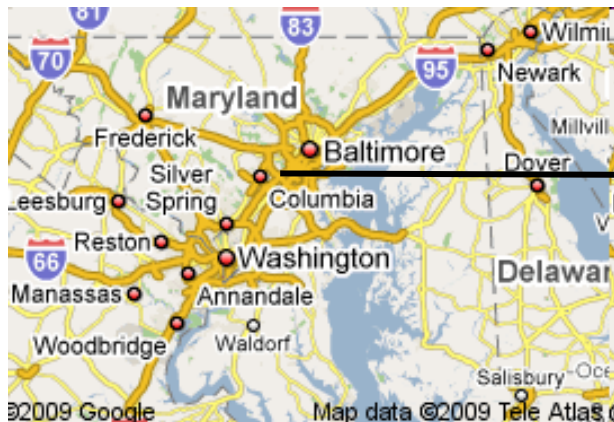


# Future careers for scientists and engineers – a look into the crystal ball

Surya Raghu  
Wits University  
ET Cube International

The Third African Conference of Fundamental and Applied Physics  
Nelson Mandela University, S. Africa  
Sept. 2023



# What I Do Now

## **Wits University, S. Africa:**

Develop new course - PGDip in Innovation and Entrepreneurship –  
Design content, courses and teaching innovation

## **Advanced Fluidics**

Research and Product Development in

1. Aerospace Sciences – Aerodynamics, combustion
2. Medical Instrumentation

## **ET Cube International (non-profit)**

1. Training and Capacity Building in entrepreneurship in developing countries
2. IP, Technology Transfer & Research Commercialization - Consulting and Training
3. Curriculum Development in Entrepreneurship, On-line Research Commercialization Tools

# My journey (from academics) to industry to entrepreneurship

**Fresh Ph.D** (thesis based on experimental work) –

Industry said my work was too “theoretical”!

**10 years academics (experiments):**

**First year in Industry:** Industry said “You seem to be able to **explain** “how things work or don’t work” but we want to **make** them work (with all the constraints)”

First invention – aerodynamically-assisted windshield nozzle spray (**hi-tech!**) – Industry did not want it – *“solution was too complex”*

Second invention – feedback-free fluidic oscillator – *“too simple a solution”!*

Now used in cars > 40 million nozzles/year.



Started Advanced Fluidics – **additional entrepreneurial skill sets needed!**

An eye-opening for me about skill-sets – **not everyone can wait this long!**

# Outline

Career Choices

Upskilling for future careers

What I do: Working on capacity building in developing countries

Summary and Conclusions

# Career Choices

Job or a career??

Passion

Jobs with higher income

More job satisfaction

Control of our career trajectories

Expanding our horizons to the real world

International experience and service

Government Service – Labs, Science Diplomacy, etc.

Setting your price tag

# Upskilling

Innovation and Entrepreneurship

Science Communication

International experience

Sustainability

Science Diplomacy

AI

# Upskilling for Innovation and Entrepreneurship

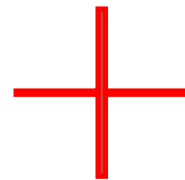
1. The missing gap in innovation skills
2. Interdisciplinary and Transdisciplinary research
3. Transferable skills and entrepreneurial skills, KSAs

# Innovation and Entrepreneurial Skillsets

Academic

Innovation

Entrepreneurship



Start-ups,  
Industry,  
Market/  
Govt.  
orgs.

