Major directions of modern TRIZ development

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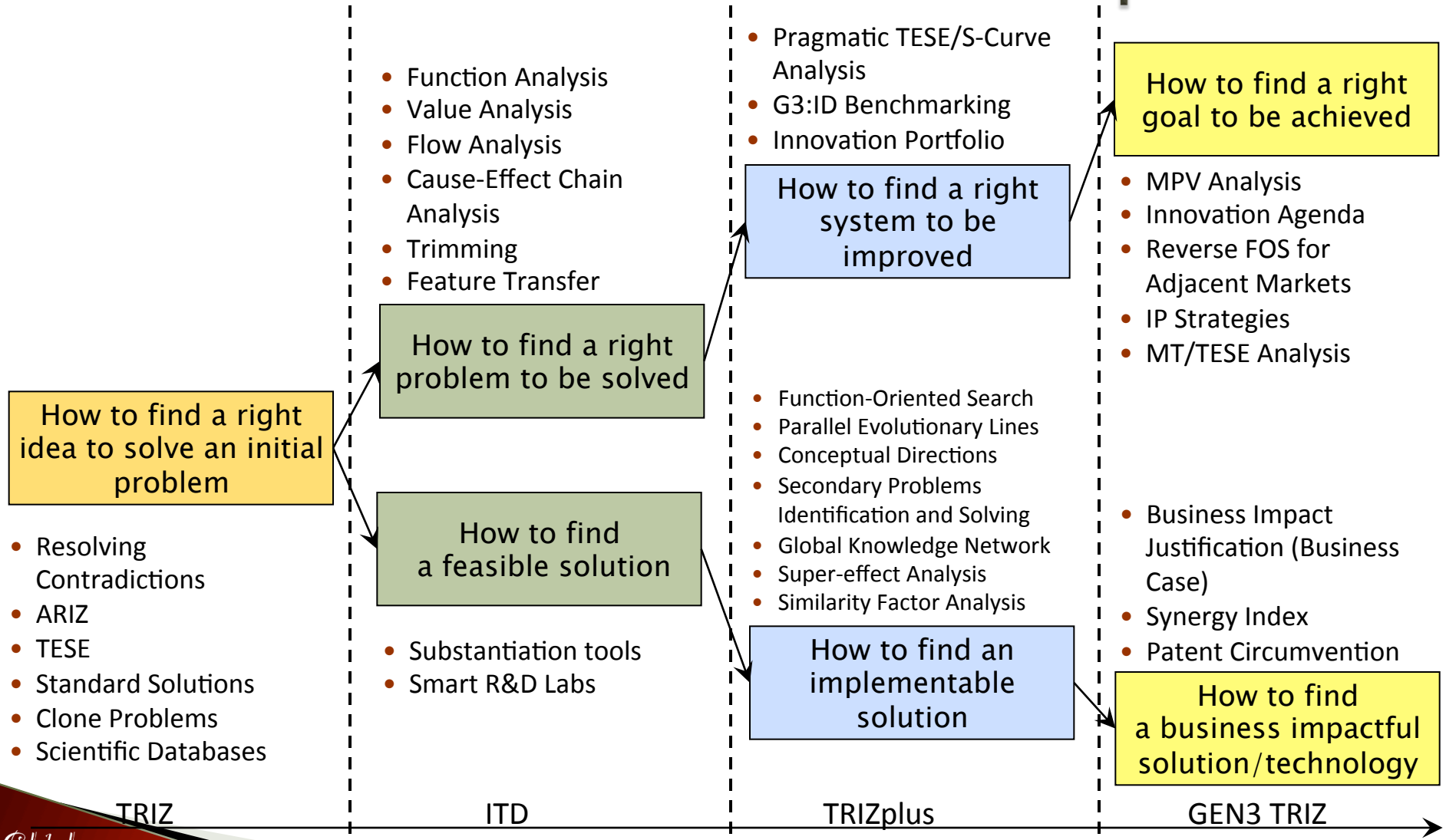
Current State of TRIZ Development



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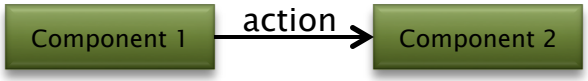
  - Product/Process Portrait development
  - Needs identification and evolution
  - Interactions and integration of different Evolutionary Trends
- Conclusions

