The Abdus Salam
International Centre for Theoretical Physics

United Nations
Educational, Scientific and
Cultural Organization

IAEA
International Atomic Energy Agency

2140-15

Workshop on Entrepreneurship for Physicists and Engineers from Developing Countries

3 - 7 May 2010

Invention to Product: Processes and Time-Lines

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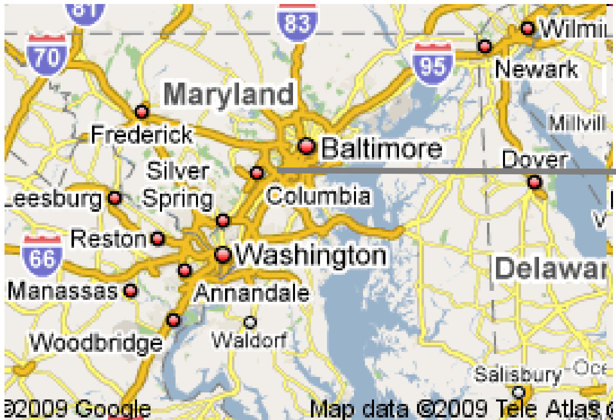
Advanced Fluidics LLC

Entrepreneurship for Physicists and Engineers
ICTP Trieste
May 3-7, 2010



OUTLINE

1. Introduction
2. Inventions, Technology Development and TRLs
3. Invention to Product: Processes
4. Invention to Product: Timelines
5. Examples of Invention to Products
6. Opportunities for inventions
7. Conclusions

The path from invention to a product

It is important to understand that there are quite a few things to be done in taking an invention to a product – and it takes some time to accomplish all these!

Various aspects of taking an invention to a product

1. Technology Development
2. Securing Intellectual Property
3. Manufacturing Process development
4. Financials
5. Business Development

(Items 1–3: My presentation)

Inventions

A *Useful Invention* is not a random idea or thought process – needs a strong scientific and technical background.
Not done before $\neq$ Necessarily useful invention!
Interdisciplinary knowledge helps…….

Applied or Commercial Research (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

An idea is not an invention

An invention is not a product

What are you inventing?

New Technology? (Method and Apparatus or Process)

"Technology is a capability that can be used in a product."

Nuclear Magnetic Resonance technology, superconducting materials, laser, radars, wireless communication, new process...

OR

A New Product? (Apparatus)

"makes use of existing or new technologies"

MRI scanners, low-loss electrical transmission systems, optical readers/scanners, laser-based eye surgery systems, cell-phones, wireless sensors ……….

A new product has a customer and a market in mind

Why do we need inventions?

- Improve quality of life – “useful”
- Commercialization for economic benefit – profit, to be more specific.

Things to take care of when working on an invention

1) Invention Notebooks

Record as clearly as possible the purpose of the work, the methodology, the results, data and inferences regularly, ***date it and have it witnessed.***

References

1. http://www.bookfactory.com/special_info/invent_notebook_guidelines.html

2. The Inventor's Notebook

by Fred Grissom and David Pressman

Things to take care of when working on an invention (continued)

2. **Think of *products*** that can be developed using the invention. Your invention/product can stand on its own or be a part of others' product or system. ….

3. **Connect yourself** to the markets in the field of invention and possibly other related areas.

Various aspects of taking an invention to a product

1. Technology Development ←
2. Securing Intellectual Property
3. Manufacturing Process
4. Financials
5. Business Development

Technology Development and Technology Readiness Levels (TRL)

TRL Table: Developed by NASA and commonly used in the US for technology development programs to measure the maturity of a technology.

9 Stages of Technology Readiness Levels – TRL 1-9

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

Inventions and Technology Readiness Levels (TRL)

TRL 1 **Lowest level of technology readiness. Research begins to be translated into applied research and development. Examples might include paper studies of a technology's basic properties. (proposal to funding agency)**

TRL 2 Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.

TRL 3 Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.

TRL 4 Basic technological components in the intersect areas are ***integrated in a similar fashion*** to establish that they will work together. This is relatively "low fidelity" compared to the eventual system. Examples include integration of "ad hoc" hardware in the laboratory.

TRL 5 Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so it can be tested in a simulated environment. Examples include "high fidelity" laboratory integration of components.

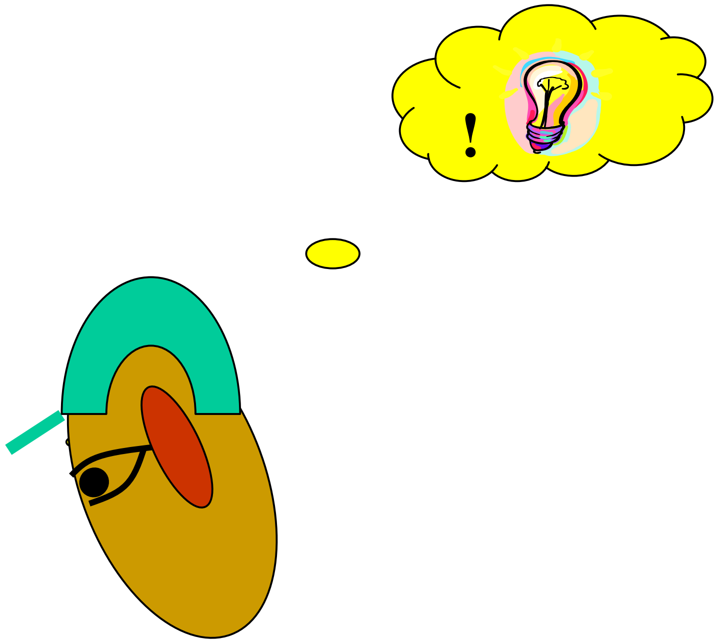
TRL 6 ***Similar but not necessarily the same system***, which is well beyond that of TRL5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include reliability and satisfactory performance characteristics in a high fidelity laboratory environment or in simulated operational environment (operating range of temperature, humidity, pressure, etc.)

TRL 7 Prototype near or at planned operational system. Represents a major step up from TRL6, requiring demonstration of an actual system prototype in an operational environment. Examples include testing the prototype in a mock-up of the final product.

TRL 8 Technology proven to work in its final form and under expected conditions. In most cases, this TRL represents the end of true system development. Examples include developmental test and evaluation of the system in its intended environment to determine if it meets specifications.

