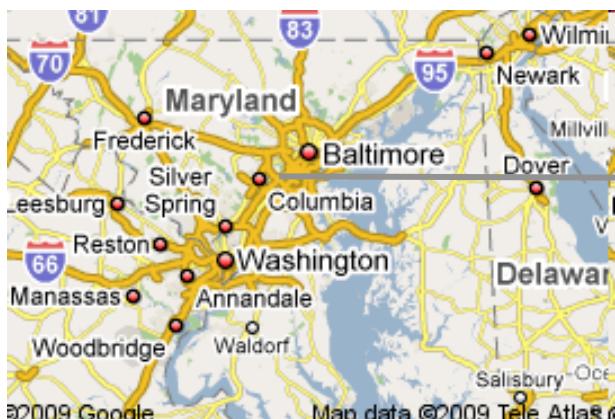


Entrepreneurship and Technology Transfer (Taking Inventions to Market)

Surya Raghu

2nd Arab-American Frontiers Symposium
Muscat, Oman
Dec. 13-15, 2014



About Me

Ph.D. Mechanical Engineering

Academics – State University of New York, Stony Brook

Industrial Scientist – Automotive and Consumer Products

~ 20 inventions, 12 Patents, 6 Products from Invention to commercialization

Entrepreneur: Started Advanced Fluidics (Small Company) in 2001

About ET Cube International and Advanced Fluidics

ET Cube International: Entrepreneurship, IP, Tech. Transfer Training and Capacity Building in Developing Countries

Argentina, Ethiopia, Ghana, India, Indonesia, Italy, Jordan, Kenya, Lebanon, Mexico, Morocco, Pakistan, Philippines, South Africa....

Advanced Fluidics LLC

Research and Product Development in

1. Aerospace Sciences – Aerodynamics, combustion
2. Micro/Nanofluidics/nanotech-based biosensors
3. Electrochemical Sensors (corrosion sensors)
4. Medical Instrumentation
5. Technology Roadmap Development and Training

Work with Universities, Small Companies, Big Companies and Govt. Research Labs.

OUTLINE

Discussions of the questionnaire:

- 1. What kind of research to take up?**
- 2. Ideas, Inventions and IP**
- 3. Technology Development and TRLs**
- 4. Timelines for Product Development**
- 5. Example of Invention to Product**
- 6. Pitfalls to commercialization**
- 7. Conclusions**

University - The Intellectual Capital

University is the richest source of ideas!



SQU

Potential to have a great multiplier effect in innovation and entrepreneurial spirit



Sultan Qaboos University

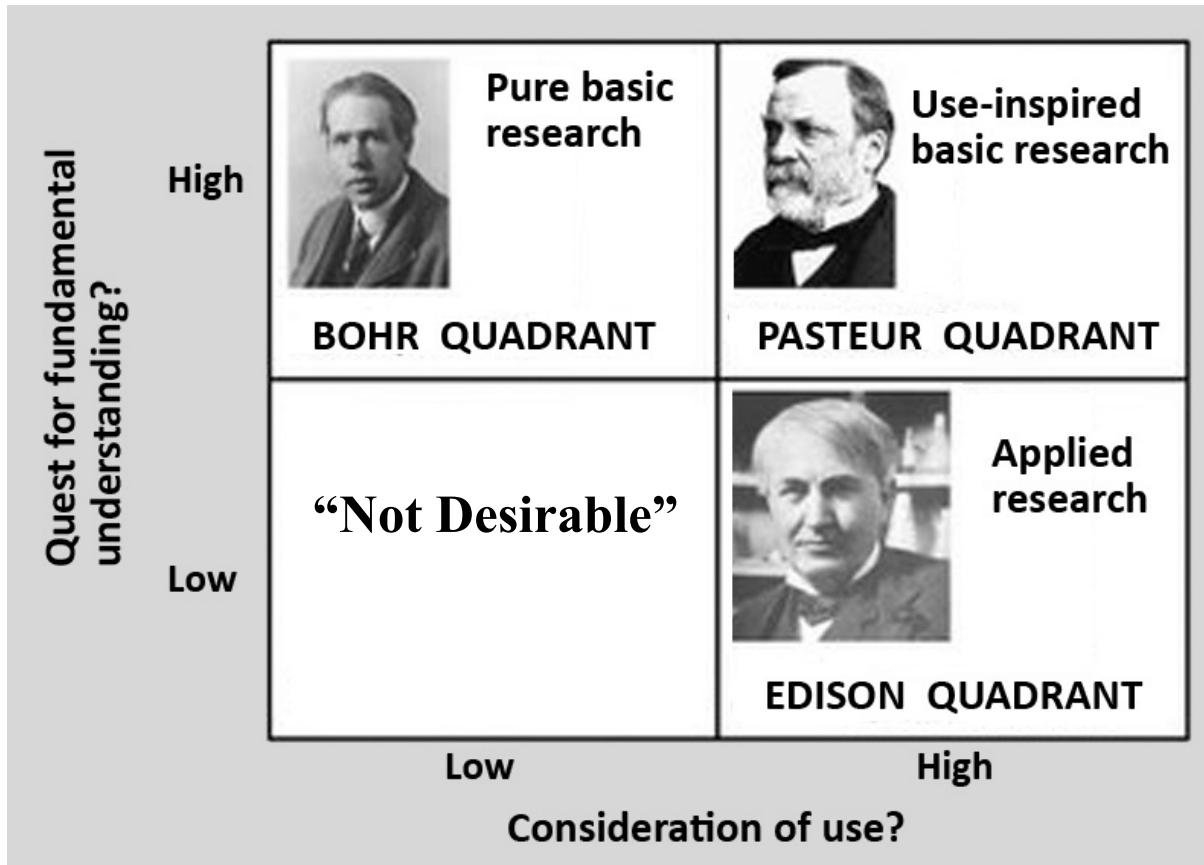


U.Nizwa



Sohar U.

