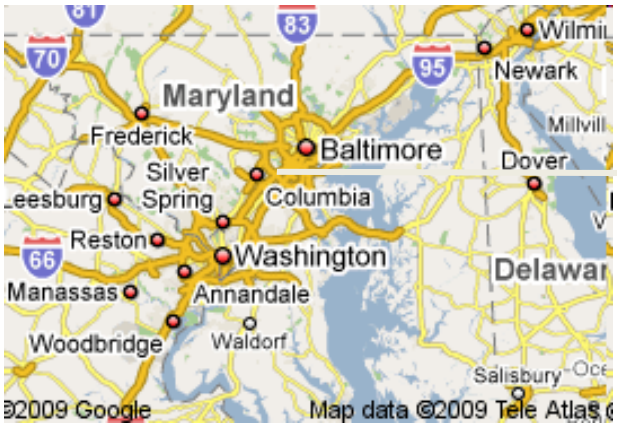
Invention to Product: Processes and Time-Lines

Surya Raghu
Advanced Fluidics LLC

Workshop on Entrepreneurship
for Physicists and Engineers
Durban, S. Africa
May 20-24, 2013



About Advanced Fluidics

Research and Product Development in

1. Aerospace Sciences – Aerodynamics, combustion
2. Micro/Nanofluidics/nanotech-based biosensors
3. Medical Instrumentation
4. Technology Roadmap Development and Training

OUTLINE

1. Introduction
2. Inventions, Technology Development and TRLs
3. Invention to Product: Processes (Things To Do) and Timelines
4. Examples of Invention to Products
5. Pitfalls to commercialization
6. Conclusions

Why do we need inventions and new products?

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

An idea is not an invention

An invention is not a product

Not done before $\neq$ Necessarily useful invention!

Useful Invention = Successful Product *only* if marketed well

What are you inventing?

New Technology? (Method and Apparatus or Process)

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

Example: Laser

(When lasers were invented in 1960, they were called "a solution looking for a problem")

OR

A New Product? (Apparatus)

"makes use of existing or new technologies"

Optical readers/scanners, laser-based eye surgery systems, laser pointer, measurement systems, golf trainer, laser machining, etc.

A new product has a customer and a market in mind

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!

Your input from yesterday ….

TEAM A – Company matters

NAME
Founder
Type of company PLC. LTD
Notary
Logo
Documents
Register company
District govt
Certificate of company registration
Trade business License
Industrial certificate
Environmental regulation certificate
Tax payer registration
Bank account
Property registration

TEAM B - Finance

FIXED COST
Legal aspect
Patent cost
Trademark cost
Assets – machines, bldg
Raw material
Packaging
Advertising
Marketing
Variable cost
Cost of making a single product – bill of materials

Team C – Sales and Marketing

Product differentiation
Determine market
Market research
Customer behaviour
Existing network of sales
Media
Exhibition
Display technology company (projector company)
Budget
Online selling
Direct selling
After-sales – guarantee

Marketing person, budget and time schedule
Focus on product,
Branding strategy
Youtube as a tool for instruction
Pricing strategy
Customer targeting

TEAM D – Technology Development

Collect data base
More options – 7 colors
Conceptual Designs
Design requirements

Identification of suppliers
Potential manufacturer of product
Prototyping
Product feedback
Industrial product

Quality assurance

TEAM E - Manufacturing

Mfrg and technical forecast
Location survey
Bldg permit
Equipment
Human resources
Technology forecasting – eraser, draw circles, voice interface (like Siri)
Read your mind!
Risk management system
Waste and recycling
Outsourcing or local mfrg?

Team F - Management

CEO, R&D manager, Adm. Manager, Sales Manager, HR Manager
Advisor,
Book Keeper (Finances)
Business Development Manager??