TRL 9 **Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. Examples include using the system under operational mission conditions.**

Inventions and Technology Readiness Levels (TRL 1-9)



TRL1

Lowest level of technology readiness. Research begins to be translated into applied research and development. Examples might include

a) Paper studies of a technology's basic properties (at the level of a proposal to a funding agency)

b) An exploratory idea that could potentially generate a new product/technology

Inventions and Technology Readiness Levels (TRL 1-9)

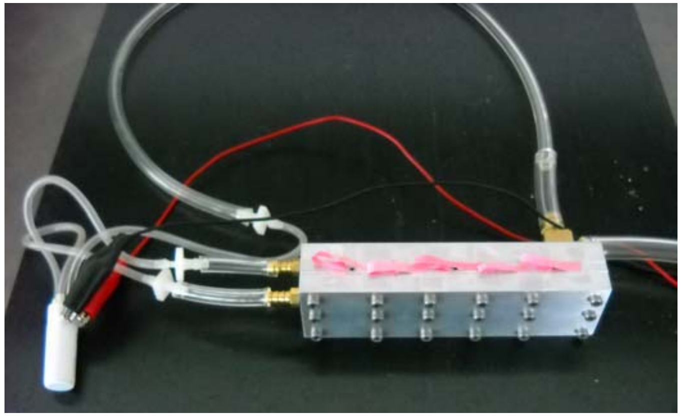
TRL 2

Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.

TRL 3

Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology.

Examples include components that are not yet integrated or representative – bench-top or "warm-feeling" experiments.



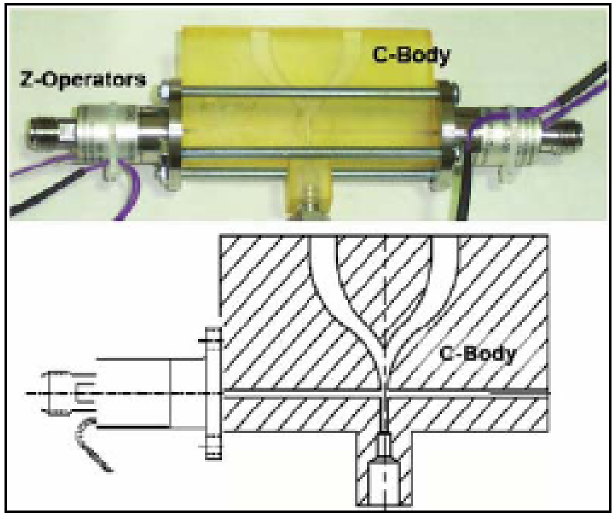
Inventions and Technology Readiness Levels (TRL 1-9)

TRL 4

Basic technological components in the intersect areas are ***integrated in a similar fashion*** to establish that they will work together. This is relatively "low fidelity" compared to the eventual system.

Examples include integration of "ad hoc" hardware in the laboratory.

Device fabricated in the lab and either glued or attached with fasteners.



(Dennis Culley, NASA/TM—2006-214396)

TRL 5

Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so it can be tested in a simulated environment.

Examples include "high fidelity" laboratory integration of components.

TRL 6

Similar but not necessarily the same system, which is well beyond that of TRL5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness.

Examples include reliability and satisfactory performance characteristics in a high fidelity laboratory environment or in simulated operational environment (operating range of temperature, humidity, pressure, etc.)

Reduces

- Product liability
- Product recalls

Corrosion Sensor

Inventions and Technology Readiness Levels (TRL 1-9)

TRL 7

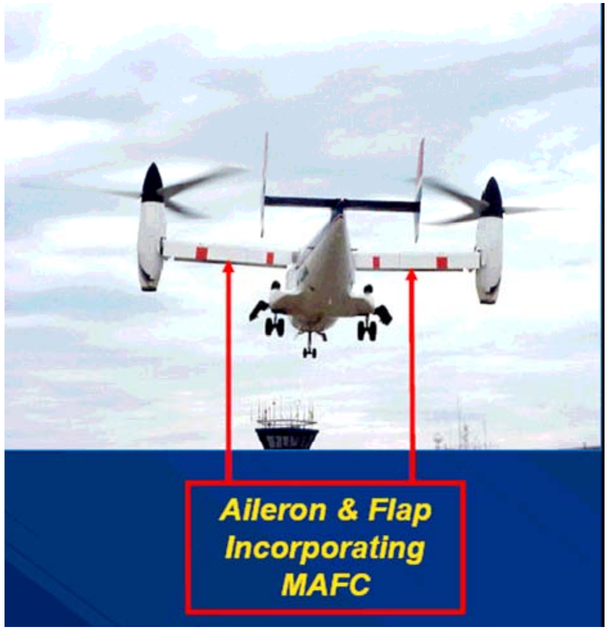
Prototype near or at planned operational system. Represents a major step up from TRL 6, requiring demonstration of an actual system prototype in an operational environment.

Examples include testing the prototype in a mock-up of the final product.

TRL 8

Technology/product proven to work in its final form and under expected conditions. In most cases, this TRL represents the end of true system development.

Examples include developmental test and evaluation of the system in its intended environment to determine if it meets specifications.



