Intel's TRIZ Journey

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Agenda

- TRIZ in Intel
- Why is TRIZ so important to Intel?
- TRIZ training overview
- TRIZ Proliferation & Adoption: Challenges & Strategies
  - Manufacturing Case Study
- Key Learning, Summary & Conclusion

TRIZ in Intel

- **Driven by manufacturing groups**
  - **Fab/Sort Manufacturing**
  - **Assembly/Test Manufacturing (ATM)**
    - Focus area: to improve equipment performance
    - Boundary conditions for equipment solutions: Effective & low cost (small changes due to large equipment base)

TRIZ at Intel

- **1996-2001 Early exploration stage** — Curious early adopters
  - 1996, Santa Clara Technology Development - Began TRIZ software pilot/training. Two very successful projects – "Sputnik" and "Bubbles"
  - 1998 Introduced to Assembly Technology Development and Flash Business
- **2002-2004 Early deployment and seeding in Mfg.** — Champion - Evangelist
  - 2002 First TRIZ class in Assembly/Test Mfg. – Cavite, Philippines
  - 2003 First class in Fab/Sort Mfg. – Kiryat Gat, Israel
  - 2004 Classes in more sites (Fab/Sort and Assembly/Test)
- **2005-2006 Adoption – Manufacturing world-wide** — Leader - Proliferators
  - 2005 First classes to Level-2 and Level-3
  - 2006 All Level-1, Level-2 classes delivered internally
- **2007-2008**
  - Manufacturing expansion
  - R&D Introduction
  - Connectivity with other methods
- **2009 -> into the future**
  - Expanding existing use
  - New fields of application
  - Synergy with other methods:
    - Lean, Six-sigma, TOC…

Courtesy Amir Roggel, Intel Principal Engineer

Intel's 1st TRIZ Summit Conference
Chandler, Arizona - Dec 2007

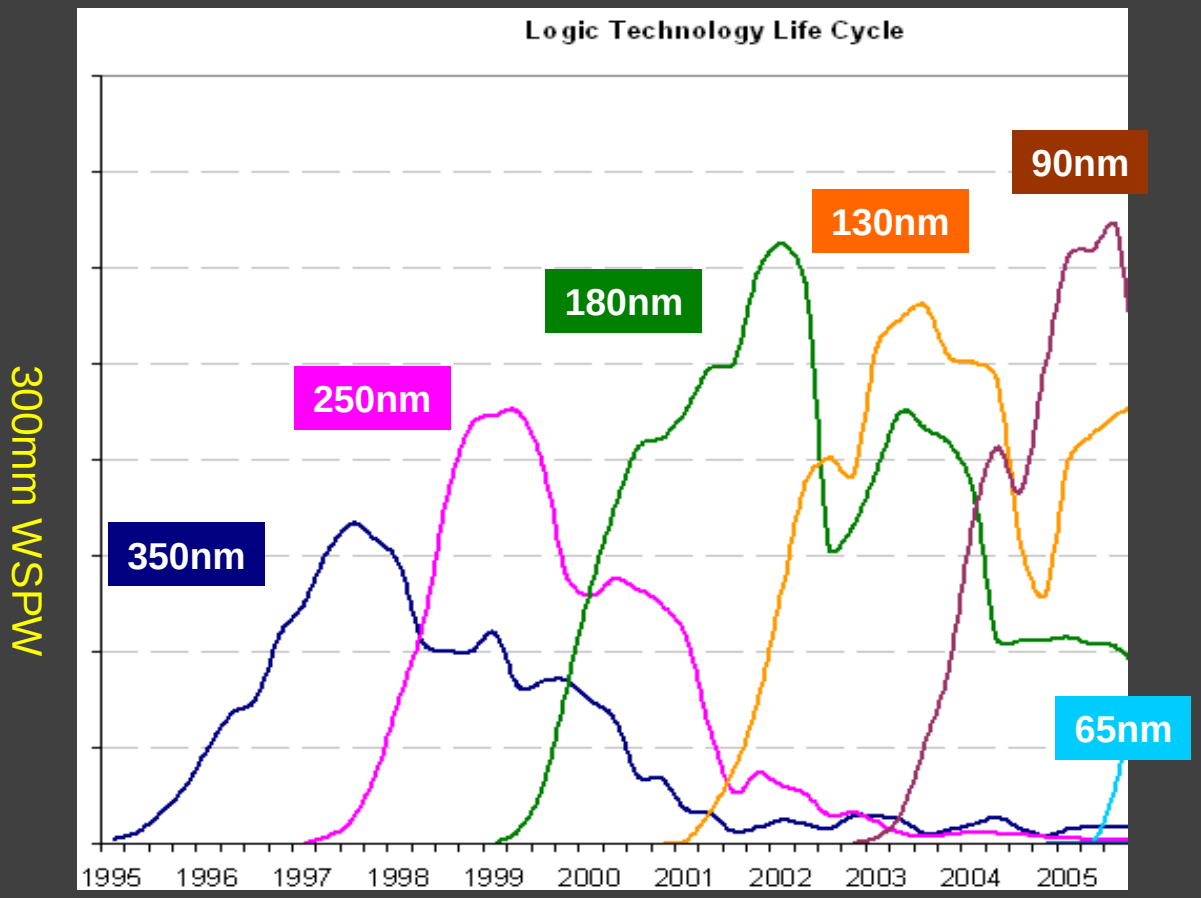
- Intel wide conference held in 2007.
- Conference Theme: "Innovating the Future"
- Over 150 attendees from around the world (40 non-US).
- 6 papers, 28 posters showcasing work across multi-disciplines
- Invited talks by Intel Fellows, industry experts, TRIZ masters