Coordination of Various TRIZ Tools

Function Analysis

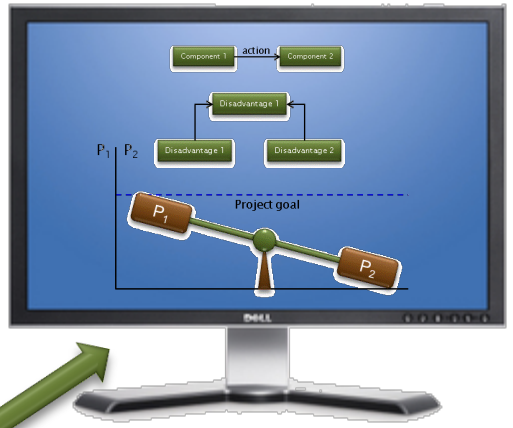


Function Language

Cause-Effect Chain Analysis

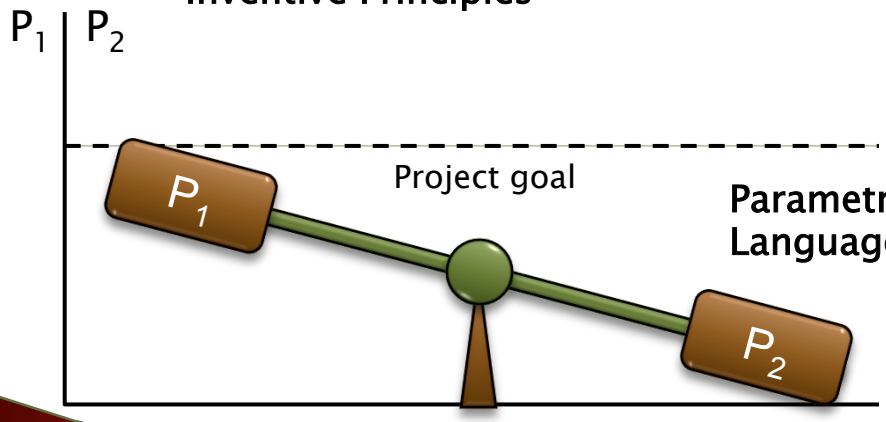
Natural Language

Parametric Language

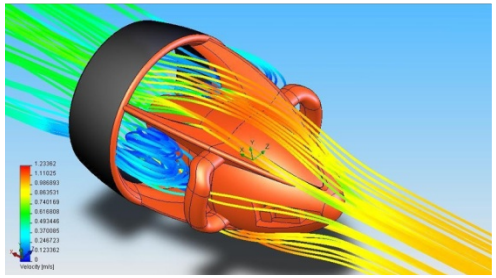


Deep computerization

Inventive Principles



Parametric Language



Deep integration with computer models

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TRIZ Tools for Supporting Open Innovation

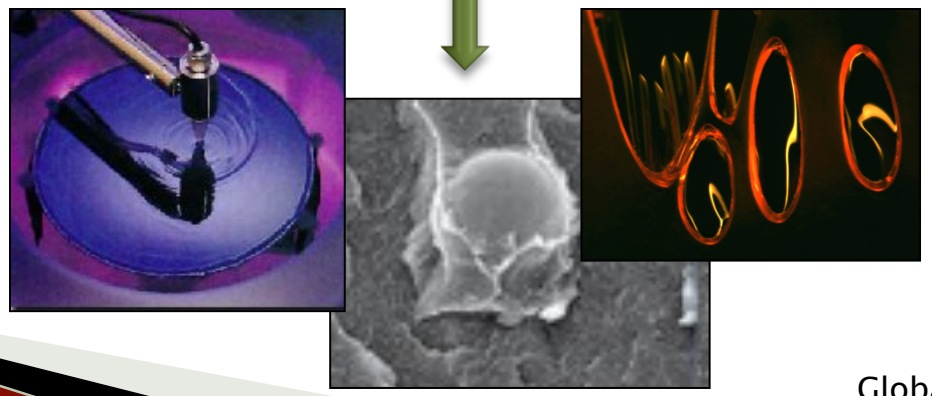
- Direct Function-Oriented Search
- Parallel Evolutionary Lines
- Reverse Function-Oriented Search
- Clone Problems
- Feature Transfer

Main approach: search for indirect analogies and existing solutions in distant industries and areas of science

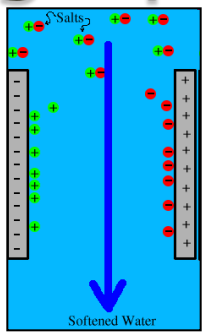
TRIZ Tools for Supporting Open Innovation

Direct Function–Oriented Search

The problem:
How to prevent bubble formation in the photoresist?



