Marketing Testbeds for High Tech Innovation: The Case of Taurob Robotics

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Abstract

This paper describes how Taurob GmbH (LLC) , a startup firm in robotics from Vienna, Austria, commercialized its flagship product platform, the Taurob Tracker, using the marketing testbed (MTB) approach.

Taurob developed a highly versatile robotics platform, the Tracker, for use in highly hazardous environments. The design is very modularized; it can be customized to nearly any environment, but one design does not fit all environments. To make the Tracker profitable, Taurob has to characterize many potential market segments before their respective market windows open.

The Hi-Tech Center, a multinational university-industry partnership in Vienna, Austria, performed a market analysis for the Taurob Tracker using the MTB approach. As a result of this analysis, the Taurob Tracker has entered or is considering entry into at least five markets—urban fire departments, railway fire departments, mining companies, petrochemical plants & nuclear power plants—in a timely manner. The Hi-Tech Center has applied the MTB approach to more than a dozen additional products in as many industries.

Key lessons learned include, 1) Cross-functionality is essential; 2) MTB is ideally suited to overcome semantic communication barriers between users/customers and suppliers/innovators; and 3) behind every bottleneck lies a new market opportunity.

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- The Hi-Tech Center is a multi-national, multi-regional industry-university partnership.
- It is funded by the European Union's fund for regional development and by various local government agencies.
- Hi-Tech Center members include the Technical University of Vienna; the Economics University of Bratislava and Vienna University of Economics and Business.

Outline

- Taurob GmbH (LLC) and the Taurob Tracker
- Marketing Testbeds (MTBs)
- The Hi-Tech Center's Marketing Testbed
- Applying the Hi-Tech Center's MTB approach to the Taurob Tracker
- Lessons Learned
- Future Applications
- Summary

About Taurob

- High tech startup firm from Vienna, Austria
- Builds specialized robots for hazardous environments
- Founded Oct. 1, 2010 as a partnership
- Converted to an LLC on July 1, 2012
- Majority owned by founders
- Funded in part by a venture capital firm.
- Alumni of INITS GmbH, a Vienna-based incubator

The Taurob Tracker™

(For detailed description see data sheet in Appendix 1)

- Current flagship product
- Intends to save human lives
- Reduces human exposure to hazardous environment
- May ultimately replace humans in extremely hazardous environments
- Highly modularized design
- Can be customized for large variety of hazardous environments
  - Explosive, poisonous, flammable, radioactive

Key Features of Original Design

- Can carry multiple sensors that detect a variety of hazards
- Outstanding visual characterization of the use environment (4 video cameras)
- Very rapid communication of measurement data to home base (rapid data transmission rate)
- Enhanced remote control for environments with communication challenges
- Documents each use case precisely in real time (liability issue)

Met Following Technical Requirements

- ATEX certification for explosions (International standard)
  - Spark-free electrical design for intrinsic safety
- Water proof under 1 bar pressure
- Readily transportable: low footprint (~1m^2), easy to pack
- Relatively light weight (75 kg including payload)
- Ability to gain physical access to critical area
  - Should not fall sideways during tilt
  - Should not get stuck
- Time is of the essence → adequate travel speed
- Perpetual communication with home base
- Tolerance of high temperatures increases time robot can stay in hazardous environment.
- Human factors: Intuitive, user friendly interface (like joystick)
- Rapidly exchangeable sensors (plug and play)
- Easy to maintain; rapidly excheangable, modular parts

Environment Classes

- Every hazard environment is unique
- But distinct classes of environments for likely use are well known from handbooks and industrial standards
  - Poison, explosive, radioactive, etc.
- Requirements vary significantly from class to class.
- Design needs to be customized for environment class.
  - Modular assembly
- Every environment class needs to be characterized in advance of use.
- Every robot needs to be tested for one use case per environment class prior to sale.

Technology Push

- ***A versatile technology is looking for multiple markets.***
  - Prototype of Tracker has been tested with Vienna fire department and is in action there.
  - Investment for Tracker can only be recovered, if it is used in many diverse hazardous environments.
  - Multiple markets, many lead users [1], little time for development

Key Issues for Taurob

- How do we identify and characterize all potential markets before the market windows open?
- How can we customize the Tracker to meet the needs of multiple customers by the time their respective market windows open?
- How can we get the customer to adopt a radical innovation within a short period of time?