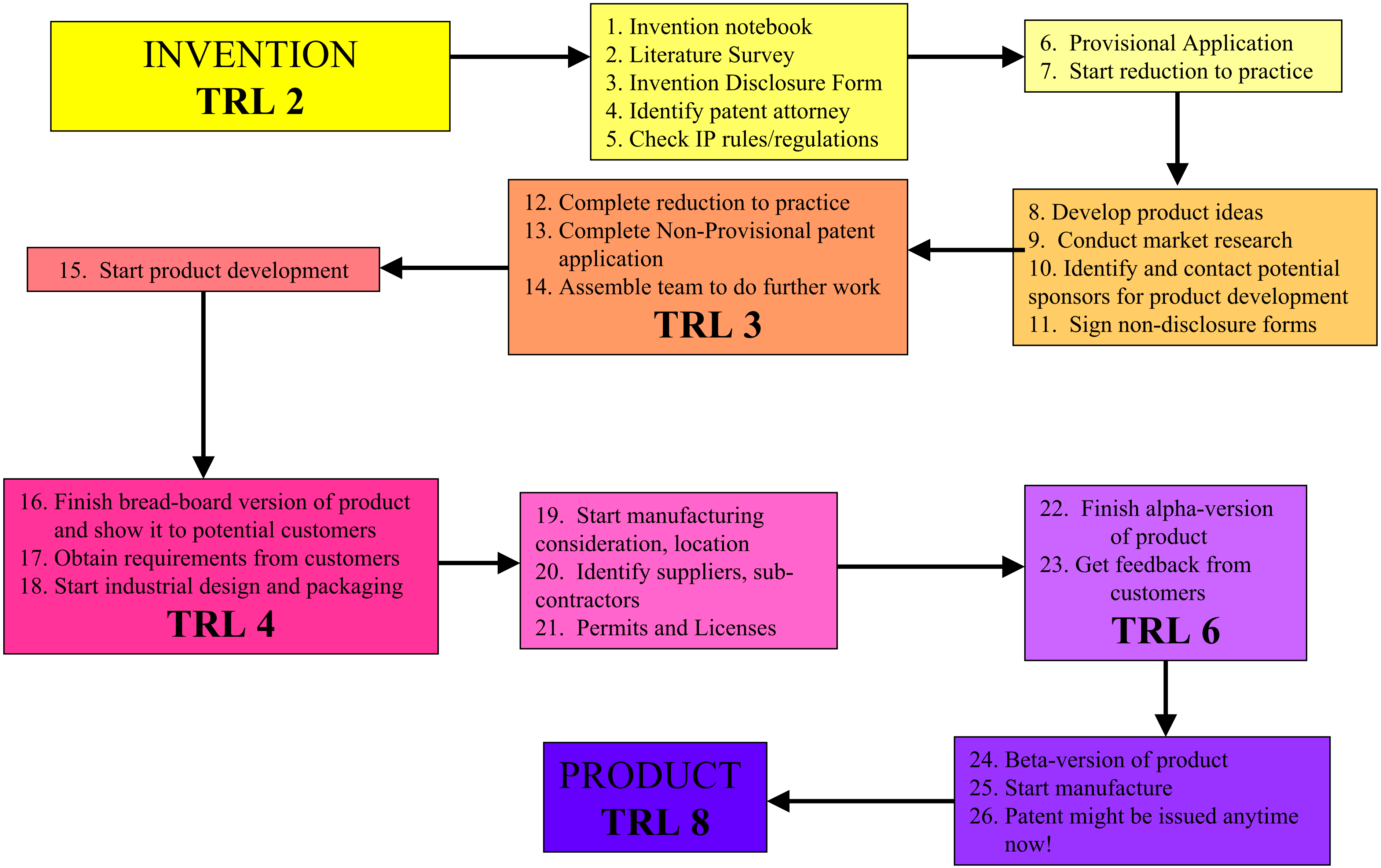
(DARPA MAFC Briefing 2003)

Inventions and Technology Readiness Levels (TRL 1-9)

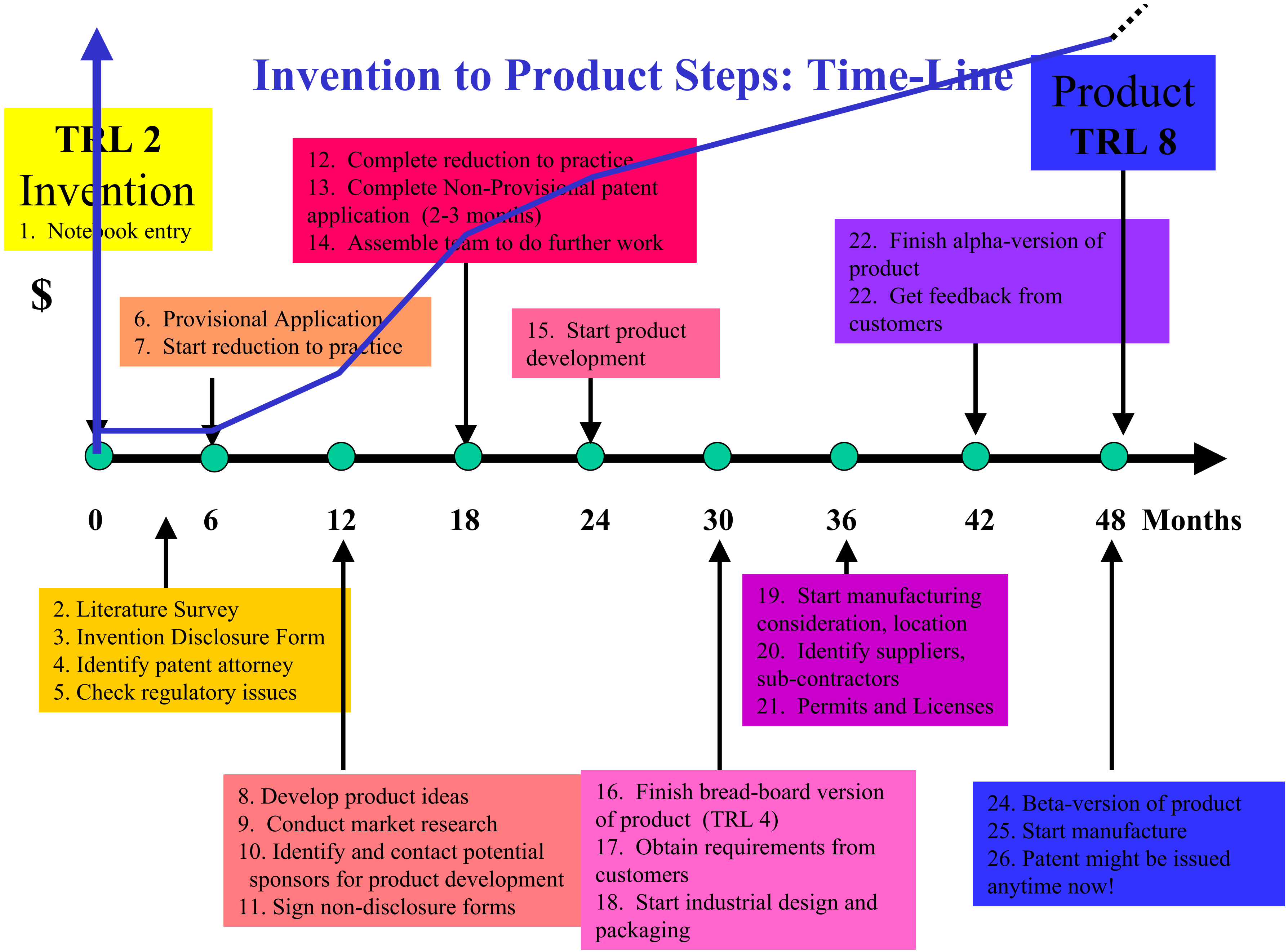
TRL 9

Actual application of the technology or product in its final form and under mission conditions, such as those encountered in operational test and evaluation. Examples include using the system under operational mission conditions.