1. What Type of Research?



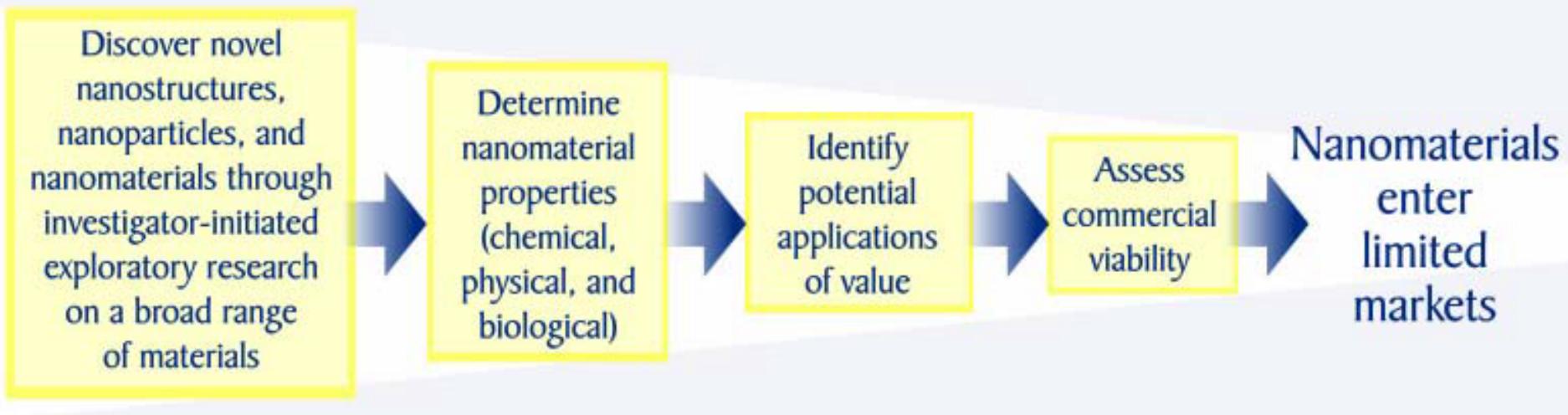
Donald Stokes - Pasteur's Quadrant: Basic Science and Technological Innovation

“Lots of Research but for What Purpose?”

THE AIM OF EDUCATION AND RESEARCH IS NOT SIMPLY THE GENERATION OF RESULTS FOR THEIR OWN SAKES BUT, IN ENGINEERING IN PARTICULAR, THEY ARE SUPPOSED TO FULFILL SOME SIGNIFICANT PURPOSE.

Mechanical Engineering, Sept. 2013)

The Tradition – Basic Research



Ref.: Chemical Industry Vision 2020
Technology Partnership Energetics, Incorporated, 2003

The New Model

FUTURE: Application-Based Problem Solving



Ref.: Chemical Industry Vision2020
Technology Partnership Energetics, Incorporated, 2003

2. Technology Transfer and IP Office??



Benefits of Tech Transfer

New products and services for **public good**

Employment generation in hi-tech industry

Growth & Sustainability of regional economies

Replace poverty with prosperity

3. IP Policies in your Institutions

Invention Disclosures

Who owns the IP

Rewards/Recognitions for Patents

Share of income on patents through royalties/sale of invention

4. Intellectual Property Training

5. Can your Idea be Patented?

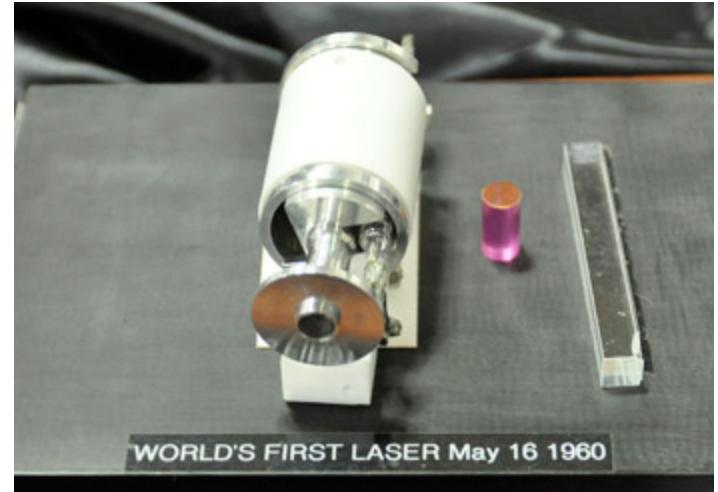
What are you inventing?

New Technology? (Method and Apparatus or Process)

“Technology is a capability that can be used in a product.”

Example: Laser – Ted Maiman (1960)

“a solution looking for a problem?”



(<http://spie.org/x39920.xml>)

OR A New Product? (Apparatus)

“makes use of existing or new technologies”

Optical readers, scanners, laser pointer, laser-based eye surgery systems, golf trainer, laser machining,

A new product has a customer and a market in mind



**Laser
Cutting & Engraving**



Publications vs. Patents

Publications

Academics – publications are recognized as a product of scholarly academic activity and the author is recognized in his field of specialization. Recognition such as fellowships and prizes, distinguished lectures and invited speeches in Professional organizations.

Recognition in only the academic community for your number of papers.

Quality of papers also count.

Publications vs. Patents

Patents

Patents are more valuable and encouraged in industry.

Patents are recognized by their *value* to a *product*.

Inventor *may or may not* be recognized publicly.

The inventor is recognized in a different way – plaques, promotions and monetary benefits.

Inventor is, in general, recognized by the impact it has on a product – not the number of patents.

6. Who Will Be The Potential User/Customer Of Your Idea?

Looking for ideas

- **Technology Road Maps**
- **Technology Mind Maps**
- **Technology Intersect Maps**
- **Looking through a crystal ball?**

Technology Roadmaps

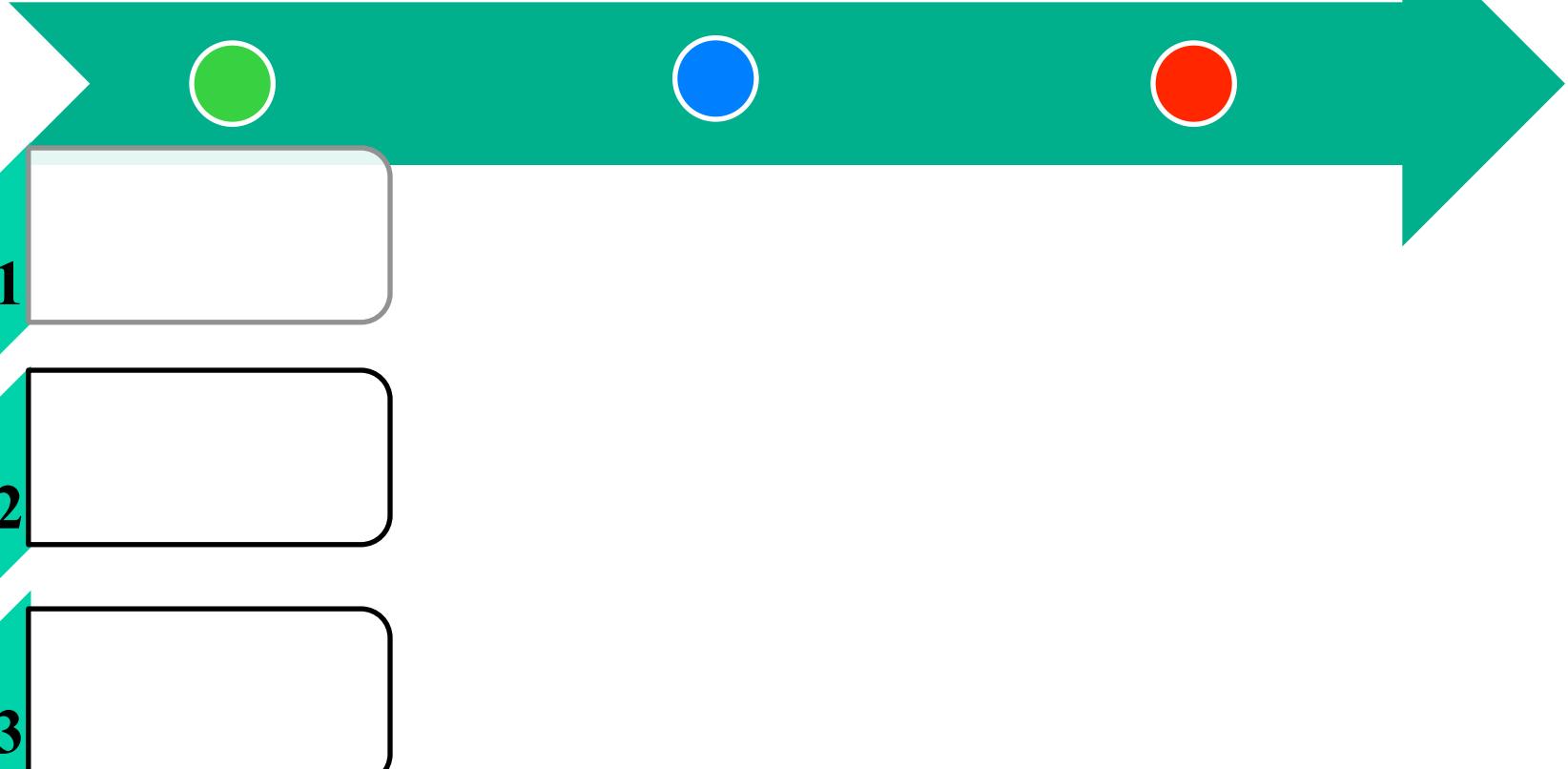
Developed to show us opportunity for inventions and products based on market evolution