Taurob's Approach:
The Marketing Testbed (MTB)

- A service for technology-driven firms
- Finds and characterizes markets for emerging technologies
- In use in telecom industry (S. Korea & Israel)

"This activity addresses the need of technology companies to validate the need for their product and its business case." [2]

- MTB is a novelty in most high tech industries

Marketing Testbed (ctd.)

- Analogous to but different from usability testbed
- Focuses on marketing tools
  - Marketing mix
  - 4Ps
    - ***Product***: technology- & product acceptance
    - ***Pricing***/willingness to pay
    - ***Promotion***: Marketing communication
    - ***Place***: Sales and distribution channels
- ***MTB service for Taurob Tracker performed by Hi-Tech Center in Vienna, Austria***

The Hi-Tech Center

(www.hitechcentrum.eu)

- Multi-national collaborative effort between local industry and universities in Central Europe
- Funded by EU Regional Development Fund and local governments
- Provides the following services for regional startup firms and firms with high tech products:
  - Market research services
  - Preparation of marketing strategies
  - Support for high tech start-up companies
  - Specific market research tasks and business development
- Many of these services are centered around the MTB concept.

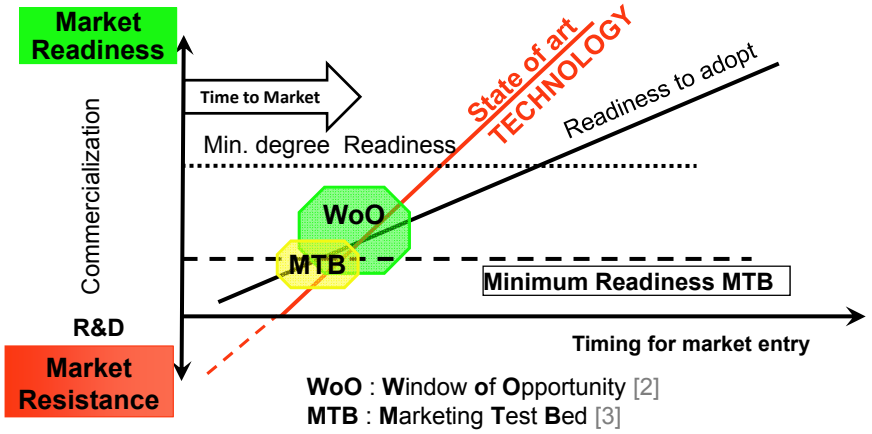
Objectives of Testbed Approach [3]

- Characterize and determine
  - Market entry date and window of opportunity [4]
  - Readiness for and resistance to adoption [5]
  - Technology acceptance and marketability [6]
  - Market entry for high tech innovation [4],[6],[7]
  - Marketing management methods for high tech products [3]-[7]

Market Research and Analysis Methods

- Problem-centered interview (PCI) [8]
- Analytical hierarchy process (AHP) [9], [10]
- MCDM (multi criteria decision making) [11]
  - especially in B2B markets
- Conjoint analysis
- Multidimensional scaling (MDS) [11]

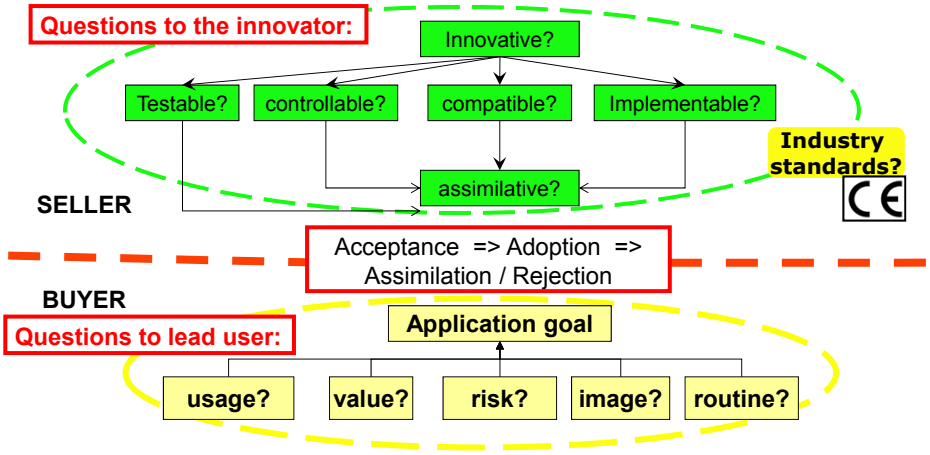
Market Entry & Window of Opportunity [2]