Why is TRIZ so important to Intel?

- Why problem solving is so critical in our current business model
- Our manufacturing objectives

Why is it important for Intel to solve manufacturing problems quickly?

Each new technology has a shorter life cycle and requires a faster ramp rate than previous technologies. Problems incurred are much more costly per day than they have ever been.



Intel's Manufacturing Mission

To be the best at:

- Ramping new products into high volume
- Yields
- Tool productivity
- Cost and agility

In order to achieve our goals, problems must be quickly contained, and with root cause understanding.

This is why we adopt TRIZ

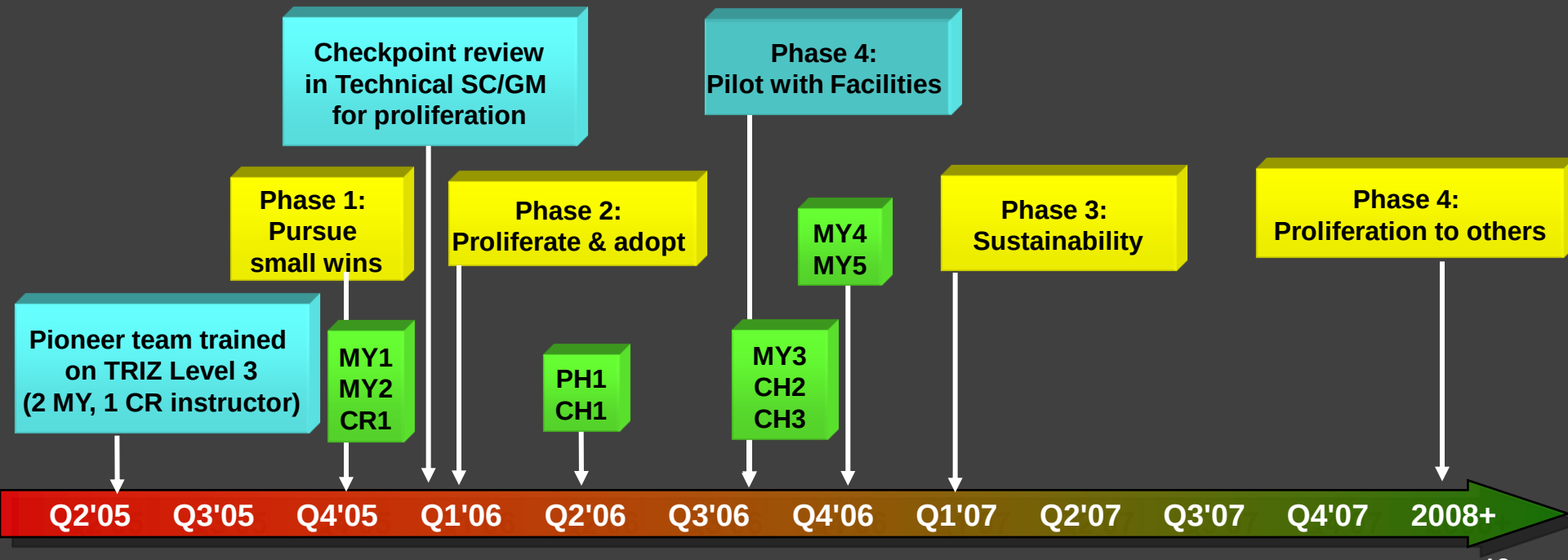
TRIZ Proliferation & Adoption - Challenges & Strategies