Technology Road Map

Near-Term

Mid-Term

Long-Term



Technology Road Map

<http://www.climatetechnology.gov/library/2006/testimony20sep2006.htm>

Near-Term

Mid-Term

Long-Term

Energy End
Use and
Infrastructure

- Hybrid Vehicles
- Plug-ins
- Hi-Performance integrated homes
- High-efficiency appliances
- High-efficiency boilers and combustion systems
- High-temperature superconductivity demonstrations

- Fuel cell vehicles and hydrogen fuels
- Low emission aircraft
- Solid-State lighting
- Ultra-efficient HVACR
- Smart buildings
- Transformational technologies for energy-intensive industries
- Energy storage for load leveling

- Widespread use of engineered urban design and regional planning
- Energy managed communities
- Integration of industrial heat, power, process and techniques
- Superconducting transmission and equipment

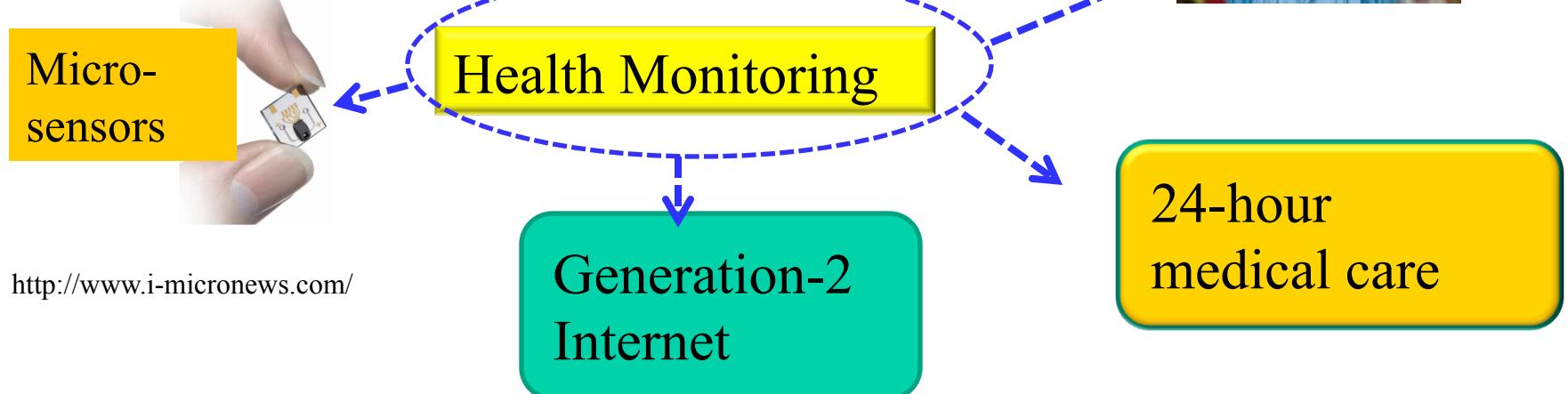
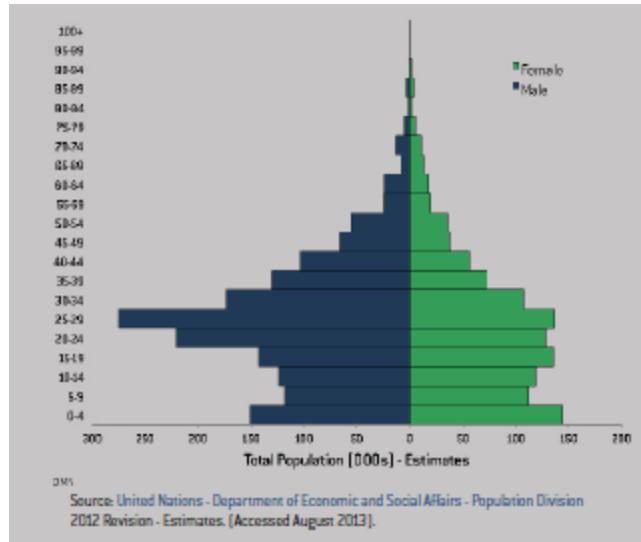
Connecting the Dots

Points to consider for forecasting

- Observing/Studying Trends
- Economic factors
- Societal factors
- Technological Advances
- Political Action/Regulatory statutes



Technology Forecasting



<http://www.i-micronews.com/>

Market for your Ideas and Inventions

7. Have You Estimated The Potential Market Size (# Of Customers) For Your Idea Or Product?

Yes No

8. Are There Competing Technologies In The Market?

9. If So, What Is The Advantage Of Your Idea/Invention Over The Competition?

From an Idea to a Successful Product

An idea is not an invention

An invention is not a product

Not done before $\not\equiv$ Necessarily useful invention!