The path from invention to a product

6 aspects of taking an invention to a product

1. Technology Development
2. Securing Intellectual Property
3. Manufacturing Process development

My presentation

4. Financials
5. Business Development
6. Company set-up and management

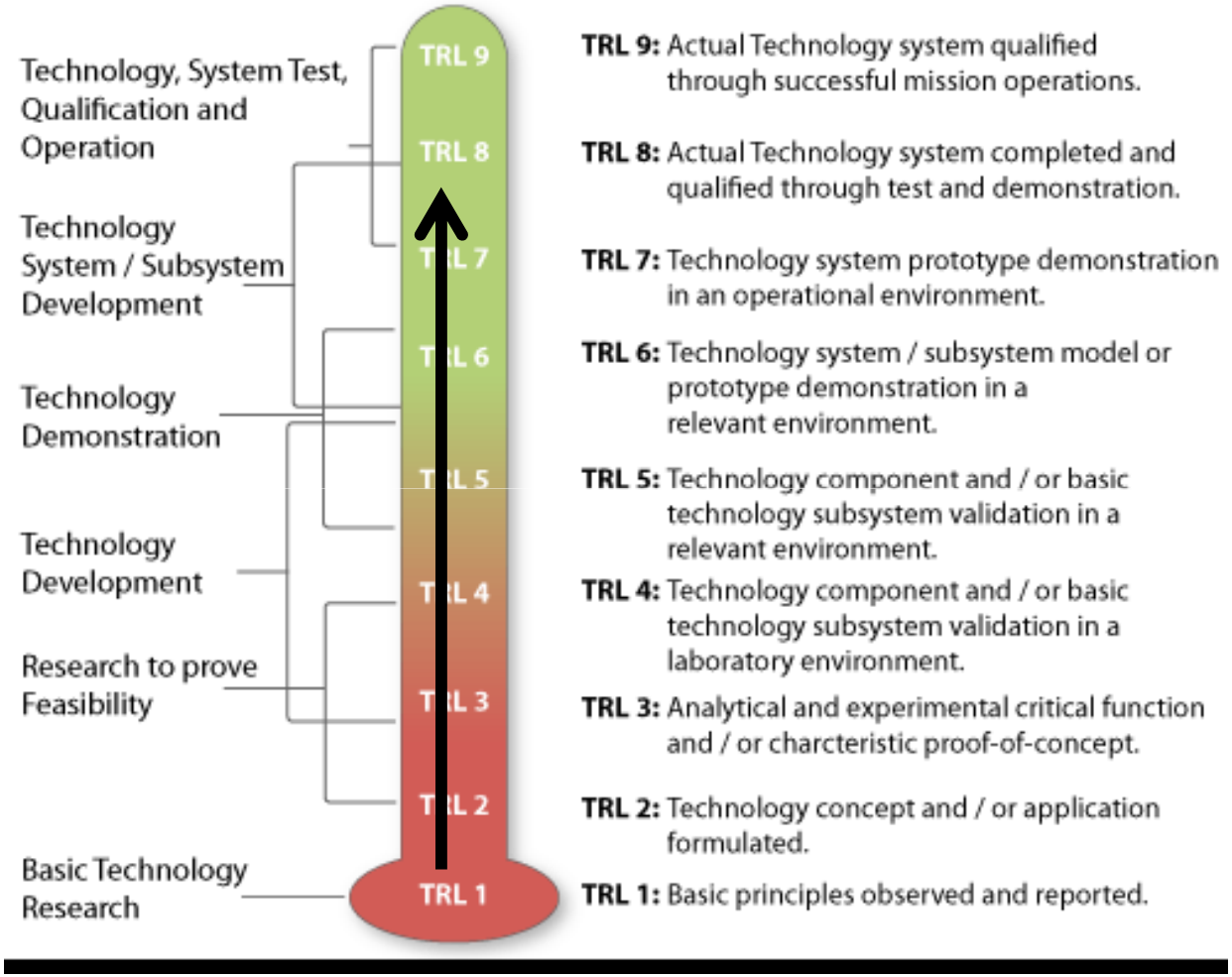
Technology Development and Technology Readiness Levels (TRL)

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)

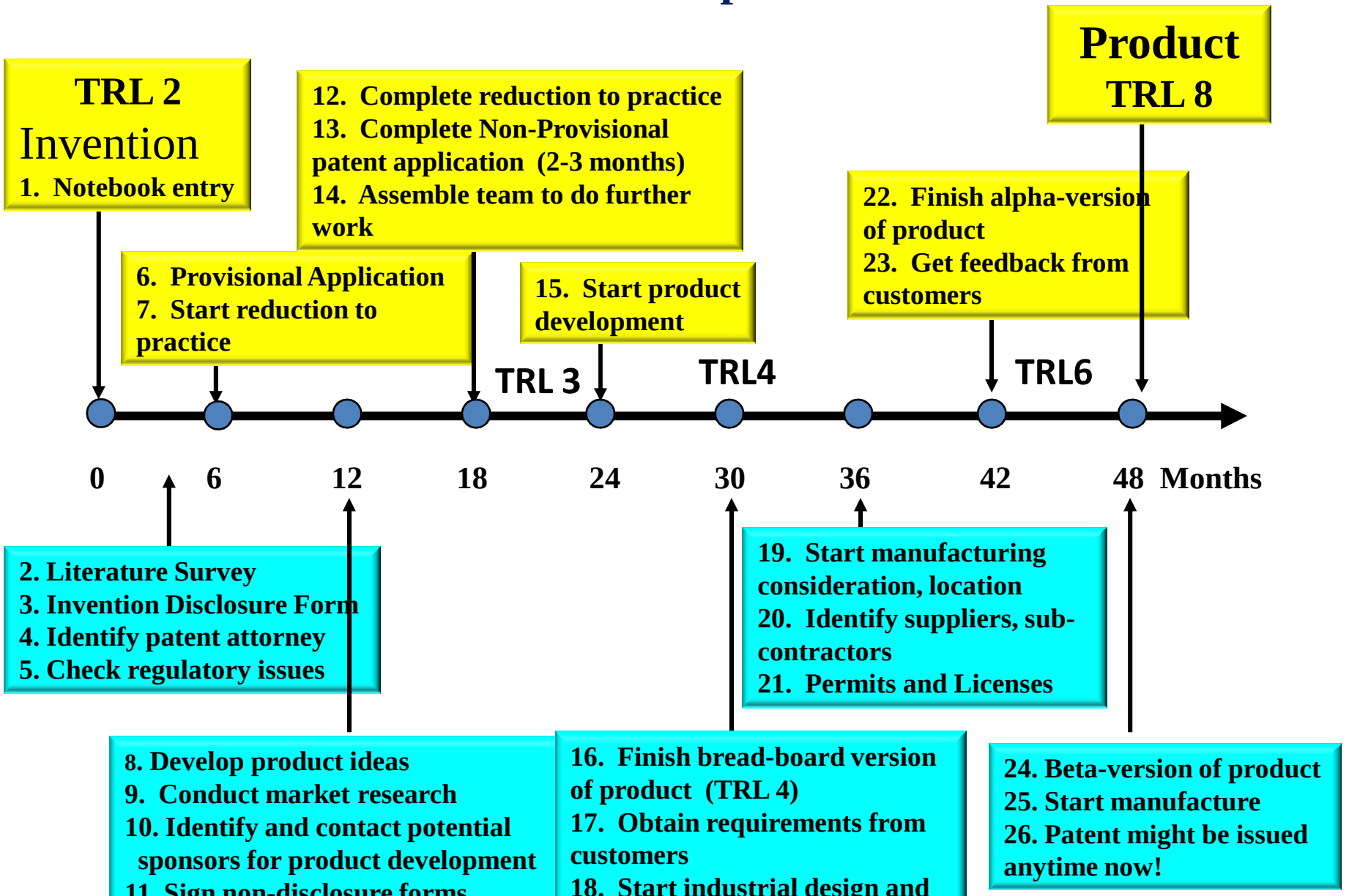
Technology Readiness Levels (TRL)