Organization case study: Assembly/Test Manufacturing (ATM) Asia

Courtesy TS Yeoh, Intel Principal Engineer

TRIZ Implementation Roadmap

- **Key Phases**
  - **Phase 1: Pursue small wins**
  - **Phase 2: Proliferation & adoption**
  - **Phase 3: Sustainability**
  - **Phase 4: Proliferation to others**

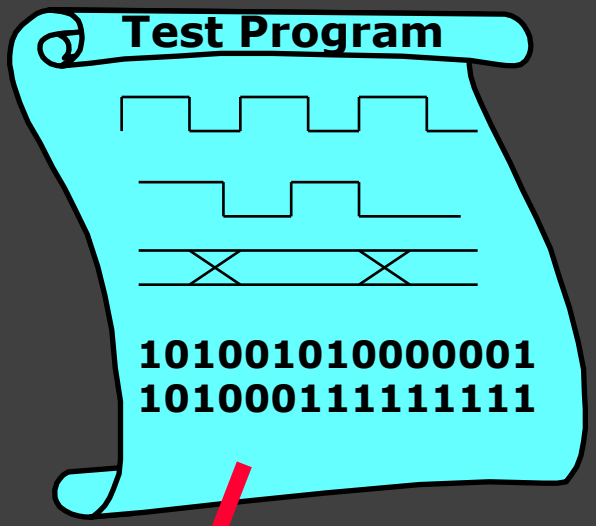


Phase 1 - Pursue Small Wins

- Challenge: Show that TRIZ works
- Strategies: Pilot & get small wins
  - Engaged 3 factories (2 MY, 1 CR)
    - Proximity of instructors (MY/CR) to factory
    - Presented TRIZ overview to factory's direct staff
      - Need solid value proposition: Accelerates problem solving tpt & generates innovative solutions vs. time out for training
      - Networking & trust - very important
    - Requested for engineers to be identified. Bring unsolved problems to 5-day Basic TRIZ training class
  - Demonstrate value add
    - Managed to generate effective and innovative solutions which included test handler which was >10 years old; and problem had existed for >3 years