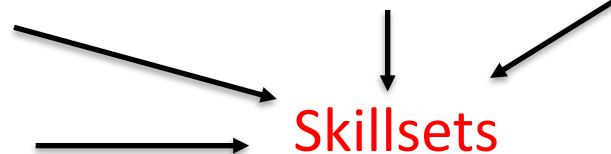
Value  
creation

Taking to  
market

Transferable

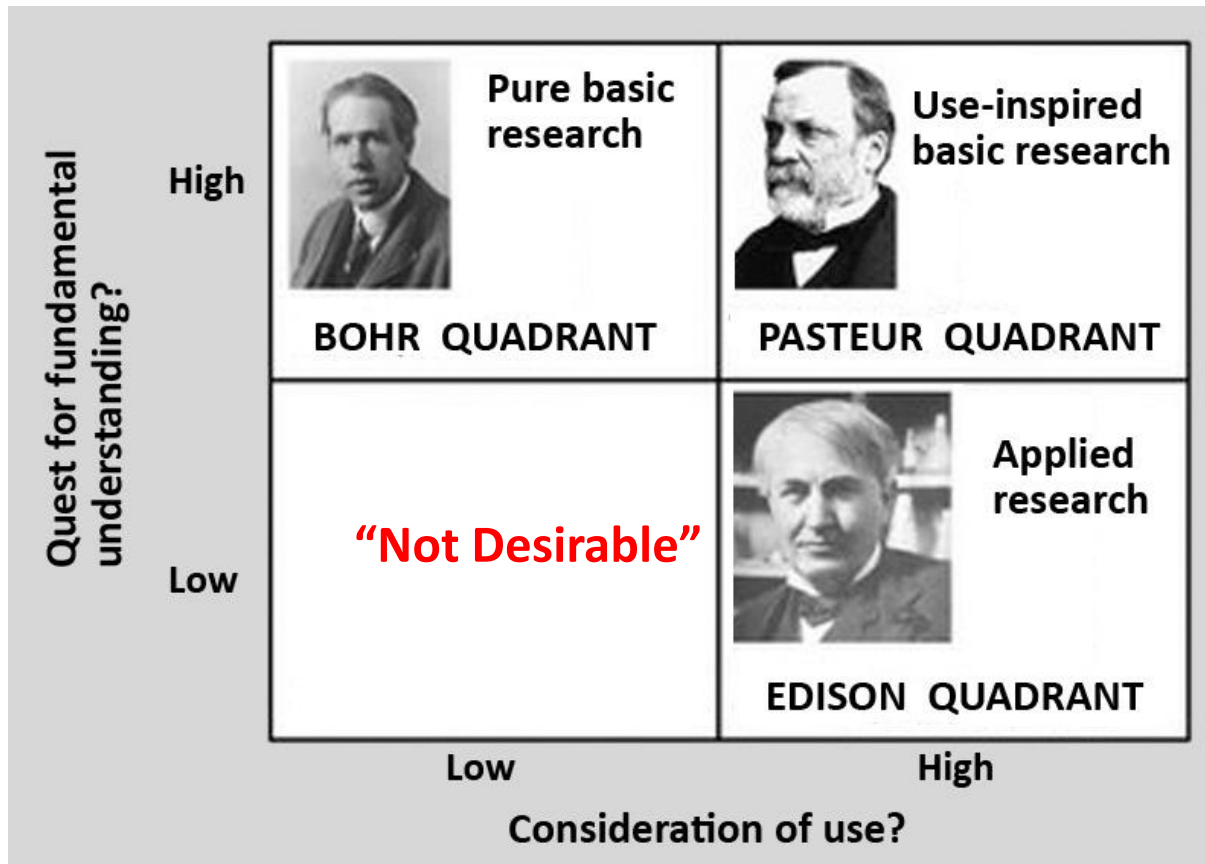
Skillsets

Interdisciplinary/  
Transdisciplinary work?





# What Type of Research?



No contradiction between basic research and use-inspired research

Donald Stokes - Pasteur's Quadrant: Basic Science and Technological Innovation

# Skillset #1: Interdisciplinary and Transdisciplinary Research

**Interdisciplinary:** integrating knowledge and methods from different disciplines, using a real synthesis of approaches - *“What can we do together?” (science, engineering, health sciences, mathematics....)*

**Transdisciplinary:** creating a unity of intellectual frameworks beyond the disciplinary perspectives: (Abstraction and generalization)  
*(seeing commonness from various fields – brings different perspectives to the same problem)*

# Skillset #2: Innovation

Hardest thing to teach and learn.....

It is team work

More often interdisciplinary

(Will come back to this later...)

# Skillset #3: Entrepreneurial Skills

Not always about creating a start-up/organization

Changing job market: Ability to produce outcomes

Being creative, opportunity oriented, proactive and innovative

Pursue opportunities without regard to the resources you currently control (and be able to identify resources that can make it work for you)

# Skillset #4: Transferable Skills

Transferable Skills: Skills learned in one context being applied in another context

Play an important role in researcher's diverse career paths

Very important for international, interdisciplinary and “gig” work

# Skillset #4 Transferable Skills

<b>Interpersonal Skills</b>	
<b>Organizational Skills</b>	
<b>Research Competencies</b>	
<b>Cognitive abilities</b>	
<b>Communication Skills</b>	
<b>Enterprise Skills</b>	

(OECD Report)

# Knowledge, Skills and Abilities (KSAs)

**Knowledge:** Organized body of information usually of a factual or procedural nature which, if applied, makes adequate performance on the job possible. Examples: interdisciplinary/transdisciplinary approach, entrepreneurship  
(Acquired through learning or experience)

**Skill:** Proficiency in manual, verbal or mental manipulation of data or things. Examples: Programming, laboratory and fabrication  
(Practiced or learned behavior – transferable skills)

**Ability:** Evidence through activities or behaviors that are similar to those required on the job, e.g., ability to plan and organize work.  
(Natural or in-built or acquired through job/volunteering)