Innovation

Useful Invention \rightarrow \$ucce\$\$ful Product *only* if marketed well

10. Stage of Your Research Project

Technology Readiness Level

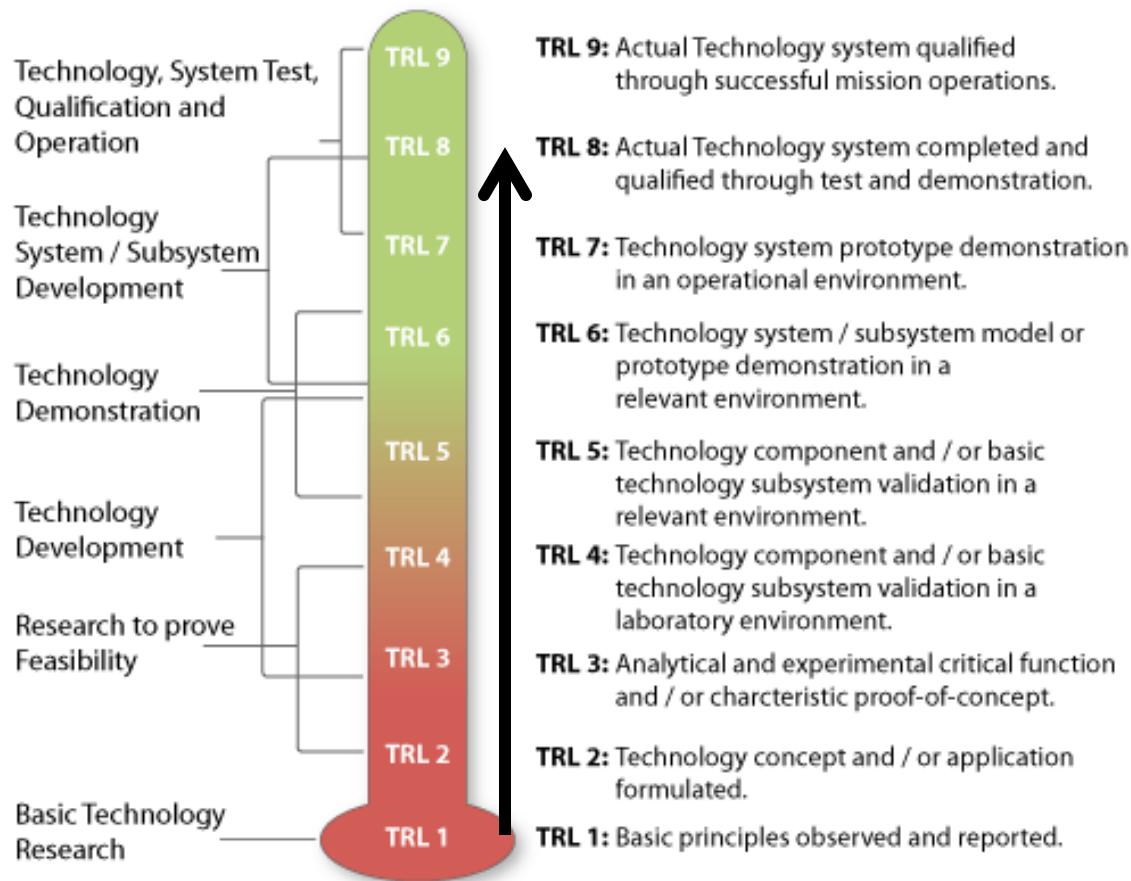
Technology Development and Technology Readiness Levels (TRL)

TRL Table: Developed by NASA and commonly used in the US (and more recently in Europe) for technology development programs to measure the maturity of a technology. **Also important in the valuation of the product/company.**

9 Stages of Technology Readiness Levels – TRL 1-9

(Ref: John C. Mankins (1995), <http://www.hq.nasa.gov/office/codeq/trl/trl.pdf>)

Technology Readiness Levels (TRL)



TTO can use this TRL concept to evaluate the stage of invention in the Institution for both internal evaluation and external marketing - Technology Push by the institution.

http://www.aof.mod.uk/aofcontent/tactical/techman/content/trl_applying.htm

11. TIME-LINE

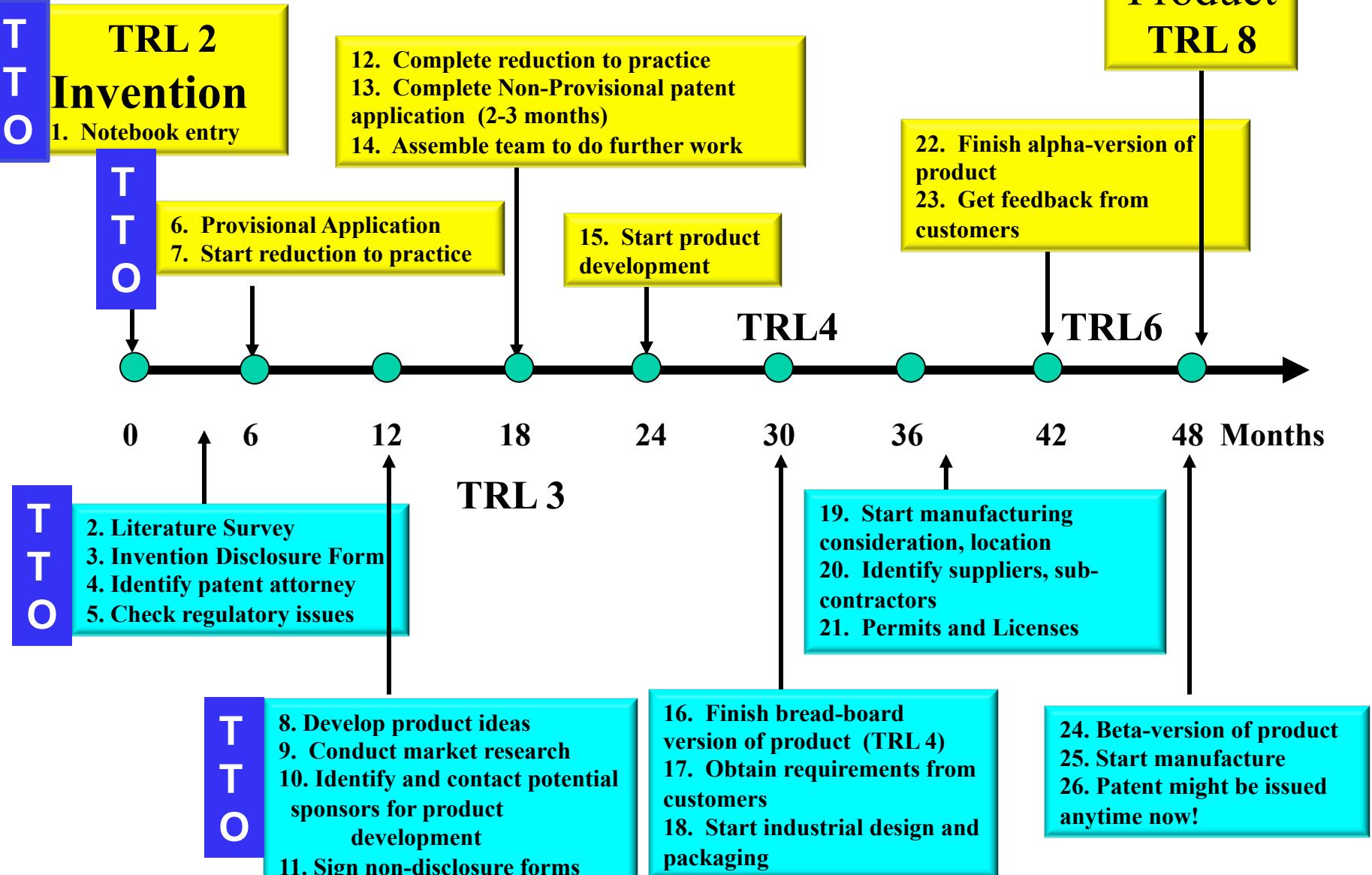
How long does it take to get from
TRL1 to TRL9?
(what is your estimate?)