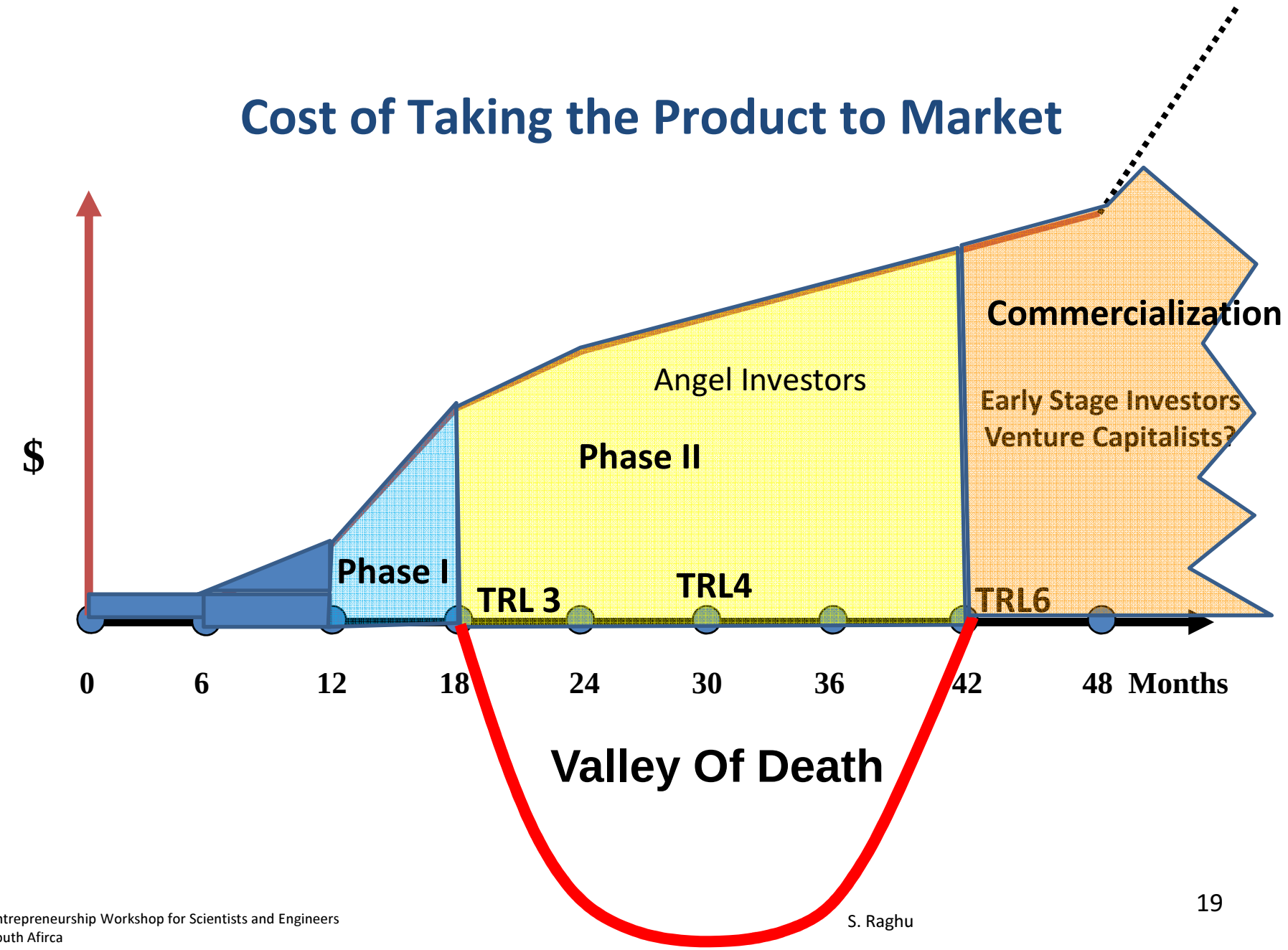
http://www.aof.mod.uk/aofcontent/tactical/techman/content/trl_applying.htm

