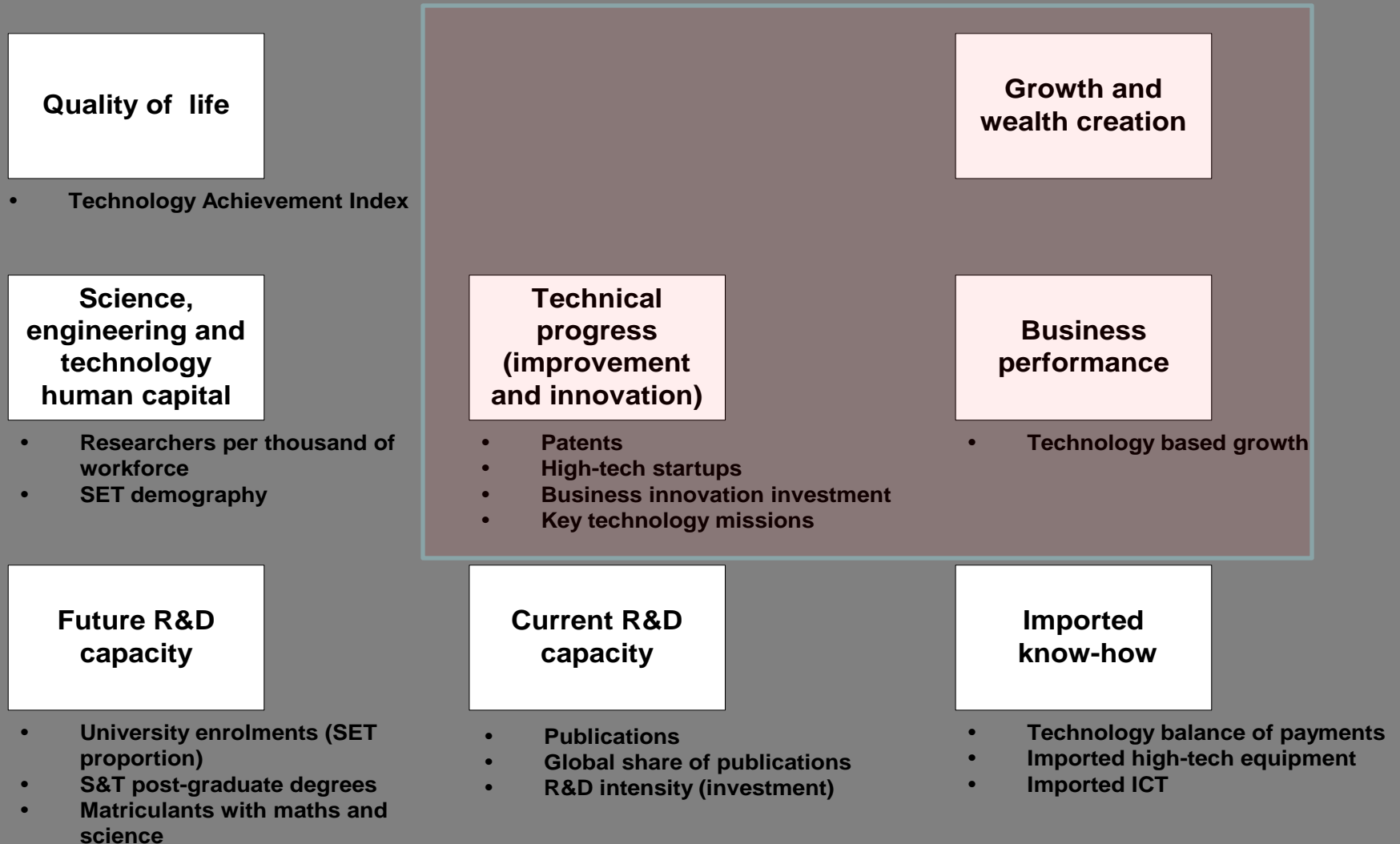


Challenges for the South African National System of Innovation (SANSI)

South Africa's National Approach

- A leader in defining a “National System of Innovation” in policy terms (1996)
- Specific and systematic implementation plans
 - Establishment of NACI and the Innovation Fund
 - System-wide Reviews and setting of new organisational KPIs
 - Addressing the HR and research capacity issues as a priority
- Developing a National R&D Strategy in 2002
- DST's National 10-year Innovation Plan released(2007)
- Creation of the Technology Innovation Agency (2009)

Performance Framework of the SANSI



Reference: South Africa's National R&D Strategy 2002

Challenges in an Emerging Knowledge Economy

- In immature Innovation Systems, the **presence** of the ‘innovation actors’ is often interpreted as sufficient
 - Generally fragmented and largely dysfunctional as an Innovation System
 - Innovation still seen as a linear process where technology push and investment dominates
- Most implementation tools focus on designated funding
 - Leadership of R&D projects dominated by Universities and State Institutions
 - **Involvement of business frequently secondary**
 - Measures and rewards linked to “academic outputs”
 - Trend for Government agencies to take equity in funded projects

National R&I Challenges

- **10 Year Innovation Plan** (Aug 2007 ;p25)

..scientific and technological innovation are crucial to developing a more competitive foothold in the global economy, and to addressing pressing developmental needs. **However, South Africa has yet to effectively mobilise innovation in support of economic growth. This "innovation chasm" is a major weakness in our economy.**

- **20 Year Human Capital Plan** (Nov 2007; p16)

The current paradigm in the South African NSI with respect to knowledge worker training is one that favours the classical academic PhD qualification. **Emphasis is laid on the upstream phases of innovation chain; in research aimed at producing new knowledge. There is little or no attention paid to training in innovation.** The translation of new knowledge into products, processes and services in the economic and social interest is therefore not occurring at the required levels. One of the reasons for this state of affairs is that academic degrees that are offered at South African universities at all levels, but particularly at the PhD level, **are blind to the need for science and engineering with an innovation outcome.** Consequently, the numbers of skilled people in these areas who are able to operate effectively at the downstream phases of the innovation are scarce..

- **OECD 2007**

The innovation chasm between upstream R&D and downstream innovation appears to remain relatively stable at an unsatisfactory level. A range of funding instruments is available to the private sector, although optimal use is not being made of them

Is there Multi-Helix Collaboration?

- Generally we have excellent policies in SA
- **General lack of understanding of “Innovation”**
- National level deficiencies in understanding the workings and benefits of the SANSI and its necessary evolution
 - “Innovation value chains” largely missing
 - Inadequate involvement and leadership by business
 - Fragmentation of effort - **inadequate levels of collaboration**
 - ‘Publish or perish’ not ‘Innovation’ as the measure of public R&D
 - A belief that an ‘Innovation focus’ does not allow cutting-edge R&D
- Insufficiently developed provincial systems of innovation
- Absence of “Neutral facilitators” to bring the parties together

Personal Views on Critical Factors

- Cultivate a correct ‘Innovation Culture’ in the country
- Stimulate ‘Innovation Value Chains’ around the key focus areas and programmes
 - Link the instruments to generate capacity, expertise and networks (local and international)
 - Ensure total engagement and buy-in of the necessary business sectors , government and research community from the outset
 - Establish mechanisms for neutral facilitators to bring the parties together
 - Involve more business expertise
 - Support institutions who can play this independent role (such as Science Parks, as in Finland) .
 - Reward collaboration between business and R&D
 - Measure the outputs as well as the inputs

Thank you

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Enough, or would you like
some examples?