# The different hats to wear

Scientist	Innovator	Entrepreneur
Need complete data to make decisions	Extrapolation	Incomplete data sets for decisions
Perfection*	Realistic	Good enough*
Publish	Create value/publish?	Create value
Individual/group hierarchy	Bold	Leadership and teamwork
“failure is fatal”?	Not risk-averse	Failure is an “honor badge”



# Upskilling (contd.)

Innovation and Entrepreneurship ✓

Science Communication – Writing and oral skills

International experience – Working in a Lab, networking

Sustainability – Relation between science and sustainability

Science Diplomacy – Science as a tool for diplomacy

Science Policy Advise - Science, public interest and economic development

Artificial Intelligence

# My activity: Capacity Building in Developing Countries

Innovation, Entrepreneurship and Research  
Commercialization Skills, Sustainability and SDG

# Institutions Involved

IEEE Entrepreneurship

International Centre for Theoretical Physics (ICTP), Trieste, Italy

TWAS, Trieste, Italy

Institute of Physics (UK), American Physical Society

UNESCO, UN-ITU, UN-MGICY, G-STIC/Vito, WIPO

UN Economic and Social Commission for Western Asia (ESCWA)  
and MENA countries

British Council

US State Department and USAID

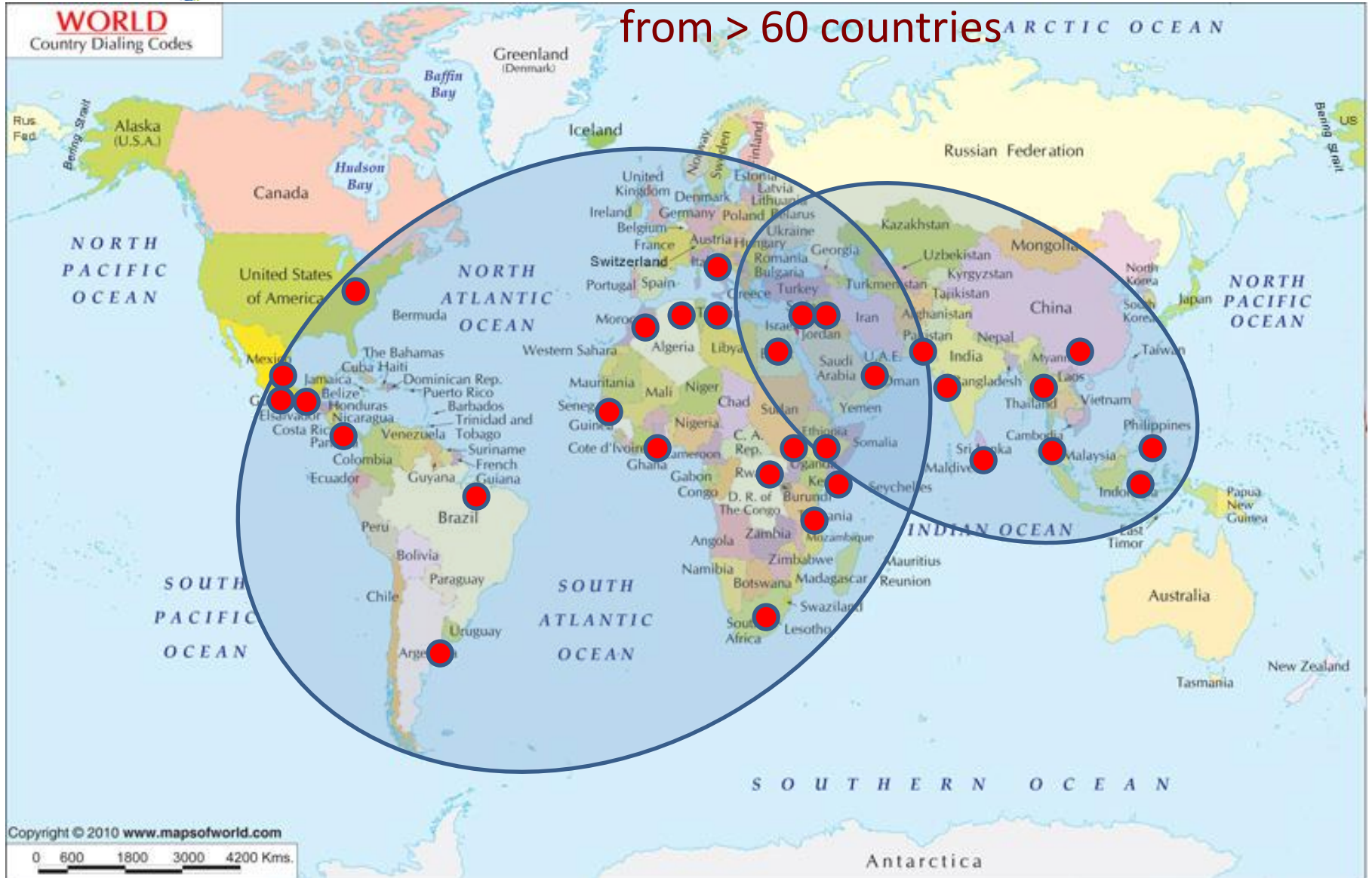
Optical Society of America (OPTICA)