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

Invention to Product: Steps and Time-Line

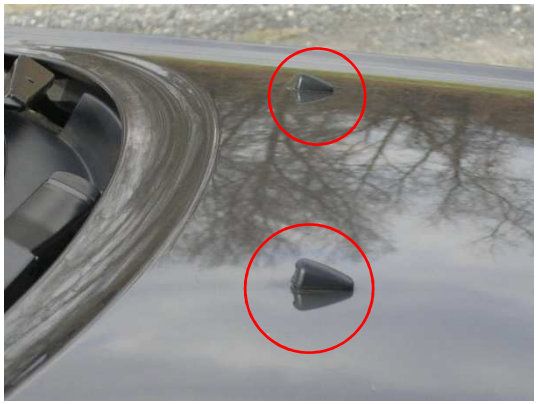


Cost of Taking the Product to Market



Examples of Timelines for Products

Windshield Washer Nozzle



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

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

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**

U.S. PATENT DOCUMENTS

3,208,462	*	9/1965	Fox et al.	137/811
3,452,772	*	7/1969	Zaloudek	137/809
4,151,955		5/1979	Stouffer	239/11
4,184,636		1/1980	Bauer	239/11
4,463,904		8/1984	Bray, Jr.	239/284 R
4,508,267		4/1985	Stouffer	239/11
4,854,176	*	8/1989	Okabayashi	73/861.19
4,976,155	*	12/1990	Challandes	73/861.19
5,213,269		5/1993	Srinath et al.	239/589.1
5,213,270		5/1993	Stouffer et al.	239/589.1
5,396,808	*	3/1995	Huang et al.	73/861.19
5,638,867	*	6/1997	Huang	137/826

FOREIGN PATENT DOCUMENTS

1550510	*	3/1970	(DE)	137/812

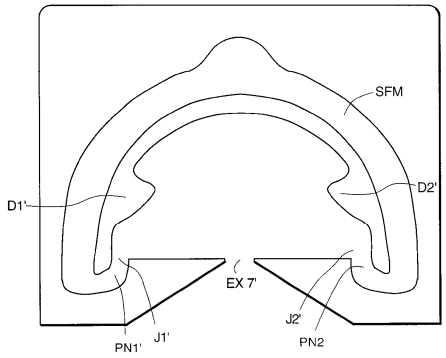
* cited by examiner

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

(57) **ABSTRACT**

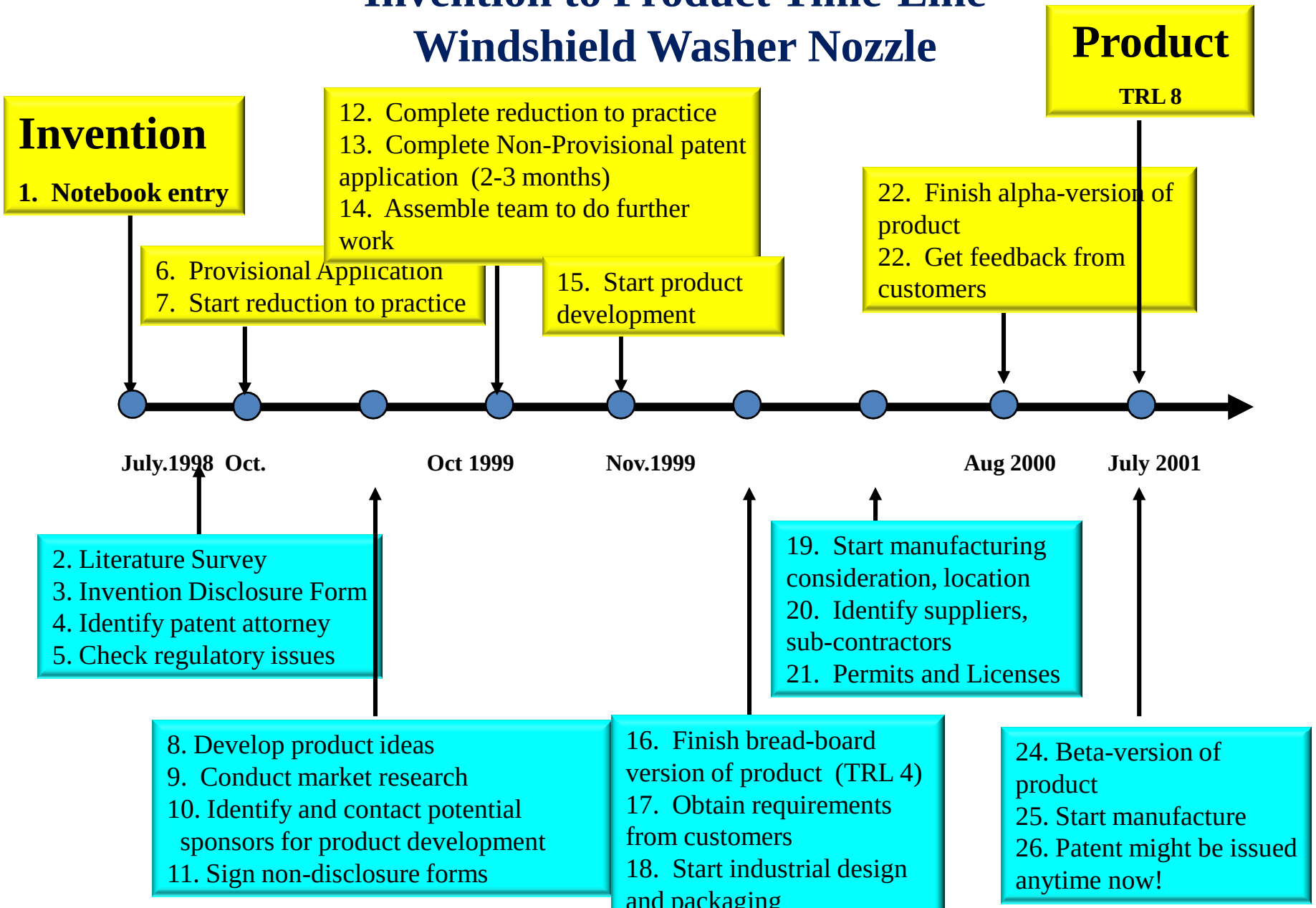
A fluidic oscillator includes a member having an oscillation inducing chamber, at least one source of fluid under pressure, at least a pair of power nozzles connected to the at least one source of fluid under pressure for projecting at least a pair of fluid jets into the oscillation chamber, and at least 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