12. Idea to Market

Various aspects of taking an invention to a product

1. Technology Development
2. Securing Intellectual Property
3. Manufacturing Process
4. Company aspects – Legal, Financial and HR
5. Business Development

Invention to Product: Steps and Time-Line



Examples of Timelines for Products

Example: Windshield washer nozzles based on hydrodynamic instabilities (Market pull)



Example 1. Windshield washer nozzles based on hydrodynamic instabilities

Inventor: Surya Raghu, USA

Invention process: August-October 1998

US Provisional application: October 1998

Non-Provisional Application: October 1999

Patent issued: July 2001 (US, Europe, Japan, Brazil, Mexico, India, China, S. Korea, etc.)

Development:

Currently an automotive product in use from 2001

- 40 million nozzles/year
- Used in GM, Ford, Chrysler, Volkswagen, Mercedes, Saab, Jaguar, Toyota, Honda and Subaru



Invention to Product Time-Line

Windshield Washer Nozzle

Invention

1. Notebook entry

12. Complete reduction to practice
 13. Complete Non-Provisional patent application (2-3 months)
 14. Assemble team to do further work

6. Provisional Application
 7. Start reduction to practice

15. Start product development

July 1998

Oct.

Oct 1999

Nov. 1999

Aug 2000

July 2001

2. Literature Survey
 3. Invention Disclosure Form
 4. Identify patent attorney
 5. Check regulatory issues

8. Develop product ideas
 9. Conduct market research
 10. Identify and contact potential sponsors for product development
 11. Sign non-disclosure forms

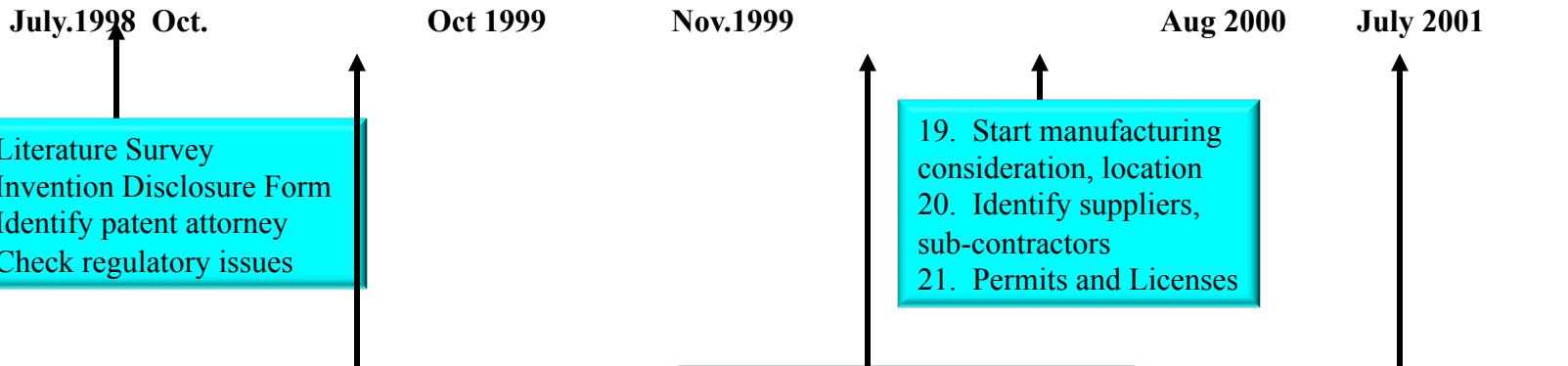
16. Finish bread-board version of product (TRL 4)
 17. Obtain requirements from customers
 18. Start industrial design and packaging

24. Beta-version of product
 25. Start manufacture
 26. Patent might be issued anytime now!

Product

TRL 8

22. Finish alpha-version of product
 22. Get feedback from customers



The Issued Patent



US006253782B1

(12) **United States Patent**
Raghu

(10) **Patent No.:** US 6,253,782 B1
(45) **Date of Patent:** Jul. 3, 2001

(54) **FEEDBACK-FREE FLUIDIC OSCILLATOR
AND METHOD**

(75) **Inventor:** Surya Raghu, Ellicott City, MD (US)

(73) **Assignee:** Bowles Fluidics Corporation,
Columbia, MD (US)

(*) **Notice:** Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

(21) **Appl. No.:** 09/417,899

(22) **Filed:** Oct. 14, 1999

Related U.S. Application Data

(60) Provisional application No. 60/104,511, filed on Oct. 16,
1998.

(51) **Int. Cl.7** F15C 1/06

(52) **U.S. Cl.** 137/14; 137/809; 137/810;
137/811; 137/813; 137/826; 137/833; 137/835

(58) **Field of Search** 137/826, 833,
137/835, 808, 809, 810, 811, 812, 813,
14

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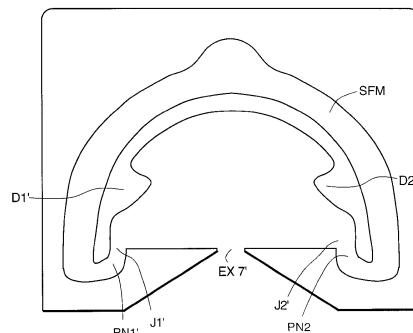
Primary Examiner—A. Michael Chambers