WoO : **W**indow **o**f **O**pportunity [2]
MTB : **M**arketing **T**est **B**ed [3]

- Early on, fear of adoption – technology not quite ready; only lead users adopt
- MTB identifies and characterizes potential markets for a technology before window of opportunity opens.
- Reduces decision uncertainty; accelerates market entry speed

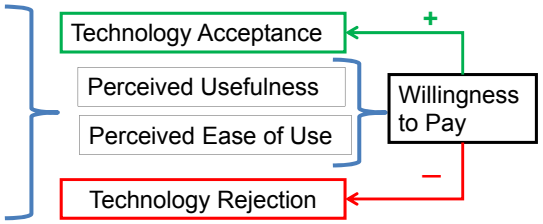
Readiness and Resistance to Innovation



- MTB determines under which circumstances innovator's capabilities meet buyer's needs.
- MTB serves as a translator between seller's language and buyer's language
- Resistance to adoption of innovation drops as parties increase mutual understanding.

High Tech Innovation: Criteria for Acceptance and Marketability

(C 1) Innovative?
(C 2) Testable/correctable?
(C 3) Controllable?
(C 4) Compatible?
(C 5) Implementable?
(C 6) Assimilative?



Example: Industrial standard EN 45545-2 (fire protection in railway systems) will open window of opportunity in march 2016 for rubber-metal composites meeting requirements of hazard level HL 3. MTB supports exploration of compliance in target market segments, helps to translate customers' expectations into functional sales arguments. Products offering functional over-compliance of C1, C2, C3, C4, C5 **AND** being in compliance with EN 45545-2 HL3 (see www.bategu.at) can speed up their market entrance.
By MTB the compliance of innovation with marketability criteria becomes ratable.

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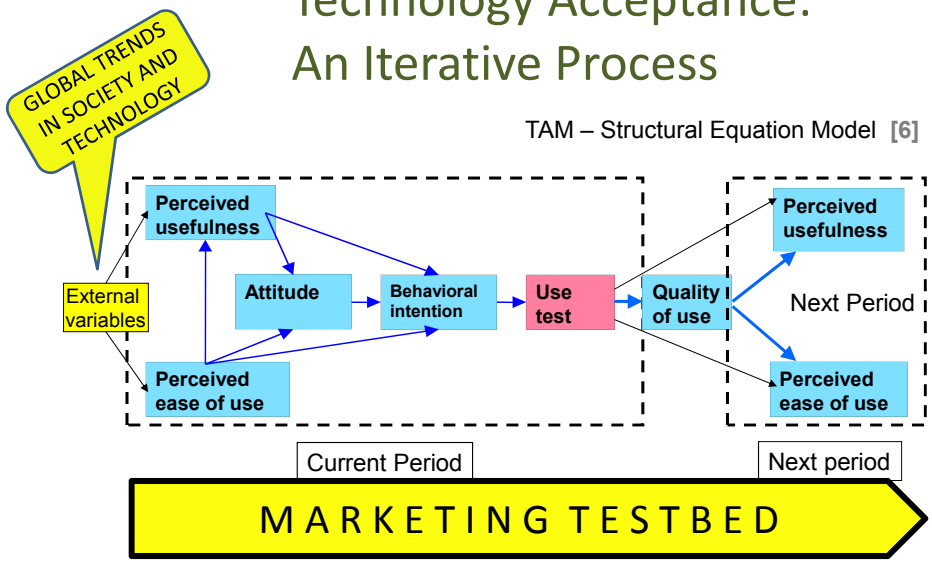
Technology Acceptance: An Iterative Process

TAM – Structural Equation Model [6]