Invention to Product Steps: Technology Development, IP and Mfrg. Processes



Invention to Product Steps: Time-Line



EXAMPLES OF INVENTION TO PRODUCTS

1. ATRIAL FIBRILLATION MONITOR

UK: MELYS DIAGNOSTICS

USA: ADVANCED FLUIDICS

ATRIAL FIBRILLATION MONITOR

•Detect any type of arrhythmia in the heart pulse based on cardio-signal analysis.

•Developed the technique particularly to identify potential AF patients who would otherwise go undetected.

•In the UK the estimate is that 1 in 10 people over 60 have AF and most of these go undetected. 1% of US population estimated to have AF. Similar statistics probable in other countries.

ATRIAL FIBRILLATION MONITOR

Inventor: Dr. Dawood Parker, UK

Invention process: 2003-2006

European Patent application: May 2006

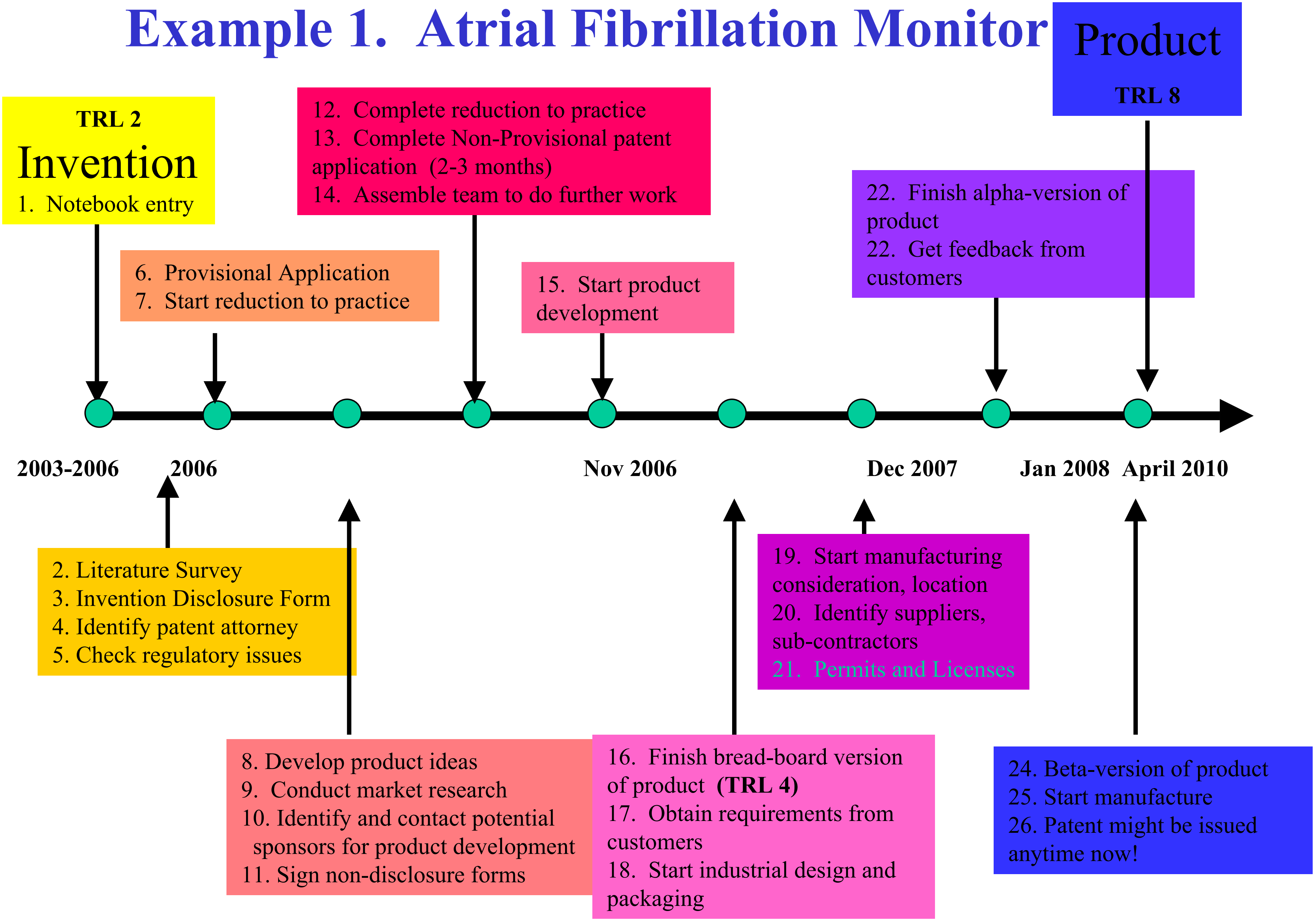
Complete Specification: May 2007

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 1. Atrial Fibrillation Monitor