(74) **Attorney, Agent, or Firm:** Jim Zegeer

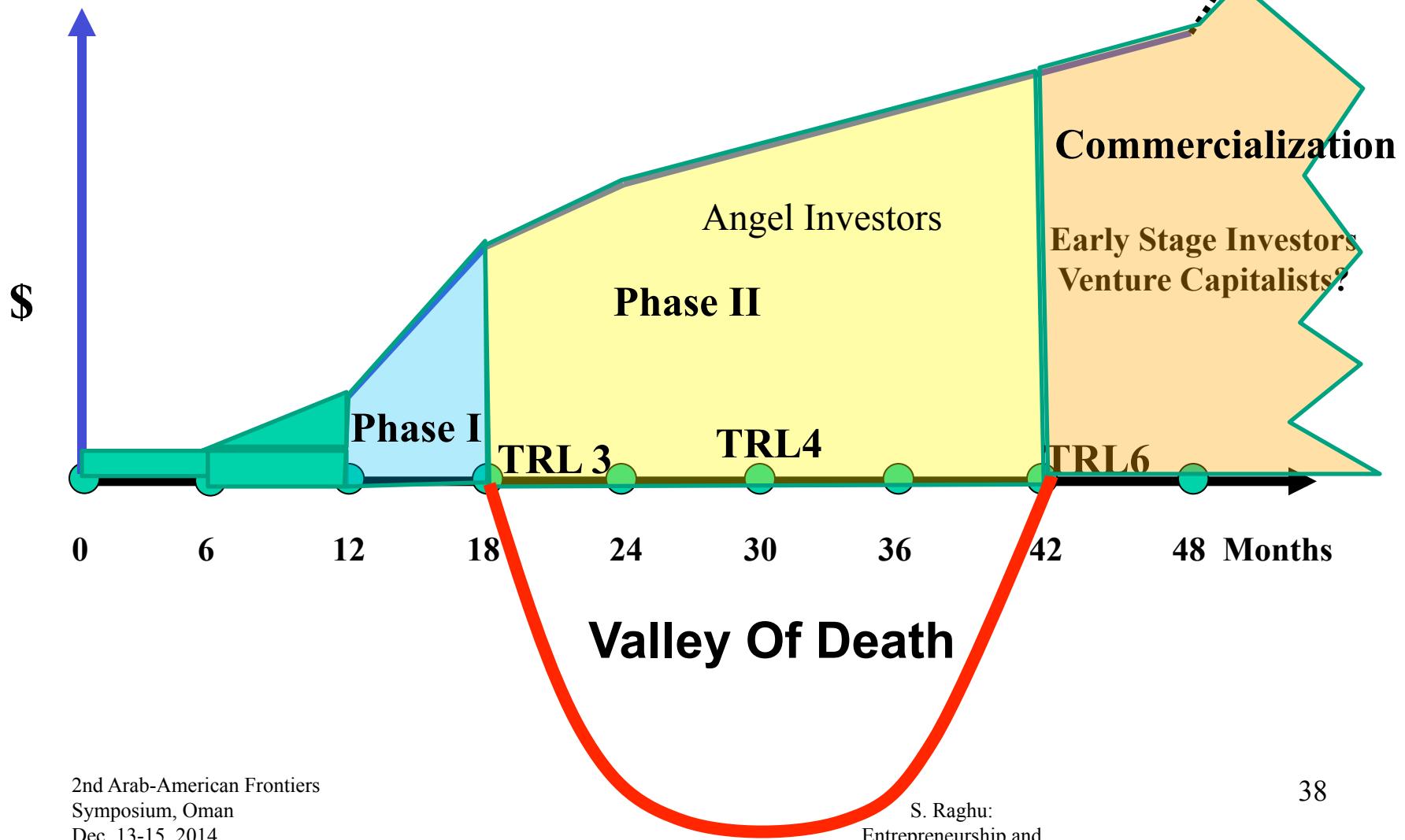
(57) ABSTRACT

A fluidic oscillator includes a member having an oscillation inducing chamber, at least one source of fluid under pressure, at least a pair of power nozzles connected to the at least one source of fluid under pressure for projecting at least a pair of fluid jets into the oscillation chamber, and at least one outlet from the oscillation chamber for issuing a pulsating or oscillating jet of fluid to a point of utilization or ambient. A common fluid manifold connected to said at least a pair of power nozzles. The shape of the power nozzle manifold forms one of the walls of the interaction or oscillation chamber. In some of the fluidic circuits, the length can be matched to fit existing housings. The power nozzle can have offsets which produce yaw angles in a liquid spray fan angle to the left or right depending on the direction desired. In some embodiments, the exit throat is off axis (off the central axis of the symmetry) by a small fraction to the left or right to move the leftward or rightward yaw angles in the spray. The outlet throat may be offset along the longitudinal axis by a small amount to produce a yaw angle of predetermined degree to the left or right depending on what is desired. Thus, one can construct circuits for yaw using a combination of the techniques described above which suits most applications.

25 Claims, 15 Drawing Sheets



Cost of Taking the Product to Market



12. Do You Have Plans To Take The Idea To Market?

Entrepreneurship is a career option

Inventor as an entrepreneur

Alternate career for Masters and Ph.Ds
(Large percentage of those employed in science are in Universities)

Faculty on sabbatical/leave of absence

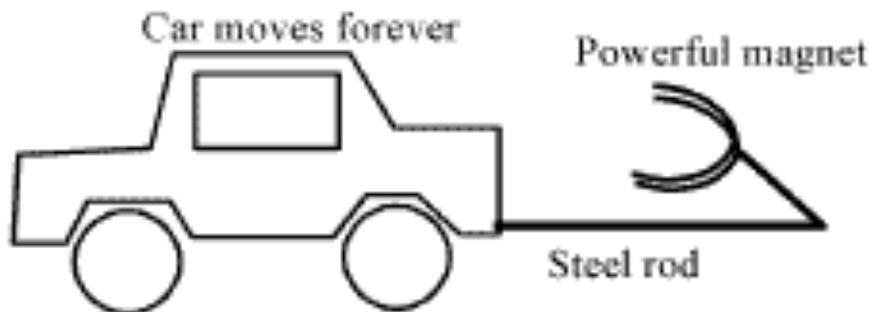
“PITFALLS IN COMMERCIALIZATION”

1. Reinventing the wheel

“PITFALLS IN COMMERCIALIZATION”

2. Ideas that did not work in reality – not really an invention
 - Do not stand the test of science!

Example: Perpetual Motion Machines



<http://ωωω.ληυπ.εδυ/~δσιμανεκ/μυσευμ/πατεντο.ητυ>

“PITFALLS IN COMMERCIALIZATION”

3. Ideas worked and *even patented* but limited or no applications (no products)



“PITFALLS IN COMMERCIALIZATION”

4. Found applications but products not successful in market
too expensive, too complicated, too big, too small, “crazy” ...