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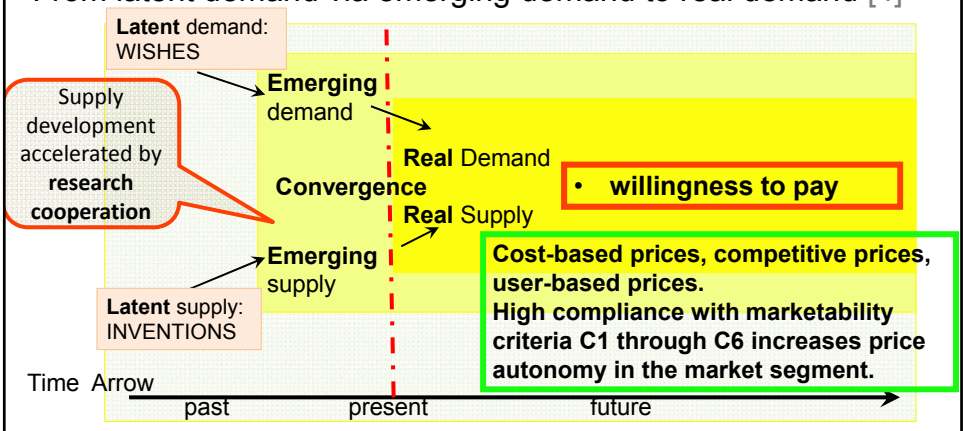
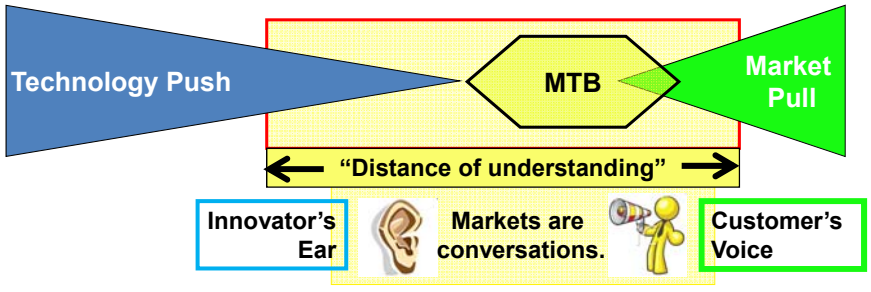
High-Tech Innovation: Market Entry

From latent demand via emerging demand to real demand [4]



- Lead users operate under emerging demand
- Mainstream users operate under real demand.

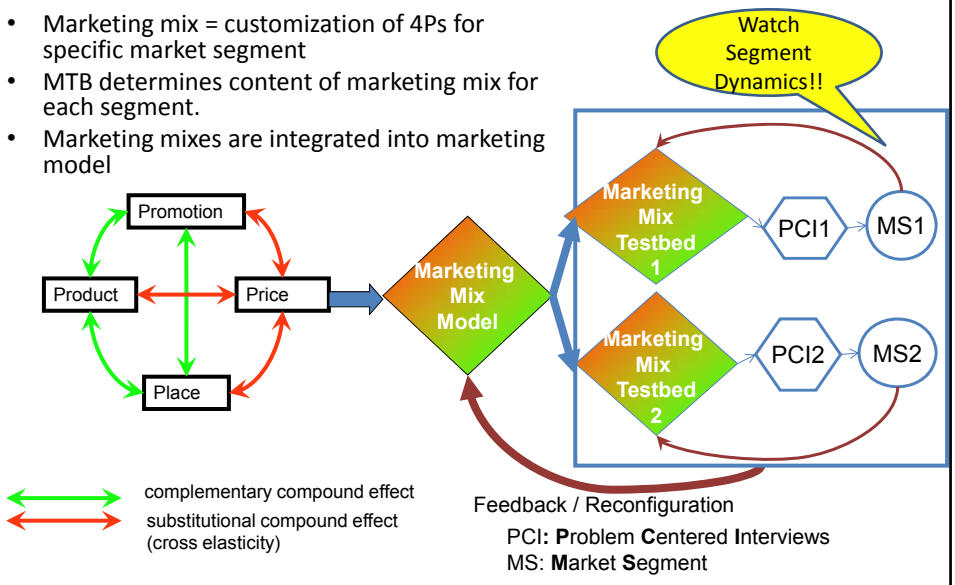
MTB and Market Entry



- Markets are conversations [12] that occur in two different "content-languages".
- The MTB translates the language of the customer into the language of the innovator, and conversely.
- Reduces distance of understanding; shortens time to market.
  - Customer offers come shortly after customer and developer understand each other