Example 2. 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

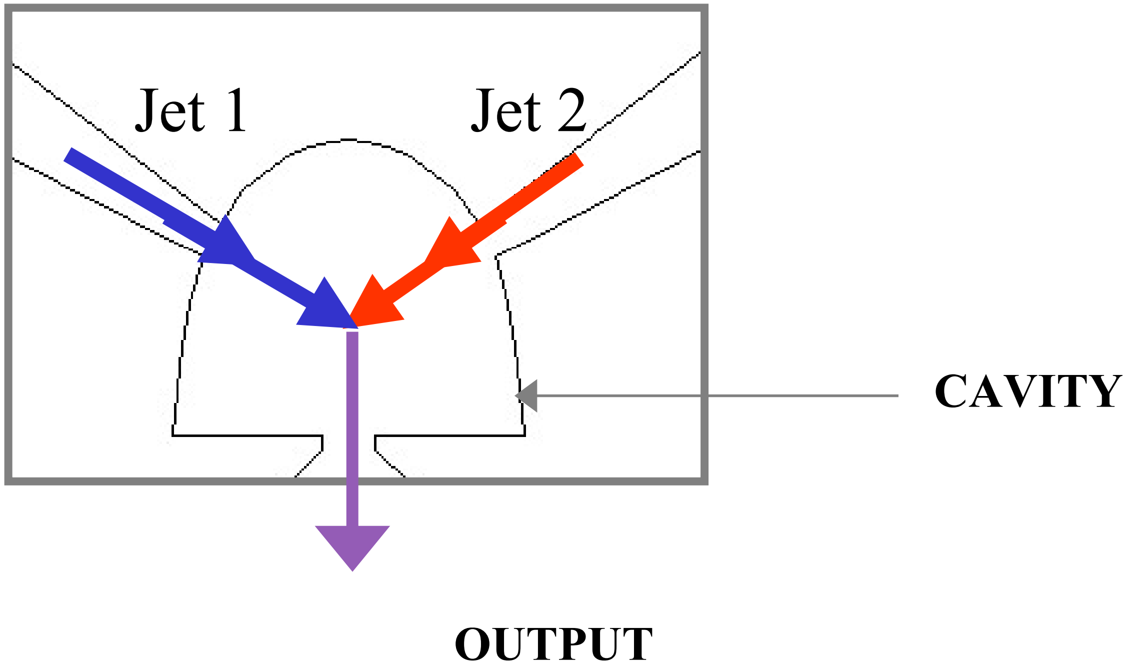
Patent issued: July 2001

Development:

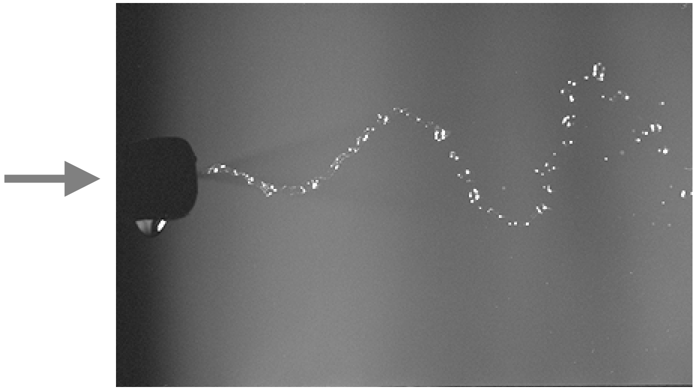
Currently an automotive product in use from 2001

Twin-Jet Fluidic Oscillators (Invented Oct 1998)

(Raghu, Filed Oct 1999, US Patent 6,253,782, July 2001)



Oscillating jet (spray) generated by the device



The Final Product: Windshield Washer Nozzle

40 million

nozzles/year

Used in

GM,Ford,

Chrysler,

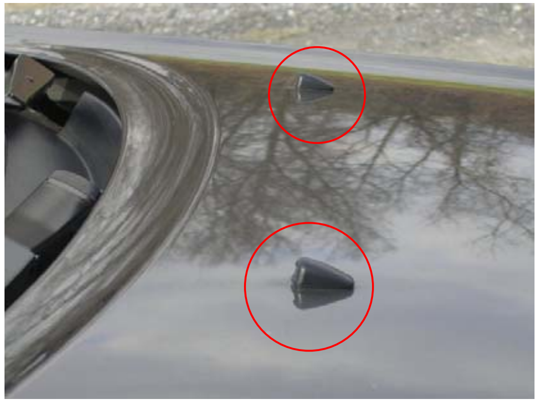
Volkswagon,

Mercedes

Saab, Jaguar

Toyota, Honda

The product in its environment (TRL 9)



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

(56) **References Cited**

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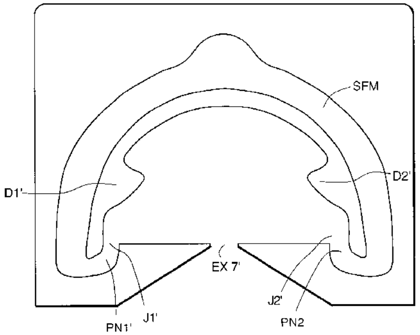
Primary Examiner—A. Michael Chambers
(74) *Attorney, Agent, or Firm*—Jim Zegeer