Wits University (S. Africa)



Brazil 2016

~ 60 Workshops since 2006 – 1500 participants  
from > 60 countries



# Why train scientists and engineers?

Technology entrepreneurship - technical solutions for market/societal needs/SDG - highest impact achieved when students with STEM background are trained

Problem of unemployment for highly skilled scientists and engineers and “brain drain” from developing countries

Emphasis on IP as a basis for knowledge economy – develop translatable and transferable skills

Increased chance of acceptance (buy-ins) of locally created solutions

# PGDip in Innovation

We are just starting (January 2024) a new PGDip in Innovation at Wits University

Pathway to innovation for your Ph.D. thesis

Terminal degree to help with innovation and entrepreneurial skills

For more info: see

<https://www.wits.ac.za/course-finder/postgraduate/science/pgdip-innovation-and-entrepreneurship/>

# Summary

Alternate careers from academics are possible – you can design your trajectory

Translating academic skills to other professions

Invest in your career and create a brand for yourself

Giving back to community

**THANK YOU  
and  
GOODLUCK!**



## **Future careers for scientists and engineers – a look into the crystal ball**

Surya Raghu

Wits University (S. Africa)

and ET Cube International (USA)

Linear career paths for scientists and engineers are less likely in the future – and a career could be what one makes for her/himself. For careers outside academia, particularly getting into industry and entrepreneurial endeavors, additional skill sets are needed beyond one's academic degrees. In order to prepare for such a scenario, skills to translate, transform or extend knowledge from one field or application to another would be very much needed. Innovation and entrepreneurial skills provide a pathway for commercialization of our own creative ideas and inventions through start-ups thus transforming oneself from an employment seeker to an employment creator. In this presentation, we will discuss the needs of the above skills in detail, avenues and opportunities to acquire such skills and also briefly mention about our work on capacity building in such skills in many developing countries.

# Maintaining Academic Contacts

Possibility of continued academic collaborations

Joint proposals – funding agencies love that!

You may return as guest lecturer

Going back to full-time academics is realistically hard!

# Still passionate about teaching...

Changing educational systems provide new opportunities

Private sector jobs with translatable skills

If you love teaching – be prepared to teach a different type of “students”

Govt. service – USAID, State Department, contractors for these agencies for international jobs.

# A program for upskilling?

- **Interdisciplinary and Transdisciplinary interactions**  
Thesis topics encouraged/mandated by such guidelines?
- **Connection to industry, community and society**  
Thesis/projects connected to this (Pasteur's quadrant!)
- **Innovation**  
Projects should present evidence of innovation/risk taking
- **Transferable skills**  
Formal training and practice
- **Entrepreneurship**  
Formal and practical training

# Content: Innovation/Entrepreneurial Skills

1. Scientists and Engineers as Entrepreneurs
2. Innovation, Design Thinking and creating value to customers
3. Opportunity Assessment
4. Intellectual Property Basics
5. Invention to Product: Timelines and Processes
6. Financial aspects of running a small business
7. Marketing and Sales
8. Soft skills and networking for business
9. Business Model and Business Plan Fundamentals
10. Local Ecosystem information



# Impact of Research beyond Academia

Impact is the effect research has beyond academia and consists of “.....benefits to one or more areas of the economy, society, culture, public policy and services, health, production, environment, international development or quality of life, whether locally, regionally, nationally or internationally”

and as “....manifested in a wide variety of ways including, but not limited to: the many types of beneficiary (individuals, organizations, communities, regions and other entities); impacts on products, processes, behaviors, policies, practices; and avoidance of harm or the waste of resources.”

*(UK 2014 Research Excellence Framework)*

# About Myself..

Ph.D. (Yale University)

Post-Doc: Yale

Alexander Humboldt Fellowship (Berlin, Germany)

Academics – State University of New York, Stony Brook

Industrial Scientist – Automotive and Consumer Products

6 Products: Invention to commercialization

Entrepreneur: Started Advanced Fluidics in 2001

Non-profit: ET Cube International in 2013

# Success Stories

Examples:

Brazil - Brewery - Rodrigo Marques

Indonesia - Acoustics Lab - Iwan Yahya

South Africa – Pharmacology and Nanotechnology (Patents) Yahya Choorna and Maalik Maaza groups

Senegal – Energy storage Baal Diop Ngom

Cuba/Netherlands – needle-less injections - David Fernandes

Cameroon – nanosatellites – Ifriki Tadadjeu

Philippines – Technology Transfer – Jinky Bornales