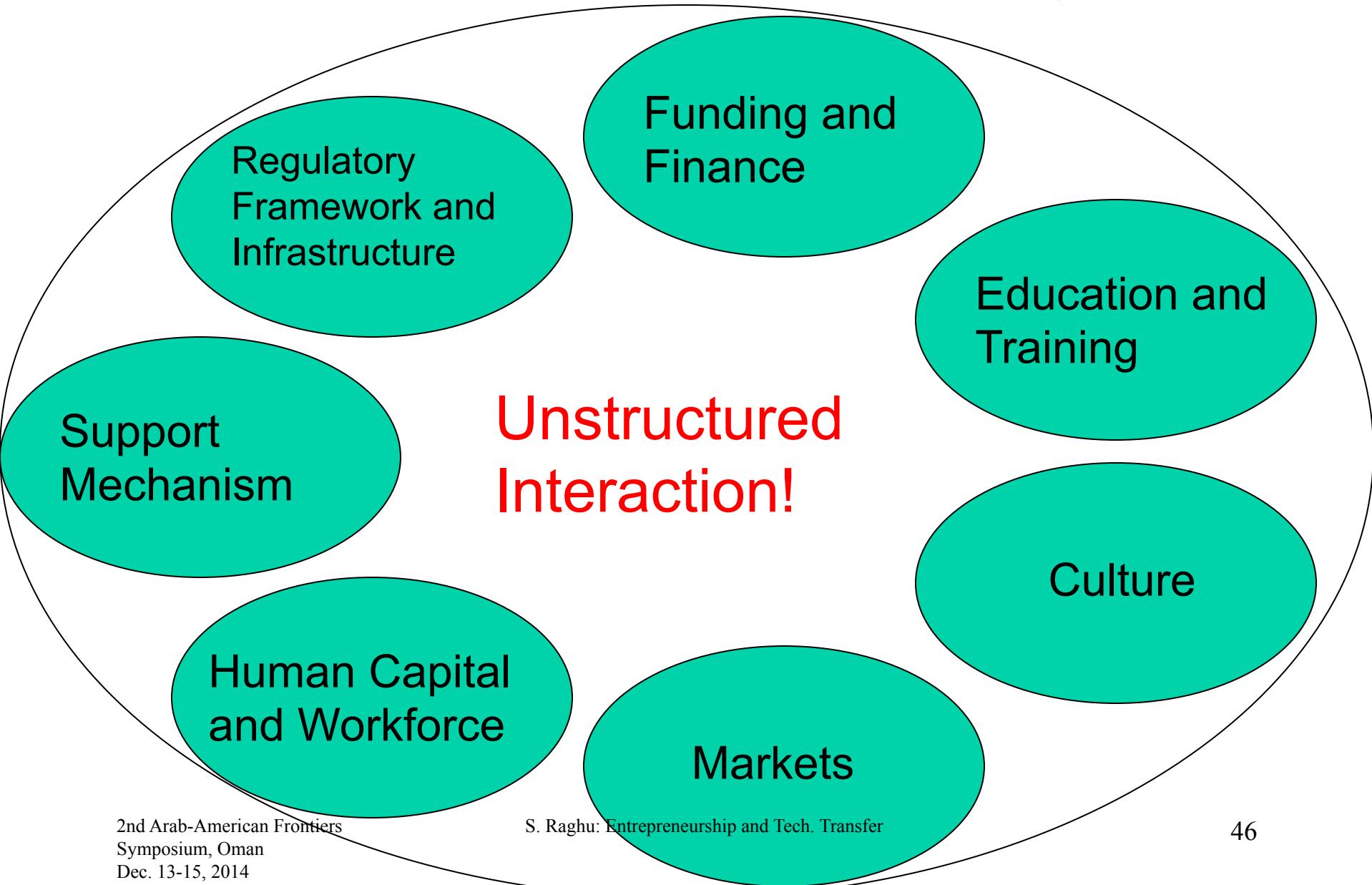


“PITFALLS IN COMMERCIALIZATION”

5. Products successful only for a short time or technology outdated

TTO can help a great deal in avoiding these pitfalls!

The Entrepreneurship Ecosystem



The Entrepreneurship Ecosystem



How do we promote Inventions and Entrepreneurship at Universities

Faculty

Selection of Research topics

Link and promote industrial interaction

Reward systems for faculty inventors, promotion policies

Students

Introduce projects with content of innovation

Master's thesis with industrial projects,

Student entrepreneurship competition that is cross-departmental and interdisciplinary

Current Educational System

“the educational system (*for scientists and engineers?*) is still rather traditional, which means that it teaches young people to obey, reproduce facts and to engage in wage-employment after finishing their education”

(Ref: The Long Road to the Entrepreneurial Society - Global Entrepreneurship Monitor 2001, The Netherlands)

One-Semester Course in Entrepreneurship

Course Title: **Introduction to Entrepreneurship for
Scientists and Engineers**

In this course we deal with scientific and
technological innovation and entrepreneurship.

CONCLUSIONS

The Research Quadrants

Looking for ideas – potential areas of research

Invention to a Product involves quite a few steps and processes

Technology Readiness Level (TRL) is a good metric for determining the stage of the invention/product

Entrepreneurship can be a good career choice for scientists and engineers

THANK YOU

How do we promote inventions and innovation in scientific and educational institutions?

1. University-Industry interaction.

Examples:

- Presentation of Industrial R&D needs to Universities so that researchers will see the market needs.
- Industrial visits

2. Industry sponsored projects to students and faculty

3. Industrial internships for students and faculty

4. Encouragement – it is OK to fail!

Example 2. ATRIAL FIBRILLATION MONITOR (Market push)