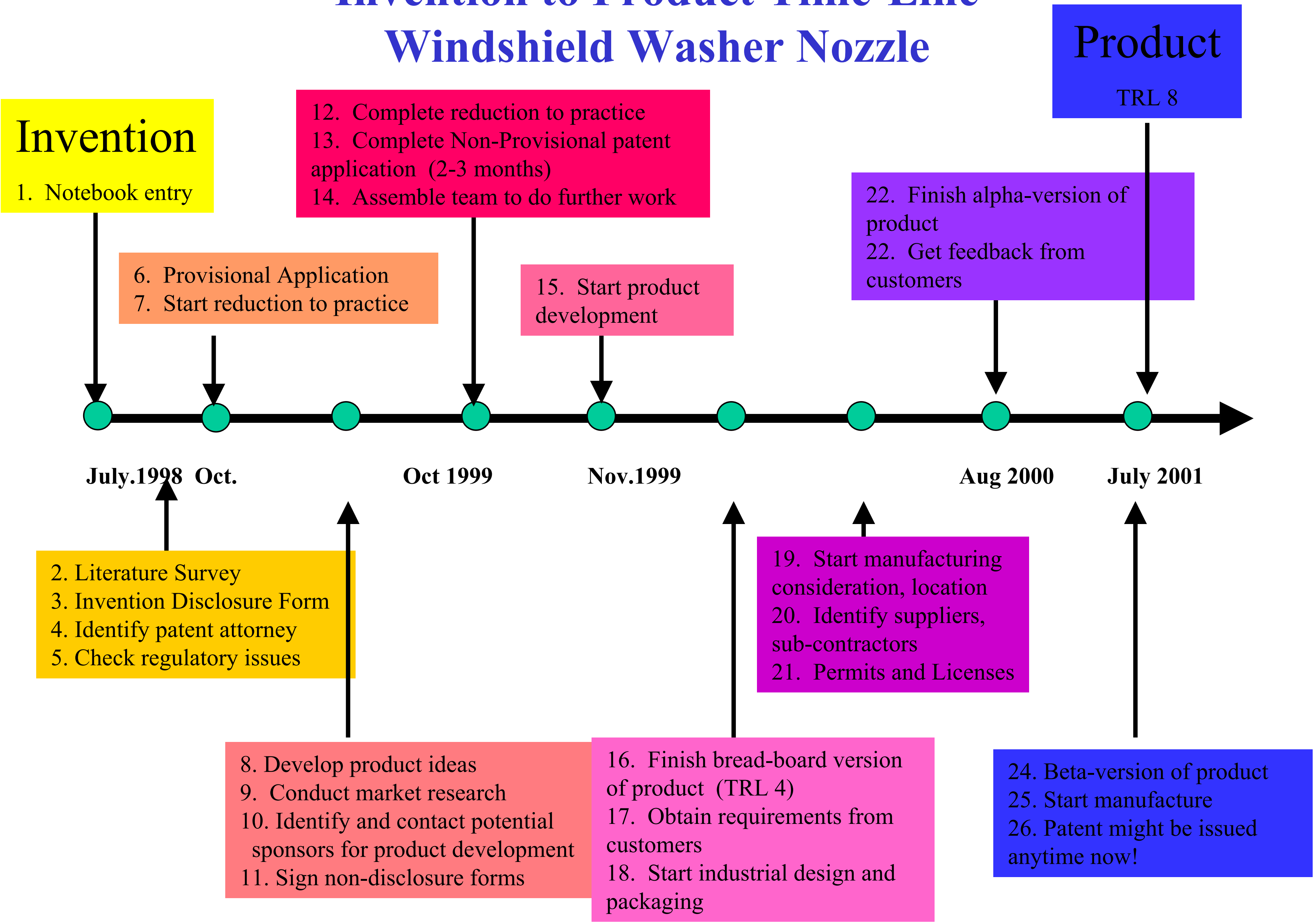
(57) **ABSTRACT**

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



Invention to Product Time-Line
Windshield Washer Nozzle



Example 3. Wireless Corrosion Health Monitor

Inventors: Guy Davis, Chester Dacres and Lorrie Krebs

(DaccoSci Inc)

Date Applied for patent: August 1999

Date Issued: Dec. 2001

Date product development began: Oct. 2005

(DaccoSci, Advanced Fluidics and Virginia Technologies)

Current status: Pre-Production Prototype ready

The Issued Patent

(12) **United States Patent**
Davis et al.

(10) **Patent No.: US 6,328,878 B1**
(45) **Date of Patent: Dec. 11, 2001**

(54) **ADHESIVE TAPE SENSOR FOR DETECTING AND EVALUATING COATING AND SUBSTRATE DEGRADATION UTILIZING ELECTROCHEMICAL PROCESSES**

(75) Inventors: **Guy D. Davis**, Baltimore; **Chester M. Dacres**, Columbia; **Lorrie A. Krebs**, Baltimore, all of MD (US)

(73) Assignee: **Dacco Sci, Inc.**, 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.: **09/372,074**

(22) Filed: **Aug. 11, 1999**

(51) **Int. Cl.**[7] **G01N 17/04**; G01R 27/02

(52) **U.S. Cl.** **205/776.5**; 205/791.5; 324/71.2; 324/693; 324/700; 204/404

(58) **Field of Search** 324/693, 700, 324/707, 713, 722, 71.2; 205/776.5, 777, 791.5; 204/404; 422/53

(56) **References Cited**

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6,054,038	*	4/2000	Davis et al.	205/776.5

OTHER PUBLICATIONS

Simpson et al "Evaluation of the effects of acidic deposition on coated steel substrates", Prog. Org. Coatings, 20 pp. 199–216, month unavail. 1992.*

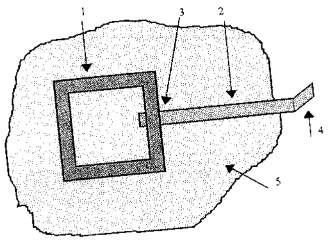
* cited by examiner

Primary Examiner—Robert J. Warden, Sr.
Assistant Examiner—Kaj K. Olsen

(57) **ABSTRACT**

A portable and nondestructive adhesive tape corrosion sensor which is utilized under actual field or laboratory conditions in detecting coating and substrate degradation using Electrochemical Impedance Spectroscopy (EIS) of coated or uncoated metal structures has been developed. The invention allows for broad applicability, flexibility in utilizing the sensor in various environments without structural compromise and the ability to inspect and evaluate corrosion of the actual structure, regardless of the size, shape, composition, or orientation of the structure. The electrodes may be removed once a measurement is made or remain in the original fixed position so that subsequent measurements may be made with the same electrode. The nondestructive sensor apparatus is comprised of a pressure-sensitive adhesive tape that consists of a conductive film or foil and conductive adhesive overlapping another pressure-sensitive adhesive tape that consists of a conductive film or foil and non-conductive adhesive. The conductive tape serves as the sensing element or device. The non-conductive tape serves as the lead between the sensing element and the point of measurement. In an alternative configuration, the tape with the conductive adhesive may be used alone, acting as both sensor electrodes and the lead to the point of measurement. The metal structure or other substrate being sensed or evaluated for degradation serves as the working electrode. This two electrode sensing device is responsive to water uptake, incubation, and corrosion by measuring differences in impedance spectra. The invention can readily detect, quantify and monitor coating and metal degradation from its earliest stages, well before any visual indication of corrosion appears, under both laboratory and field conditions.

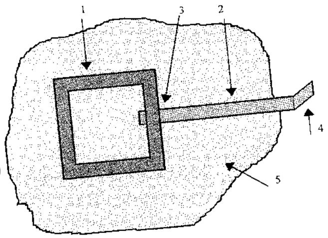
2 Claims, 2 Drawing Sheets

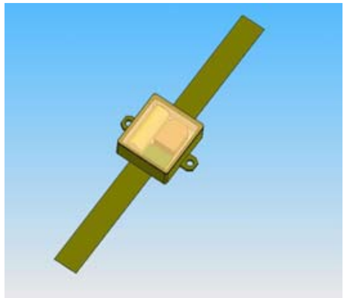


Invention to Product: Corrosion Health Monitor

Product concept (2005)

INVENTION → Patent (2001)





"mock-up" (2006)

Product (2008)

www.electrawatch.com

TRL 7 (2007)

Prototype 1

“PITFALLS IN COMMERCIALIZATION”

Reinvented the wheel

Ideas that did not work in reality – not really an invention

Ideas worked but limited or no applications (no products)

Found applications but products not successful in market

  too expensive, too complicated, too big, too small, …

Products successful only for a short time or technology outdated

EXIT STRATEGIES

Be ready to quit anytime for good reasons – no emotional attachment!