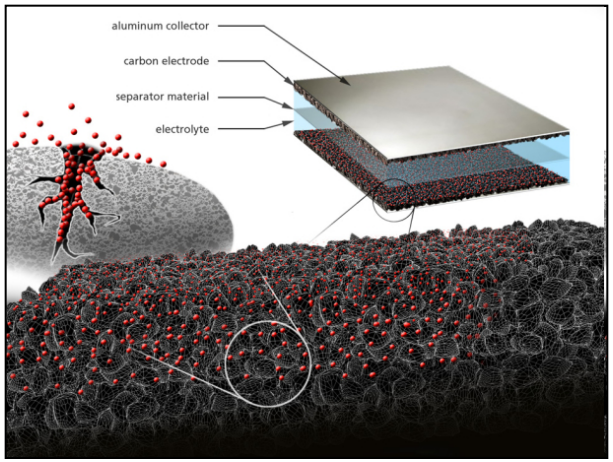
TRIZ Tools for Supporting Open Innovation

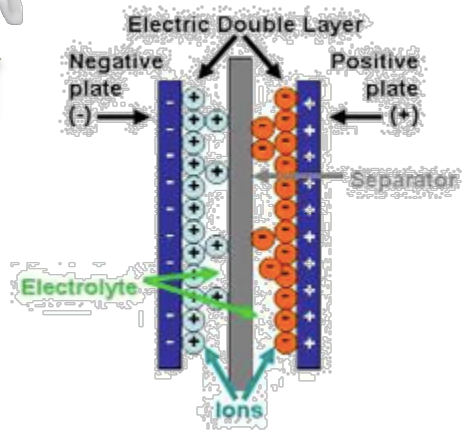


Water desalination

Reverse Function-Oriented Search

What is potential application areas for ultra capacitors?





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Special Tools for Secondary Problems Identification

- General idea of FOS-Derived solutions (FDS) substantiation is to prove that the specific area where the suggested FDS was found has a high Similarity Factor (SF) with the initial area and/or increase the SF by solving Adaptation Problems (AP)
- Steps of FDS Substantiation:
  1. Identify the initial level of SF for the FDS addressing the target MPV by identifying the similar conditions
  2. Identify significantly different function performing conditions and corresponding Adaptation Problems
  3. Identify other MPVs to be addressed and corresponding Adaptation Problems

Example: Anti-Allergenic Nasal Filter

- New product development: Anti-Allergenic Nasal Filter (ANF)
- Initial situation:
  - Goal – to prevent allergies caused by contact between small organic particles (5-20 microns) with the mucous membrane in the nostrils
  - Target MPVs – Filtering Effectiveness (not less than 95%), and Breathing Resistance (should be as low as possible)
  - Other identified MPVs – Inconspicuousness, Cost, and Safety (filter material should be bio-compatible)
  - Best product on the market – nasal filter with filtering medium inside (Japan)

Example: Anti-Allergenic Nasal Filter

- FOS results:
  - Specific Function – to trap pollens from inhaled air
  - Initial engineering/scientific area – medical inhaling devices
  - Generalized Function – to separate small particles from a gas flow
  - Function-Leading Area of engineering – industrial dust collectors, specifically in cement and chemical production
  - Expertise from Global Knowledge Network – Negev-Tornado company (Beer-Sheva, Israel)
  - Selected FOS-Derived Solution/technology – industrial cyclones have a very high Filtering Effectiveness (99.9%) with a very low aerodynamic resistance (open inlet, no filtering medium)
  - FDS action principle – centrifugal separation. Centrifugal forces are caused by a vortex created by a spiral inlet of the filter

Example: Anti-Allergenic Nasal Filter

- FDS Substantiation algorithm:
  1. Identify the initial level of Similarity Factor:
     - ANF target MPVs are already addressed by Industrial Cyclones (IC) because of their operation principle – high Filtering Effectiveness and low Aerodynamic Resistance
     - Function Conditions of ANF that are the same, similar, or less severe than IC conditions:
       - Size of particles to be separated – similar
       - Presence of air flow
       - Vortex creation principle – spiral inlet
       - Absence of filtering medium
       - Particles concentration – less severe
       - Necessary dust collection capacity – less severe

     Preliminary conclusion – function conditions for IC and ANF have a pretty high Similarity Factor. Continued analysis to further increase the SF should occur

Example: Anti-Allergenic Nasal Filter

- FDS Substantiation algorithm (cont.):
  2. Identify significantly different function performing conditions and corresponding Adaptation Problems:
     - Filter size – IC are large versus a Nasal Filter that has to be placed into the nostrils
     - Air flow – is much larger in IC than in ANF
       Adaptation Problem 1 (AP1): would the air flow be sufficient to create the necessary centrifugal force if we place the cyclone inside the nostril?
     - Fans are a source of air flow in ICs; there is no space for any fans inside the nostrils.
       AP2: how to provide the necessary air flow within the cyclone without fans?
     - There are dust collectors in ICs to keep the separated dust – there is a very limited space for this function in the nostrils
       AP3: how to trap particles without dust collector?