UK: MELYS DIAGNOSTICS
USA: ADVANCED FLUIDICS



ATRIAL FIBRILLATION MONITOR

Inventor: Dr. Dawood Parker, UK

Invention process: 2003-2006

European Patent application: May 2006

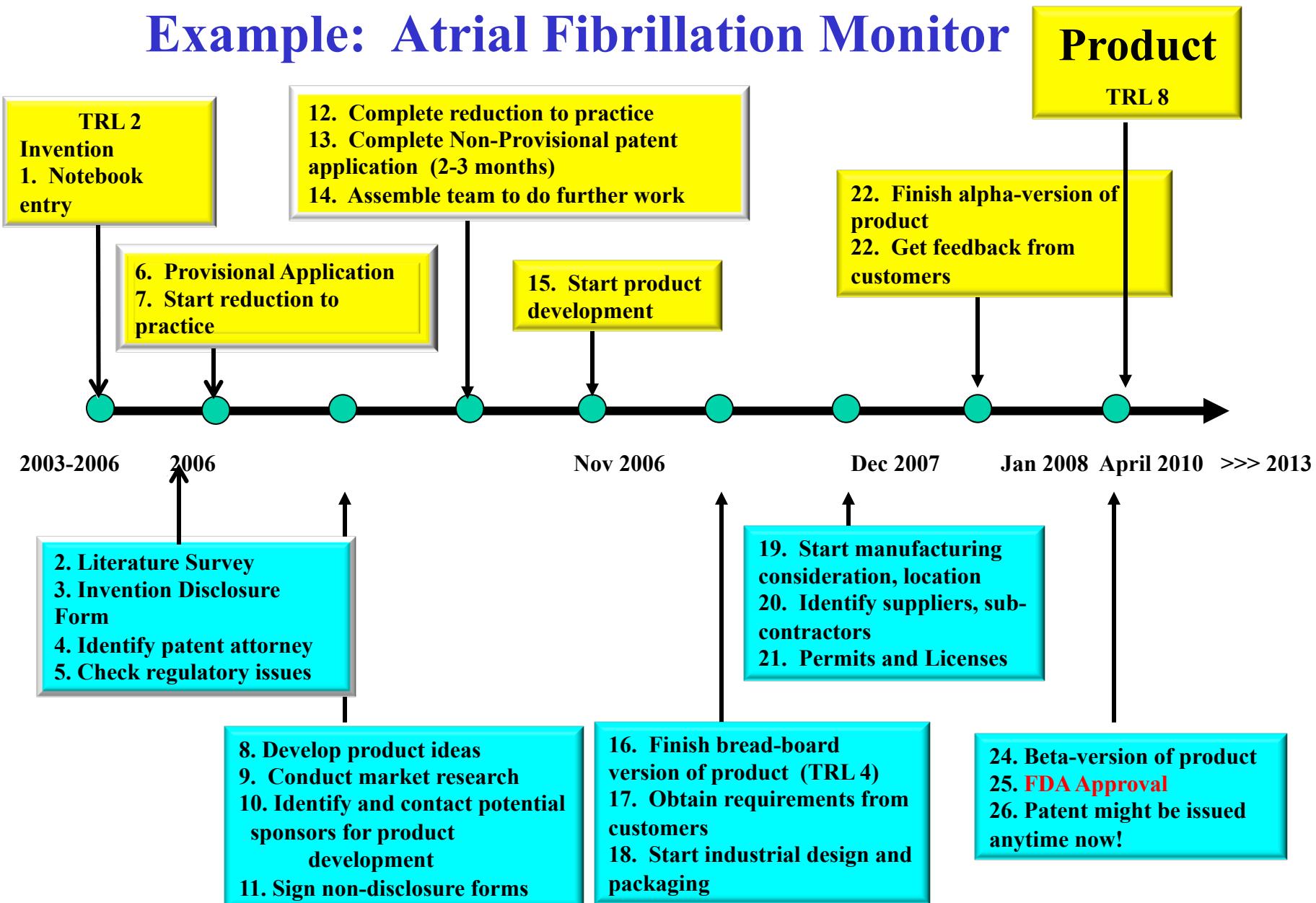
Complete Specification: May 2007

Patent issued (date): To be issued

Development:

1. Proof of concept
2. Validation with EKG (UK &US)
3. Pre-production (Alpha) Prototype ready in November 2007
4. Manufacturing prototype Version 1 2008
5. FDA Approval Process and Redesign for Manufacture (2009)

Example: Atrial Fibrillation Monitor



Examples of inventions from research institutions

NASA's top inventions – “spin-off”s

Digital ear thermometers (infra-red sensors)

Aural thermometers use an infrared sensor to measure the temperature of energy radiating from your ear drum.



Dental braces (translucent polycrystalline alumina (TPA))

Invisible ceramic braces



NASA's top inventions – “spin-off”s

Scratch resistant glasses

A process NASA developed while refining helmet visors for astronauts led to scratch-resistant lenses for eyeglasses and sunglasses.

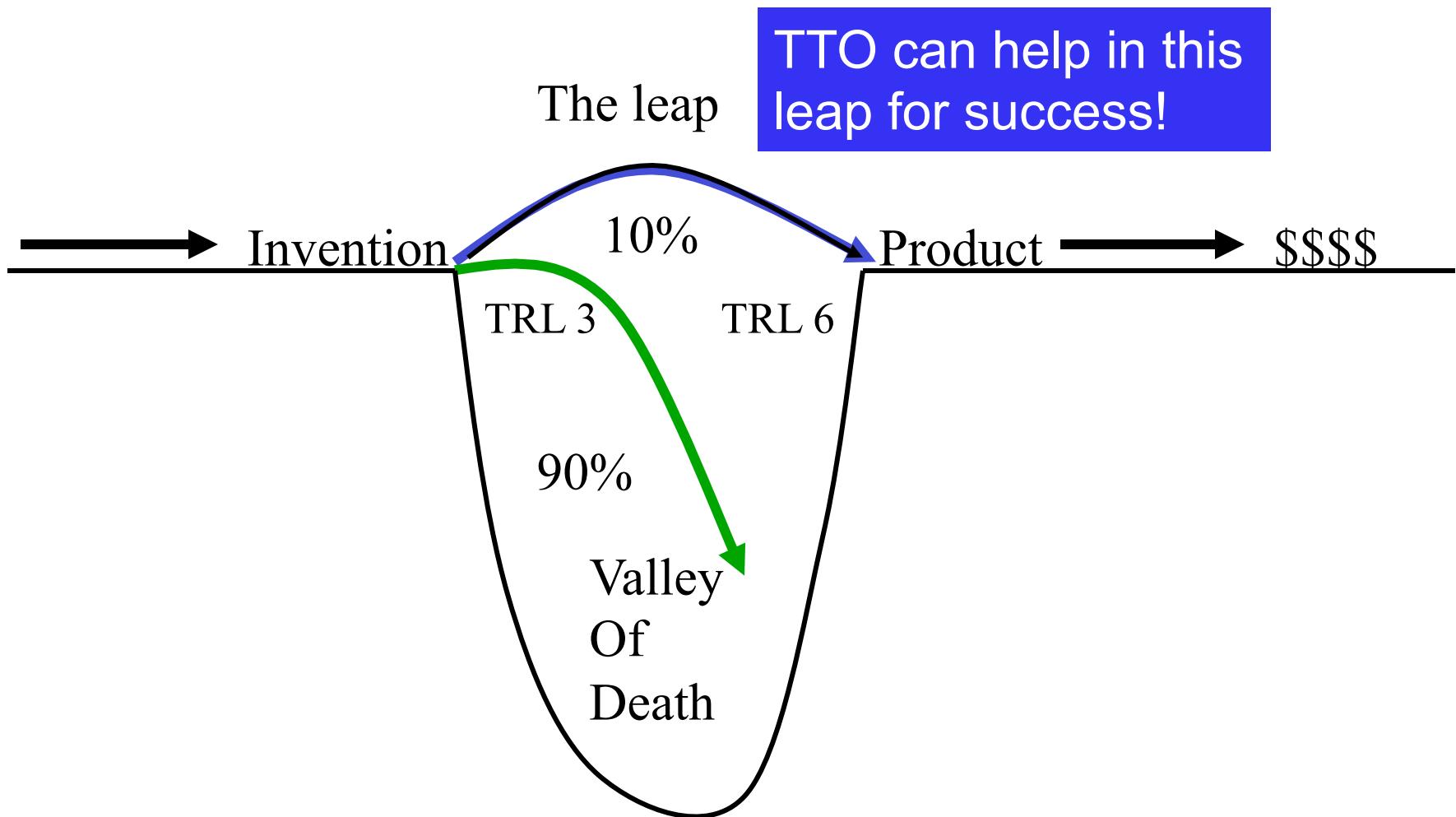


Insoles (cushions for astronauts)

Space boot technology in athletic shoes is meant to put more spring in your step.



CONCLUSIONS



CONCLUSIONS

Watch out for pitfalls!

Encourage risk taking by students and faculty at the University

Accept failures as part of the entrepreneurial spirit

Interviews from Young Scientists

Research, Discovery and Inventions

Applied or Commercial or Use/Context-based Research

Example: New plastics in plastics industry, new cancer drugs in pharmaceutical industry. Objectives are somewhat known.

Basic Research (Context-free research)

Typically University Research/Research Institutions

Example: Research on Properties of fluids or matter

Generally, we have faster development of products from Applied or Commercial Research



“PITFALLS IN COMMERCIALIZATION”

2. Ideas that did not work in reality – not really an invention
 - Do not stand the test of science!