Iterative Marketing Testbed Process

- Marketing mix = customization of 4Ps for specific market segment
- MTB determines content of marketing mix for each segment.
- Marketing mixes are integrated into marketing model



Services Offered by Hi-Tech Center

- Engaged with stakeholders in multiple potential markets
  - Urban fire departments in different countries
  - Railway fire departments
  - Coal mine emergency response teams,
  - Petrochemical companies
- Conducted problem-centered interviews
- Questionnaires
- Performance tests under real conditions in use environment.
- Proof of usability and economic feasibility
- Identification of demand
- Marketing mix strategy (4Ps) for each segment,
- Composite model for the integrated marketing mix.

Market Segments Identified

- Urban Fire Departments (multi-purpose)
- Railway Fire departments
- Mining industry
- Petrochemical plants
- Nuclear power industry

Tests complete
Tests in progress
Tests designed
Under consideration

Some Specific Results of MTB

- Identified detailed, but crucial environmental factors that affect Tracker performance. For example,
  - Sunshine on display reduces readability of information
  - Impact of recoil of water hose during use
- Determined perceived usefulness and perceived ease of use by qualitative market research with firemen and miners
- Identified willingness to pay estimates with potential users.

Results: Urban Fire Departments

- Results from tests with Vienna fire department were applicable to other urban fire departments.
- No major redesign was needed.

Results: Railway Fire Departments

(Please see Appendix 2 for details)

- Tests performed with Slovakian Railway fire department revealed that …
  - Communication between two robots is critical.
  - One robot detects gas; the other brings the antidote.
  - Command and control center needs to assure coordinated behavior between robots.
  - Any interference between robots needs to be eliminated.
  - For example, collisions between robots in environments with low visibility needs to be avoided.
  - Battery life = 4 hours at high performance; rapid battery change.

Results: Mining Industry

(Please see Appendix 3 for details.)

- Robot has to be even smaller than robots for urban fire departments.
  - Taurob Tracker meets size requirements for mining industry.
- Mining robots need to be
  - Explosion proof;
  - Intrinsically safe (e.g. in flamable gas)
- Ability to work with another remotely controlled robot even more challenging
  - Disaster is remote and difficult to access
  - High temperatures; reduced visibility
  - Deformed, collapsed or burning structures in shafts
  - Explosion proof and fire proof transponder infrastructure
  - Bandwidth bottleneck--Will wavelength be available in an emergency?
- Significant exposure reduction of rescue teams in coal mining

Preliminary Results: Petrochemical Plants

- Requires protection against hydrogen sulfide (H_2S).
  - H_2S is byproduct of cracking (pyrolysis) process.
  - Currently first responders are human.
  - Decontaminated in ‘acid gas wash’
  - Should we replace human with Taurob Tracker?
  - What technical requirements make this possible?
  - How do we decontaminate the robot?
  - Research is in progress.

Nuclear Industry

- Situation is analogous to petrochemical industry.
- In addition, gases / aerosols can be radioactive.
- Marketing testbed design for nuclear industry is under consideration (depending on emerging demand).

Tracker Redesigned to meet Requirements Identified by MTB

- Hose installed on robotic arm to dilute gas hazards.
- Redesign for communication within mine shafts is in progress.
  - Wireless solution or cable-based solution?
  - Biggest challenge: communication protocols

Lessons Learned #1:
Cross-Functionality is Essential

- High tech marketing inherently involves communication between multiple knowledge disciplines.
- Negotiations between buyers/users and suppliers/innovators
  - Require interdisciplinary cross-functional teams
  - Both on the buyer's and the seller's side.