S. Raghu

Invention to Product Time-Line
Windshield Washer Nozzle



The Final Product: Windshield Washer Nozzle

40 million nozzles/year

Used in GM,Ford, Chrysler, Volkswagon, Mercedes Saab, Jaguar Toyota, Honda

Links to commercial products

http://www.deltafaucet.com/smarttechnology/h2okinetic-technology.html

http://www.bowlesfluidics.com/products/advanced/case-study-toro-irrigation-irrigation-nozzles-precision-spray-nozzles/

http://www.bowlesfluidics.com/products/advanced/case-study-evapco-cooling-nozzle-uniform-flow-distribution/

http://www.bowlesfluidics.com/products/advanced/case-study-sundance-spa-custom-spa-nozzles/

http://www.bowlesfluidics.com/products/advanced/system-integration/

Example: 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

US006328878B1

(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**

U.S. PATENT DOCUMENTS

4,806,849	*	2/1989	Kihara et al.	204/404
4,890,622	*	1/1990	Ferrari	128/640
4,899,754	*	2/1990	Bly et al.	128/640
5,069,774	*	12/1991	Hladky et al.	204/404
5,306,414	*	4/1994	Glass et al.	204/404
5,438,988	*	8/1995	Duan et al.	128/640
5,859,537	*	1/1999	Davis et al.	324/693
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.*

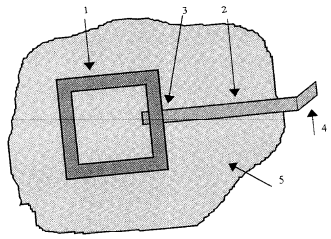
* cited by examiner

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

(57) **ABSTRACT**

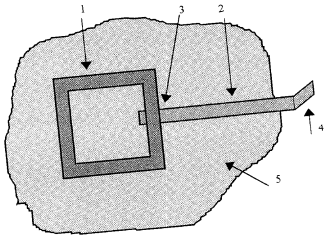
A portable and nondestructive adhesive tape corrosion sensor which is utilized under actual field or laboratory conditions in detecting coating and substrate degradation using Electrochemical Impedance Spectroscopy (EIS) of coated or uncoated metal structures has been developed. The invention allows 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

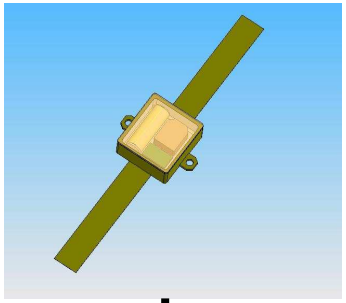


Invention to Product: Corrosion Health Monitor

INVENTION → Patent (2001)



Product concept (2005)



"mock-up" (2006)

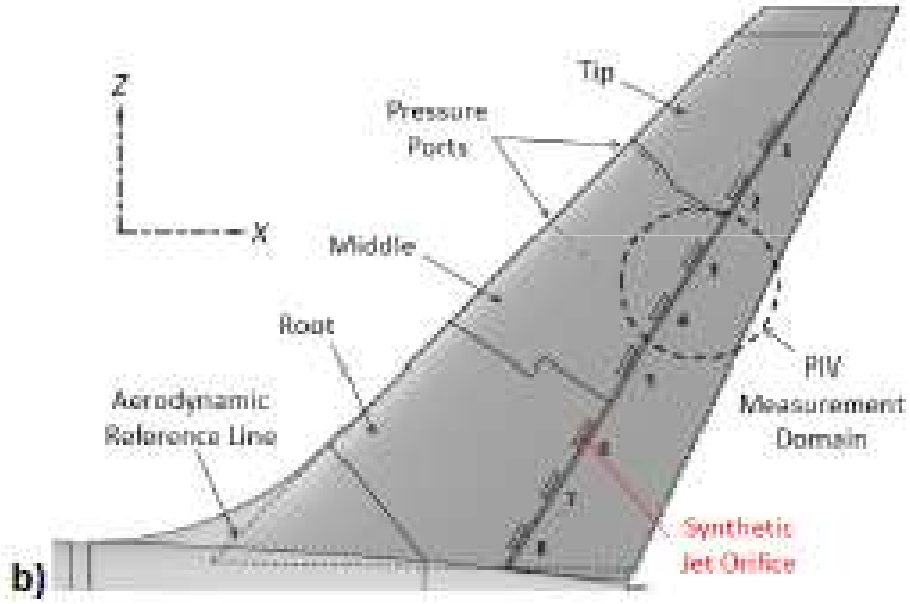
Prototype 1

TRL 7 (2007)

Product (2008)

www.electrawatch.com

Aerodynamic Flow Control Devices for Future Airplanes



Rathay et al, AIAA 2012-0071

Aerodynamic Flow Control Devices for Future Airplanes

Advanced Fluidics + NASA + U. of Arizona + Boeing
(Networking helps!)