Example: Anti-Allergenic Nasal Filter

- FDS Substantiation algorithm (cont.):
  - Timing of application – years for ICs vs. hours for ANF
    AP4: does the sticky layer have enough capacity for 6-8 hours of use?
  - Two cyclones are needed for two nostrils – there is no problem
  - Need to insert the filter into nostrils and then take it out. There is no problem inserting the filter.
    AP5: how to take out the filter without conspicuous parts?
  - Mass production of ANS vs. small scale production of ICs
    AP6: how to efficiently produce a mini-cyclone with a complicated shape on a mass scale?

Example: Anti-Allergenic Nasal Filter

- FDS Substantiation algorithm (cont.):
  3. Identify other MPVs to be addressed and corresponding Adaptation Problems
     The other ANF MPVs that are not addressed by ICs:
     - Inconspicuousness – ICs are very large. Solutions for AP1 (mini-cyclones) and AP5 (transparent connection strip) also address this MPV
     - Cost – ICs are very expensive because of their large size and several complicated units like fans and dust collectors. Solutions for AP1, AP2 (no fans), and AP3 (sticky layer as the dust collector) are addressing this MPV
     - Safety – filter and sticky layer material must be bio-compatible and non-irritants
       AP7: what materials are both bio-compatible and fit the mass production manufacturing process? The effective materials were selected later during the Technology Development/Validation stage

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Further Development of MPV Discovery Techniques

Main Parameter of Value (MPV): Key attribute/outcome of a product/service that is hereto unsatisfied and important to the purchase decision process

Innovation: Significant improvement along at least one Main Parameter of Value

MPV Definition

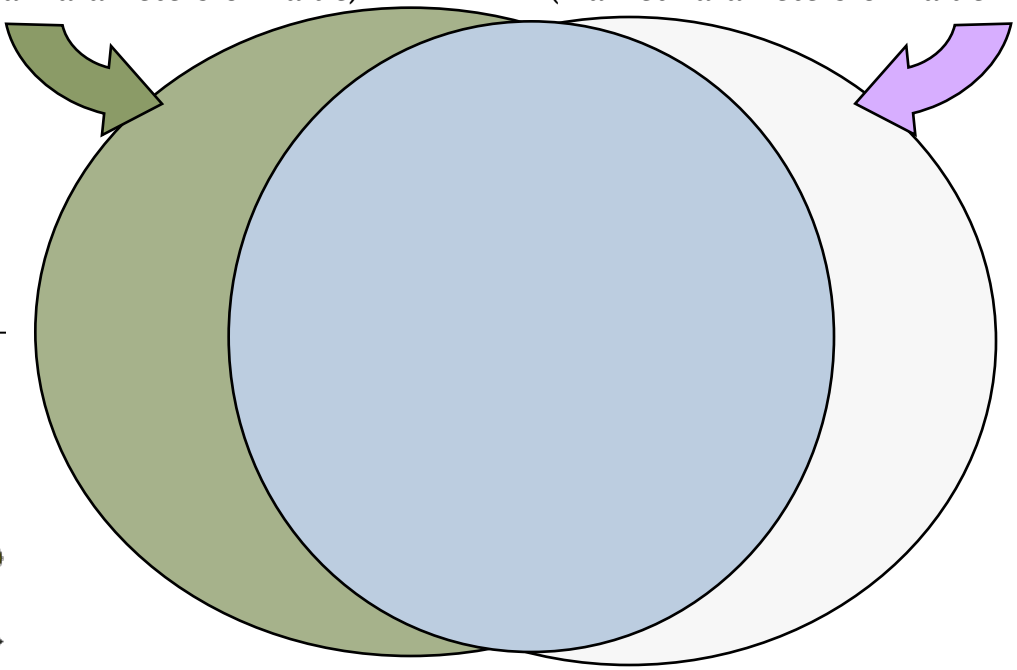
MPV Example

What Do Consumers Want from Domestic Airlines?

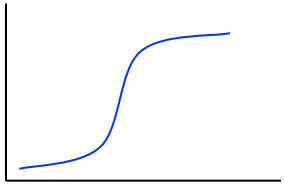
MPV Discovery: VOC and VOP Cooperation

"Voice of the Product"
(Objective Functional Parameters of Value)

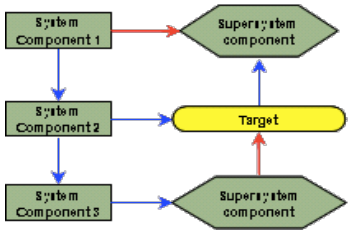
"Voice of the Customer"
(Market Parameters of Value – needs, occasions, actions)



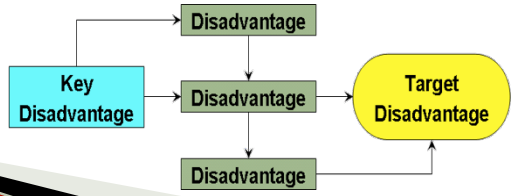
Trend Analysis



Function Analysis



Cause-Effect Chain Analysis



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Product/Process Portrait Development