Be realistic! Cannot pursue for ever if not working out.

Inventor's syndrome "Everything is mine" – does not work.
At some point someone else has to take over the project.

Sell off the patent/IP/company at the right time

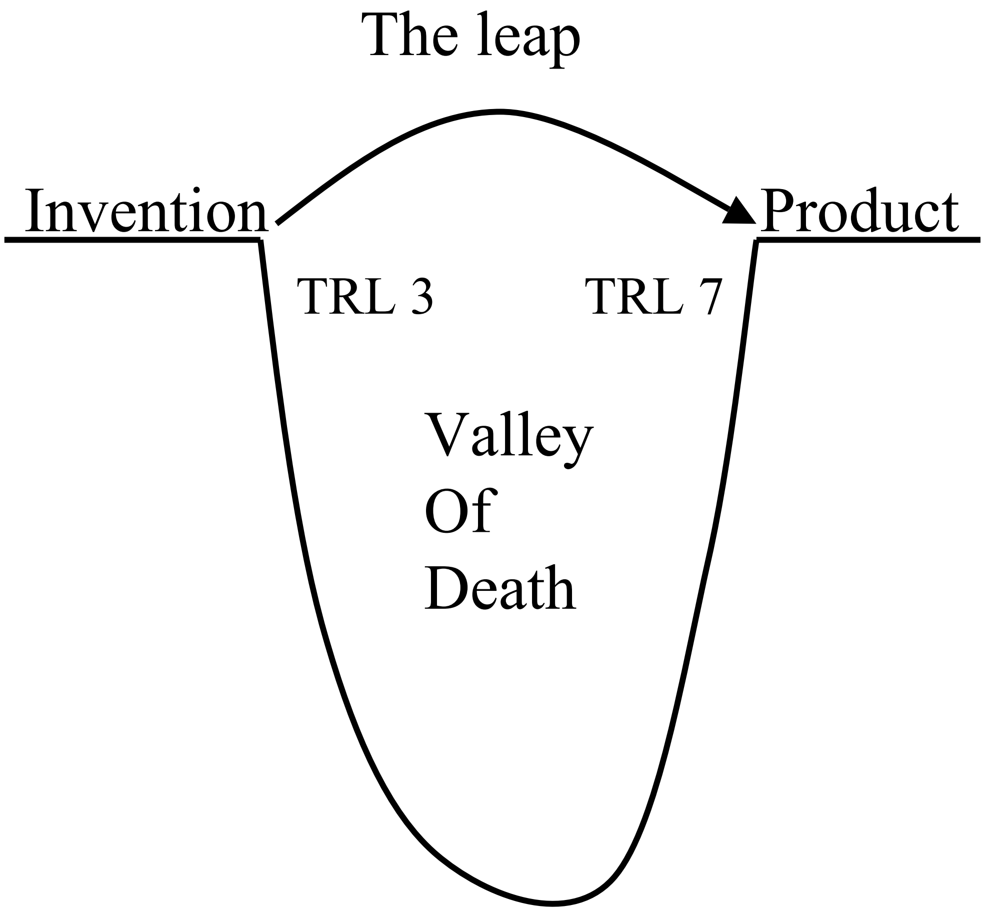
Some facts about inventions

All inventions do not end up as products!

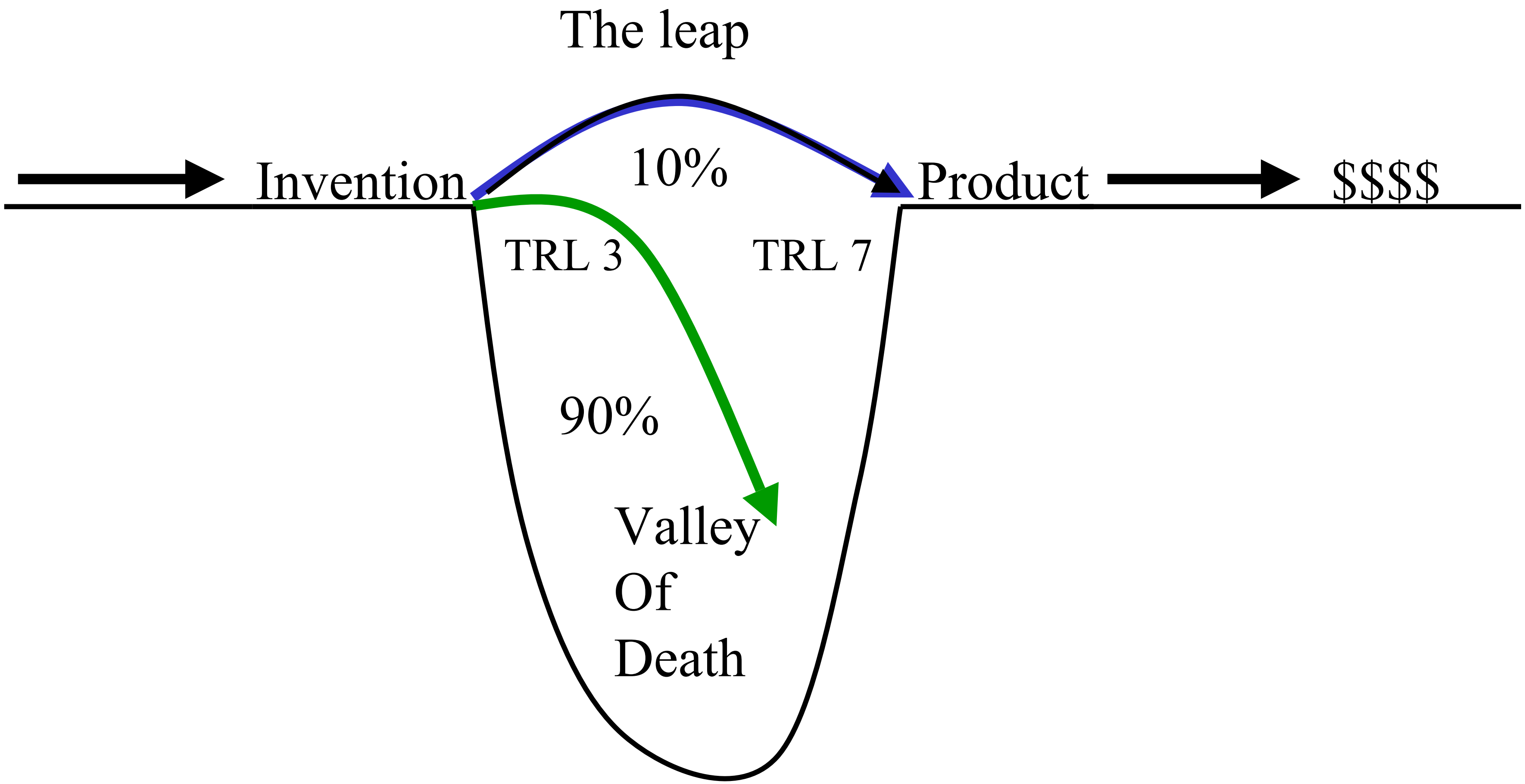
Only < 0.1% of all inventions patented are ever converted into commercial products!