The development cycle is much longer because of system level requirements and testing

Idea: 2006: Started working in 2008 (Invention)

Full US Patent Application in 2010
Patent Issued February 2013

TRL ~ 5 Competition begins!

NASA Press Release

***"NASA Chooses Demos For Next Phase Of Green Aircraft Program"* – Aviation Week News – January 11, 2013**

"….The active flow-control experiment will flight test sweeping-jet actuators on the vertical tail to increase rudder effectiveness. Increasing the sideforce on demand by making the rudder more effective will allow the tail to be smaller, reducing drag and weight.

The goal is to increase the side force by 20%, for 1-2% fuel saving. Wind-tunnel tests have demonstrated a 50% improvement. The flight test is planned for 2014-15."

What not to do?

“Less-useful” Patents

Apparatus for facilitating the birth of a child by centrifugal force US Patent 3216423

Electrified table cloth US Patent 5107620

Method of exercising a cat 5443036

Motorized ice cream cone 5971829

Mouse device with a built-in printer 6650315

“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!

"PITFALLS IN COMMERCIALIZATION"

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

More Inventions

What is this?

http://wildammo.com/2012/04/19/10-interesting-but-useless-inventions-you-may-or-may-not-want/#8

“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 while or technology outdated

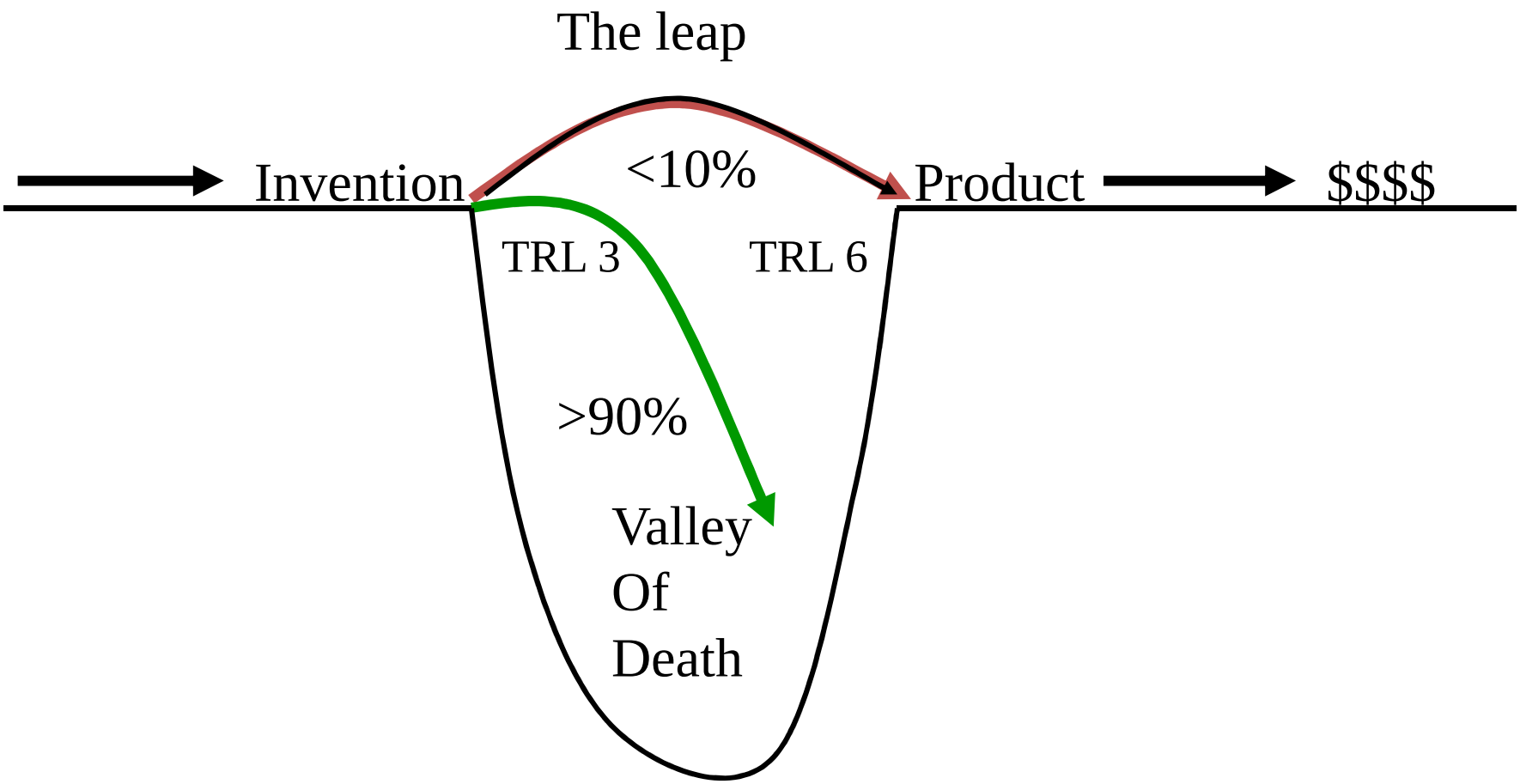
Fountain Pens
Typewriters
Pay Phones
Landline phones
Carburetors
Internal Combustion Engines?

CONCLUSIONS

Invention to a Product involves quite a few steps and processes

Technology Readiness Levels (TRL) is a good metric for determining the stage of the product.

CONCLUSIONS



CONCLUSIONS

Watch out for pitfalls!

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!