Lessons learned #2:
Semantic Barriers [13]

- Users/Customers and suppliers/developers speak different languages.
  - Use-environment-oriented versus technology-oriented jargon
- Marketing Testbed process is ideally suited to break down these barriers.
  - Initially, Hi-Tech Center acted as interpreter
  - Then Hi-Tech Center taught each party the other's language
    - Naïve questions and concrete examples enable simple formulations
  - After that, user/supplier collaboration worked smoothly.
  - Willingness to collaborate followed soon.

Lessons Learned #3: Potential Market

- Behind each bottleneck lies a potential market.
  - For example, highly qualified labor (e.g. firemen) is in short supply and very expensive.
  - Statistical value of human life is high
    - ~US$5M-10M per qualified employee [14]
    - Cost of insurance is high
  - Tight budgets constitute bottlenecks.
  - They open the market for robots (*Price ~$five digits*).
  - Total cost of ownership and lifecycle costs of robots are two orders of magnitude lower than those of humans.

Current and Upcoming Applications for Taurob Tracker

- Tracker in use at Vienna Fire Department and other fire departments in Europe
- Tracker prototype for railway fire departments, mining industry and chemical plants are under development at Taurob.
- Application for nuclear industry requires additional marketing testbed.

Additional Applications for Marketing Testbed at Hi-Tech Center

- 2D Laser Scanner
- Printed foil sensor for man-machine interfaces
- Cellular materials (repetitive structures, reduce weight)
- Wireless strain gauge
- Elastic Photovoltaic- Lithium-Battery Sandwich
- Phase change material for building construction
- Medical care robot for continuous, compliant passive motion
- Atmospheric plasma on surfaces of functional material
- High precision 3D printing
- Spine response simulation
- Ambient assisted living robot
- Diamond-like carbon material

Future Plans

- Taurob to expand applications of Tracker platform.
  - Increasingly international business
  - Expansion into multiple industries
  - Reduced cost of platform derivatives
- Hi-Tech Center plans to
  - Become a private company that specializes in MTB service
  - Collaborate with incubators

Summary

- Firms like Taurob develop highly innovative technology that is looking for new markets
- Marketing testbed studies identify and characterize these markets
- They bridge the gap between suppliers/innovators and users/customers
- Technology enters more markets.
- Time to market is reduced.
- Flop risk is reduced.

Q&A

Thank you for your attention!

Additional non-confidential data for MTB studies on the Taurob Tracker are available upon request. Some are presented in Appendixes 2 and 3.

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Appendix 1: Detailed Data Sheet for Taurob Tracker


Informationsblatt - Feuerwehrroboter

TAUROB

Überblick

Technische Daten

Alleinstellungsmerkmale

Aktueller Stand und weitere Schritte

Appendix 2: Railway Fire Departments-- Real figures and statistics

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Railways of Slovak Republic		2012	2013	2013/2012
Total Number of Accidents		616	393	0,64
From:	Fires	304	132	0,43
	Outflow of Gases	44	1	0,02
Help with fires (at other companies)		125	58	0,46
Expected excursions with robot		56	25	0,45
Fatal accidents		0	1	x
Severe injuries		5	2	0,4

Appendix 2:
Remarks on Railway Study

- Number of accidents decreasing significantly
- Better applications of rules and laws
- Aim of robot use is to
  - save the firemen lifes and more efficient fitting of rescue middles
  - Reduce the burden of work during a rescue intervention
  - Decrease of material losses
  - Quick recovery of workings

Appendix 3:
Qualified Figures:
Mining Industry

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Coal mine in Handlová /brown coal/ the real figures are unknown - qualified estimation		
Total number of accidents		150
Of these:	Fires	50
	Outflow of Gases	55
Expected excursions with robot		105

Appendix 3:
Remarks on Coal Mine Study

- Accidents are very rare.
- Precise operating instructions – what to do in the case of accident
- Number of robot applications is more frequent.
  - In principle, robot excursions could occur anytime.
- Goal of using robots
  - To save the lives of miners and rescue teams;
  - To make the rescue action easier.

Appendix 3:
Remarks to rescue action in the mine

- Composition of teams
  - Two squads of five people
  - One team leader
  - + /if neccessary/ 1 doctor and 1 chemist
- Very specialized preparation and schooling, which occurs on a regular basis.
- The risk during intervention is very high.
- The frequency of intervention is 1-2 times/week.