Inventions need a champion (maybe yourself!) to get them into the competitive market to be economically successful.

CONCLUSIONS



CONCLUSIONS



THANK YOU

Challenges for Inventors and Entrepreneurship in Developing Countries

1. Poor physical infrastructure and no financial support
2. Lack of government and institutional support
3. Lack of planning and metrics for progress
4. Economic, cultural and moral factors on inventions
5. Societal and cultural taboos on failure

Opportunities

You have to make them yourselves!

Grand Challenges (National Academy of Engineering, USA)

[http://www.engineeringchallenges.org]

- Make solar energy economical
- Provide energy from fusion
- Develop carbon sequestration methods
- Manage the nitrogen cycle
- Provide access to clean water
- Restore and improve urban infrastructure
- Advance health informatics
- Engineer better medicines
- Reverse-engineer the brain
- Prevent nuclear terror
- Secure cyberspace
- Enhance virtual reality
- Advance personalized learning
- Engineer the tools of scientific discovery

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

1. University-Industry interaction.

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

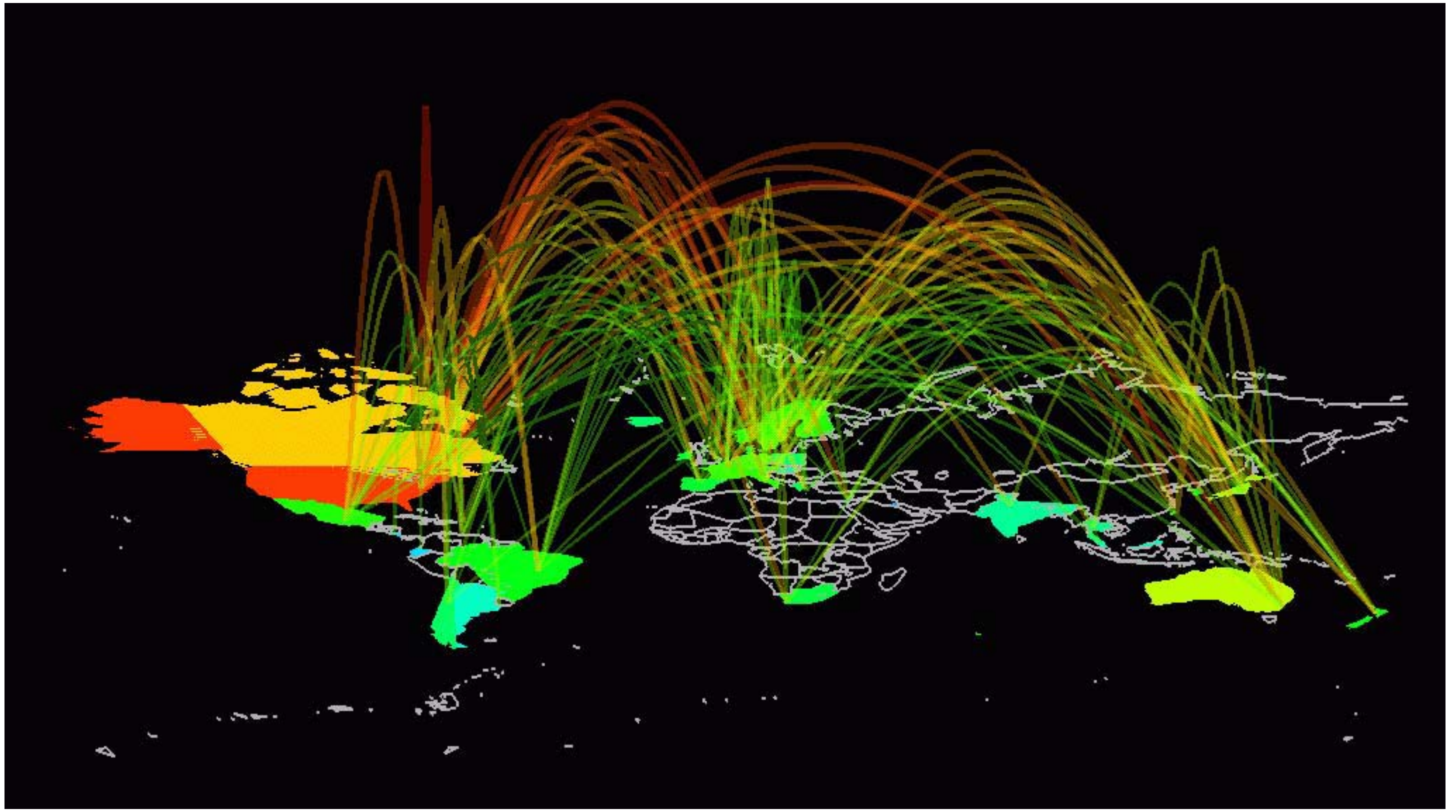
2. Industry sponsored projects to students and faculty

3. Industrial internships for students and faculty

4. Encouragement – it is OK to fail!

5. Patents are not substitutes for papers – too expensive!

It is a Flat World!



• We can compete for all markets if we have the right product.

Some Useful References:

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