Some Useful References:

1. www.uspto.gov
2. Patent It Yourself --A complete inventor's guide. (11th ed. Spring 2005) By David Pressman, Patent Lawyer, San Francisco
3. http://www.wipo.int/portal/en/resources_innovators.html
4. http://www.wipo.int/patentscope/en/data/developing_countries.html#P11_68
5. http://www.engineeringchallenges.org

Dr. Snore

Anti-Snoring Device

For better breathing

Helps in sleep apnea

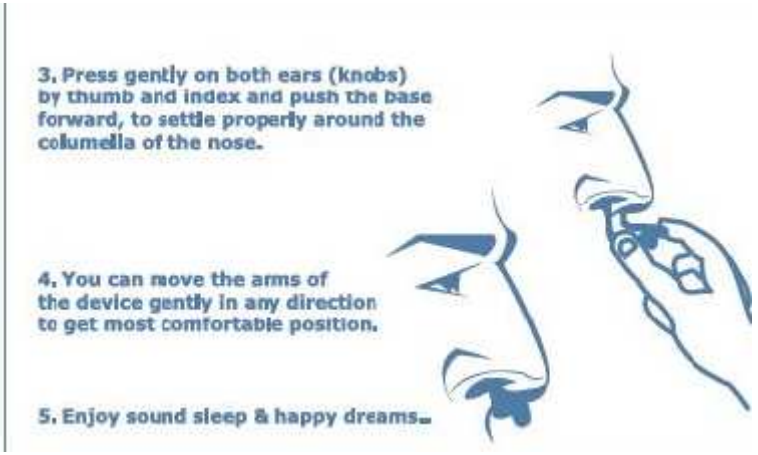
Inventor: Dr. Nasri Al-Zeir
(Small business, Jordan)
Patented in Jordan

Commercialization started in 2011

Guess who is the customer?

Initial Manufacturing in USA

Global Marketing Efforts



Beginning steps

1. **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. ….

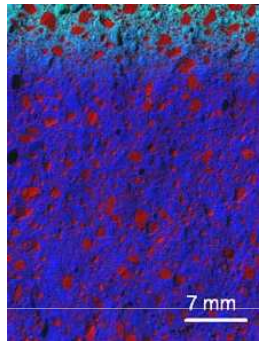
2. **Connect yourself** to the markets in the field of invention and possibly other related areas.

3. **Document your invention** - this is important for patent filing

Research and Inventions
(Solving puzzles and problems)

Applied or Commercial Research (“**use-inspired science” or market-pull research)**

Research responding to a need - objectives are somewhat known.



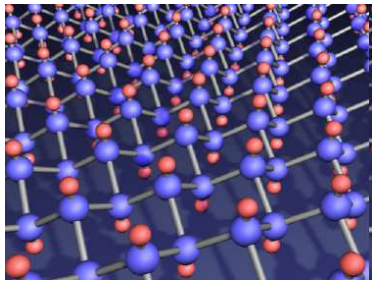
Nano-sized additive strengthens concrete (*Technology Review*)

Basic Research (market-push research)

Typically University Research/Research Institutions

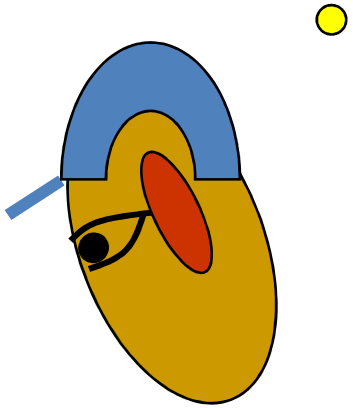
Example: Research on Properties of fluids or matter

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



Graphane makes its debut
(NanotechWeb)

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

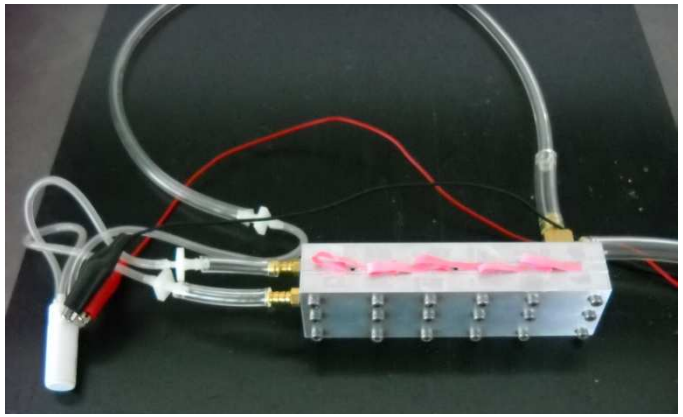
Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.

Inventions and Technology Readiness Levels (TRL 1-9)

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.



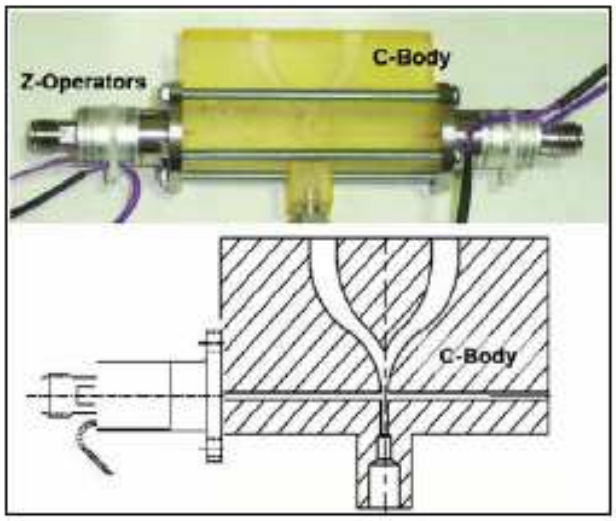
Inventions and Technology Readiness Levels (TRL 1-9)

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)

Inventions and Technology Readiness Levels (TRL 1-9)

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.