MPV to be addressed:

Users Want Portability

Flatter Laptop

Users Want a Large Display & Keyboard

No Compromise on Size

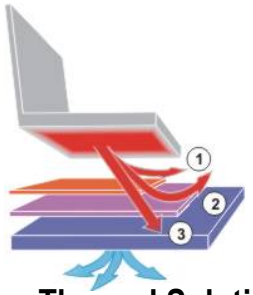
Users Want a Strong and Good-Looking Laptop

Appearance and Ruggedness

Users Want Performance

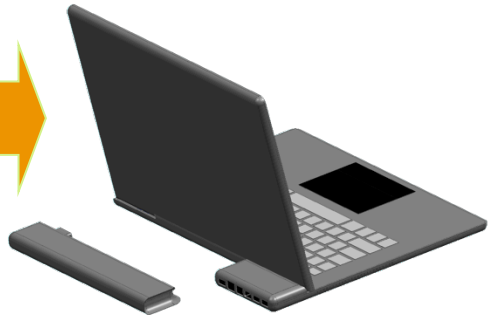
Better Heat Dissipation

Laptop/Chip Makers Want Heat Management and Fewer Parts



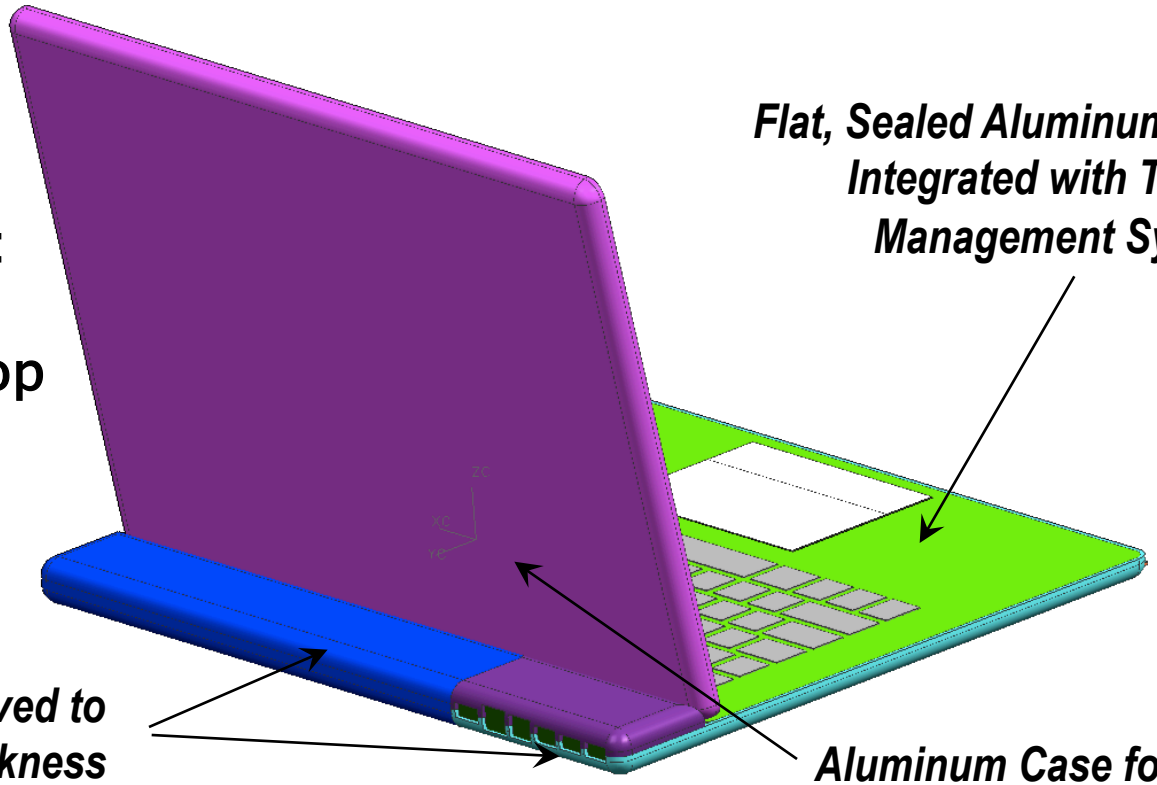
Better Thermal Solutions

Ideal Product Portrait: Ultra-Thin AI Laptop



Product/Process Portrait Development

Product Portrait:
Ultra-Thin
Aluminum Laptop



Flat, Sealed Aluminum Keyboard Integrated with Thermal Management System

Battery and ports moved to rear to minimize thickness

Aluminum Case for Appearance & Ruggedness

MPV Addressed:

- Portability
- Appearance
- Ruggedness
- Thermal Management
- Part Consolidation

Product/Process Portrait Development

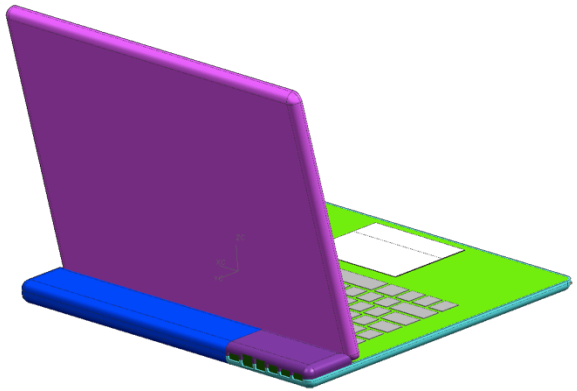
Value Proposition

Provides thin, high performance laptop by removing battery from base and using flat keyboard with integrated thermal management system. Laptop attractiveness improved through use of aluminum case and assembly friendliness increased through part consolidation.

Differentiation/Technical Advantages:

- Thinnest laptop available
- Flat keyboard technology (optical or pressure sensors)
- Sealed keyboard
- Thermal conductivity of aluminum
- Aluminum surface finishing technology

Business Case



Key Success Factors

- Successful consolidation of keyboard and thermal management components
- Cool/attractive surface finish

Stakeholders in the Value Chain

CPU → ODM → OEM → End Users

3YR Mkt Potential*	Overall Risk	Technical Risk
$2.7B 3YR Proj. Rev.** $74MM		

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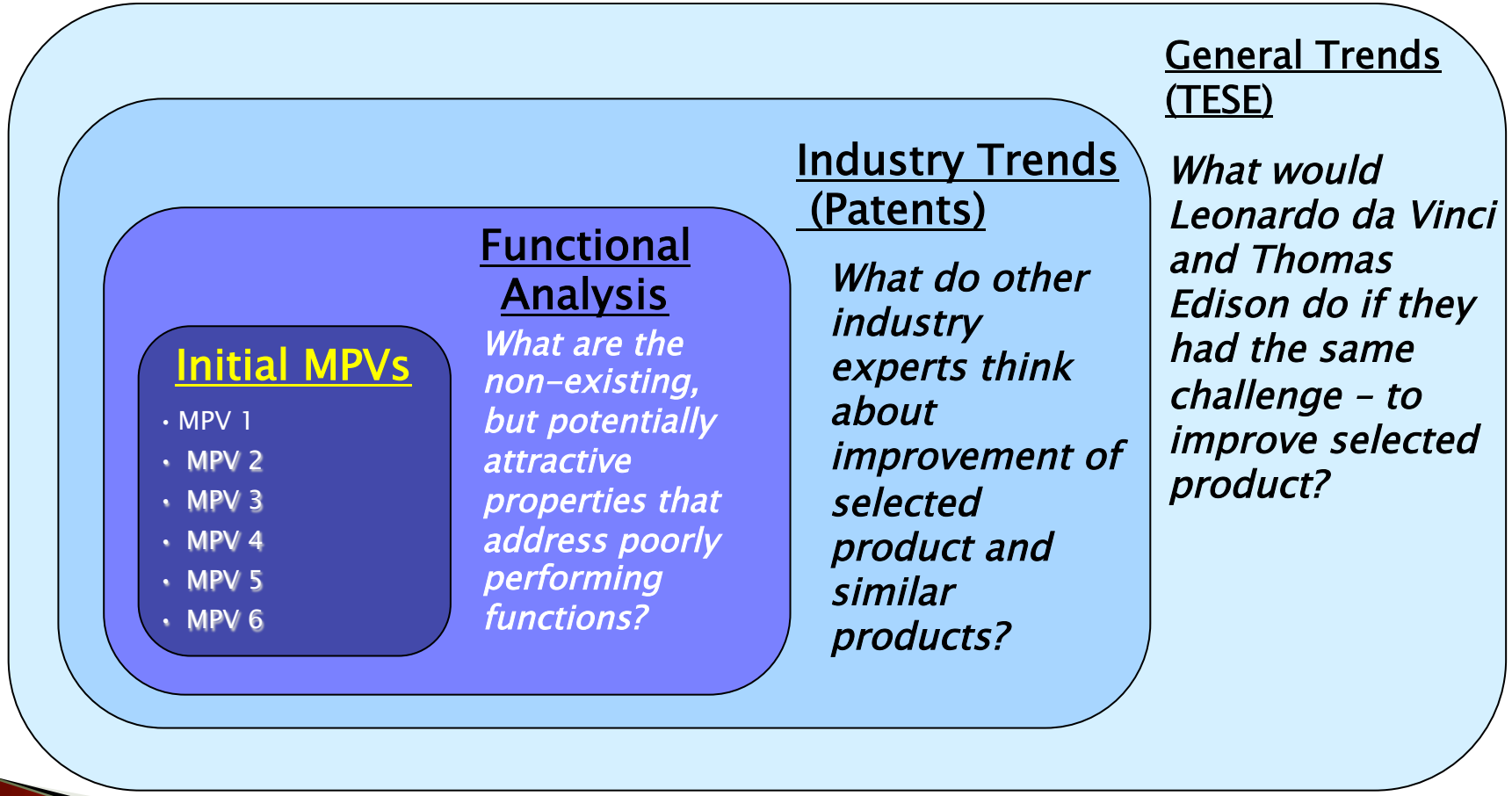
Needs Identification And Evolution