Inventions and Technology Readiness Levels (TRL 1-9)

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.

Inventions and Technology Readiness Levels (TRL 1-9)

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.

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.
- 1 in 10 people over 60 have AF and most of these go undetected. 1% of population estimated to have AF.

ATRIAL FIBRILLATION MONITOR

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

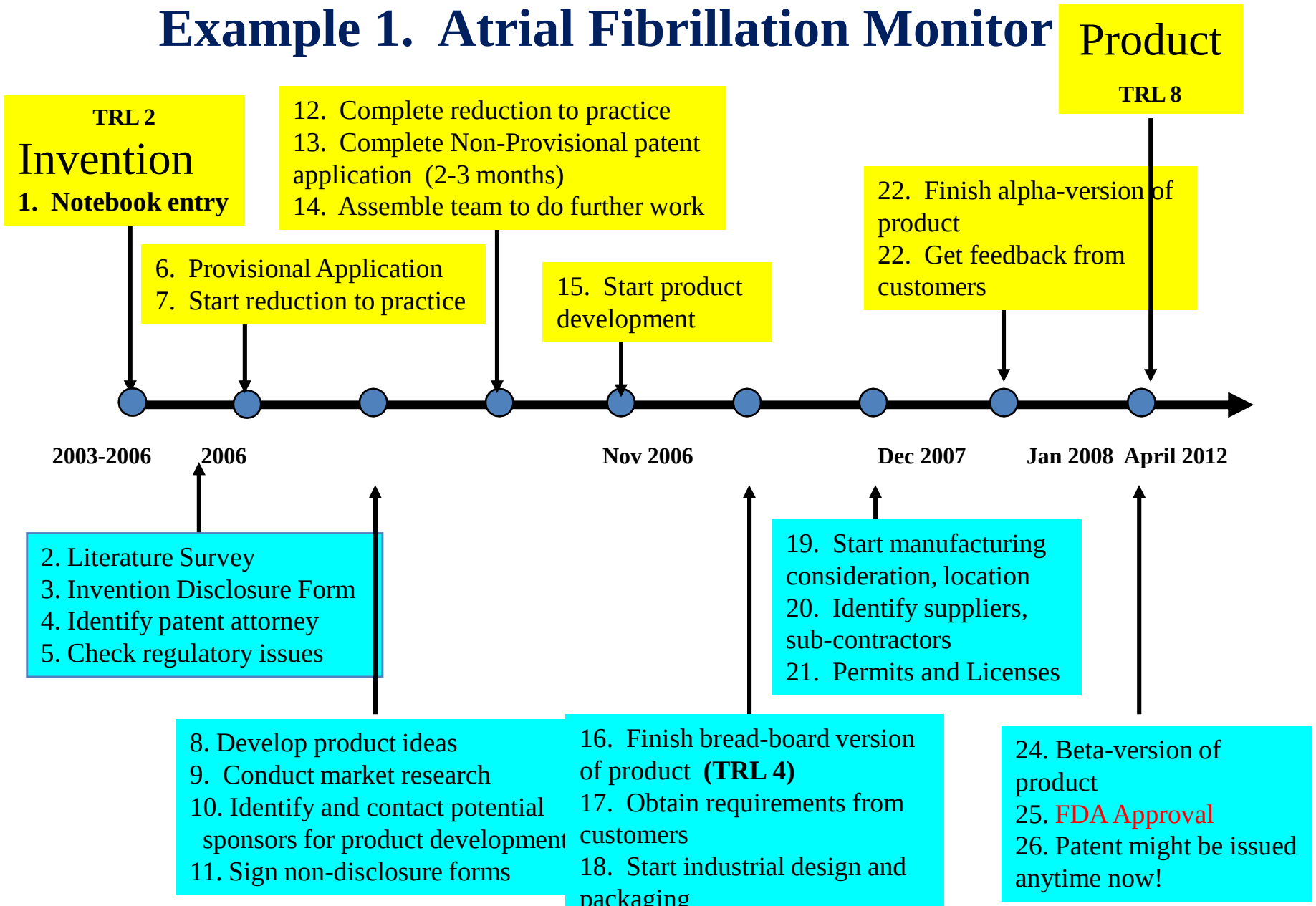
2. Validation with EKG (UK &US)

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 1. Atrial Fibrillation Monitor



	PAT. NO.	Title
1	7,293,722	Method and apparatus for generation of low impact sprays
2	7,210,937	Method and apparatus for microfluidic extrusion
3	7,070,129	Spa tub fluidic nozzle
4	6,978,951	Reversing chamber oscillator
5	6,872,484	Scalable all-polymer fuel cell
6	6,253,782	Feedback-free fluidic oscillator and method
7	6,240,945	Method and apparatus for weaving the sprays issued from fluidic oscillators
8	D417,131	Vehicle windshield washer nozzle
9	5,860,603	Low pressure, full coverage fluidic spray device
10	5,853,424	Fluidic spray nozzle for use in cooling towers and the like
11	5,820,024	High-speed windshield washer nozzle system