We are not very good at identifying needs

- Limitations of market surveys – people don't know what they don't know
- Product presumptions limit needs assessment – people can't believe they may ask for some advanced product's features and parameters of value

Needs Identification And Evolution

Latent Need Identification: VOP tools



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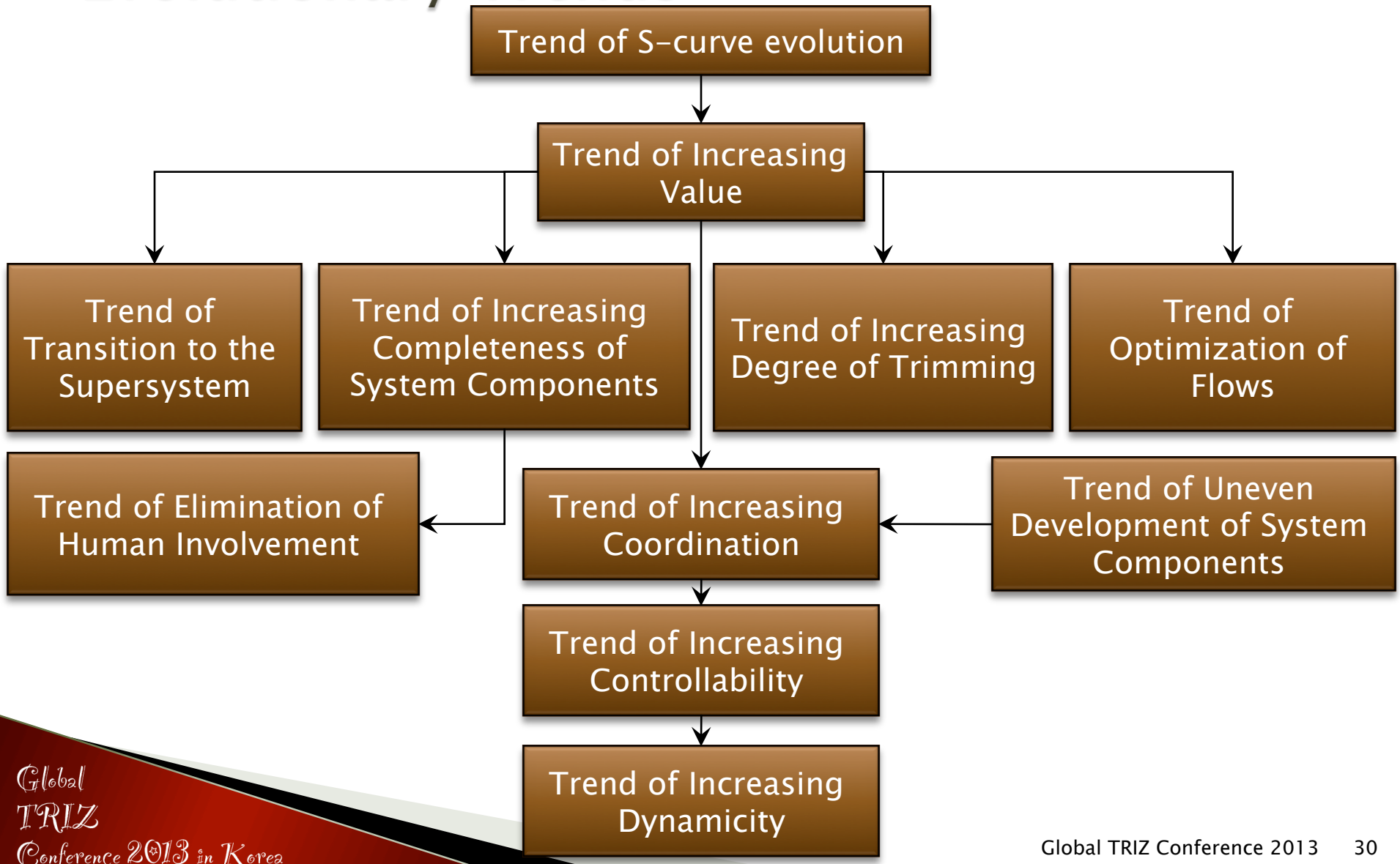
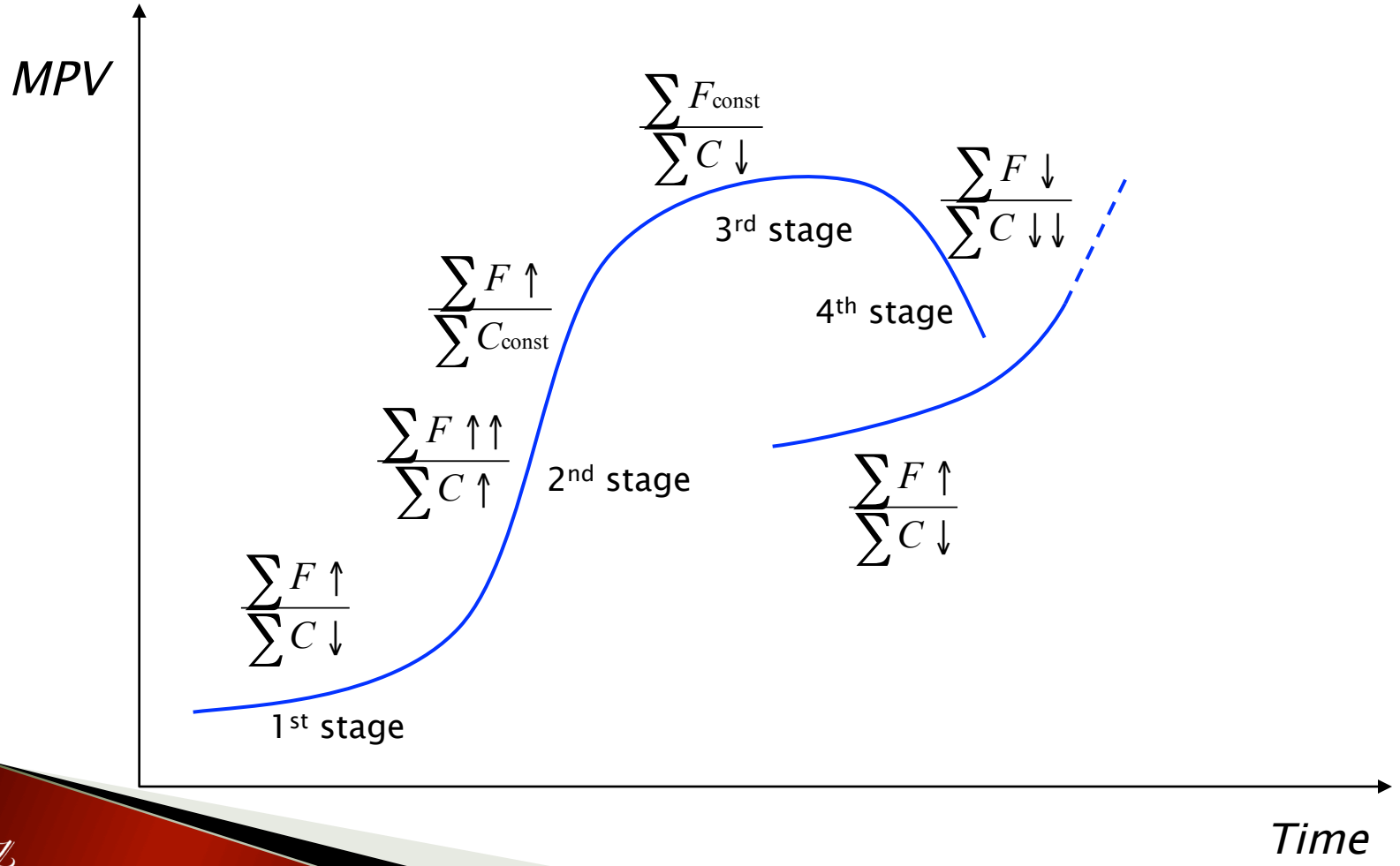
Interactions and Integration of Different Evolutionary Trends



Interactions and Integration of Different Evolutionary Trends



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Conclusions

- TRIZ is still a young science that has multiple challenges and a great potential for further development
- Two major trends of TRIZ development are building the bridges between business challenges and technical problems and transition from ideas to real products and technologies
- There are seven major directions of further TRIZ development that were recently identified within TRIZ community
- Several new TRIZ tools that address these directions were developed during last two decades
- There is still a need for developing new TRIZ tools within identified major directions

Thank you for your attention!
Q & A

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