Early stages - pursue small wins, show value add

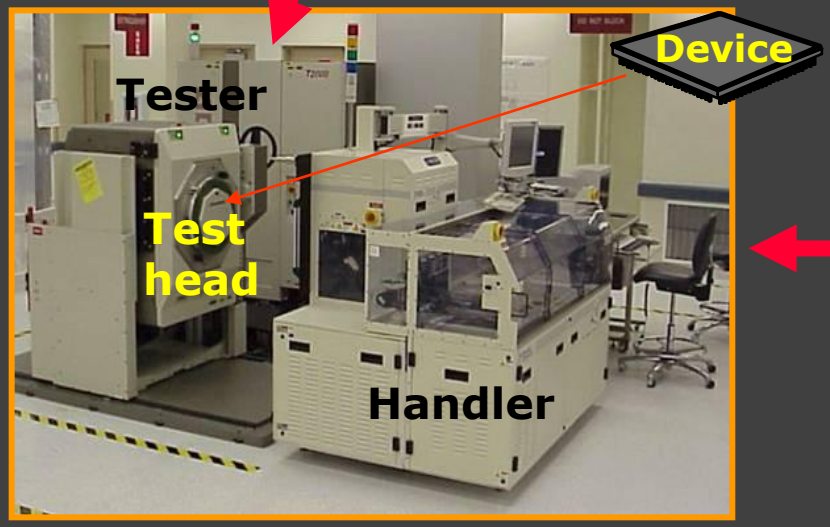
Test manufacturing - brief introduction



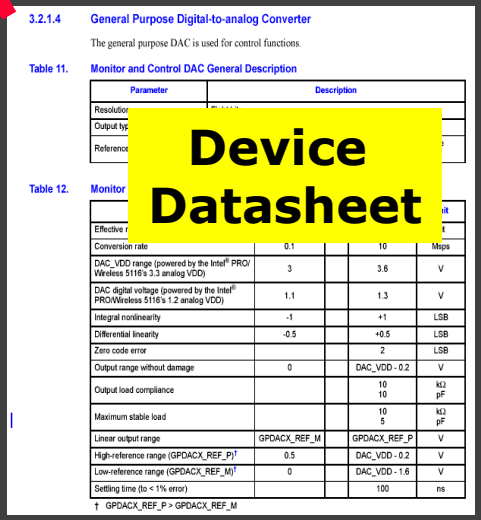
Code generation

Vector generation /validation

Software

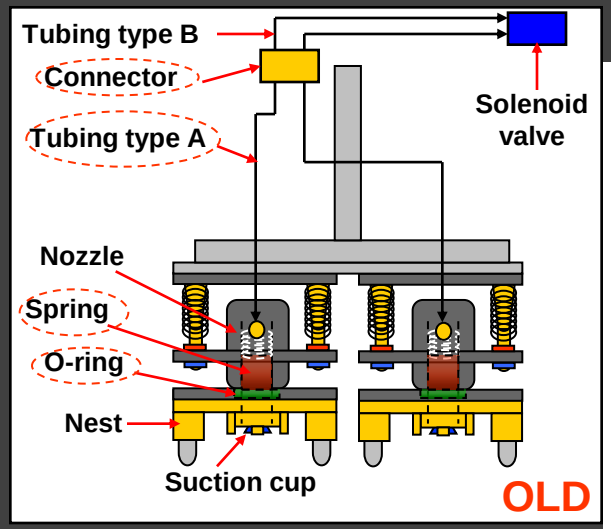


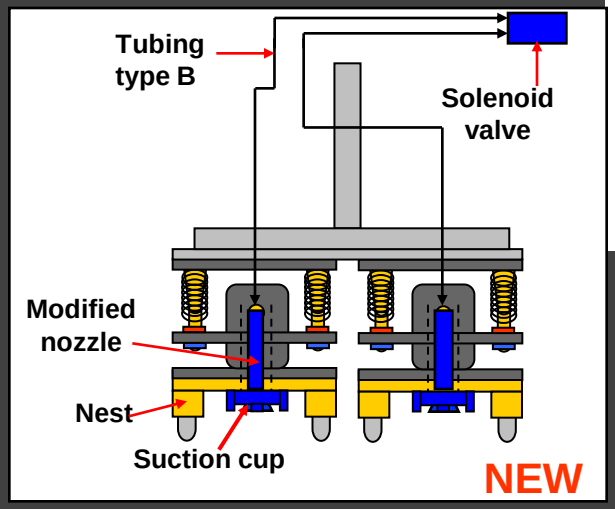
Hardware

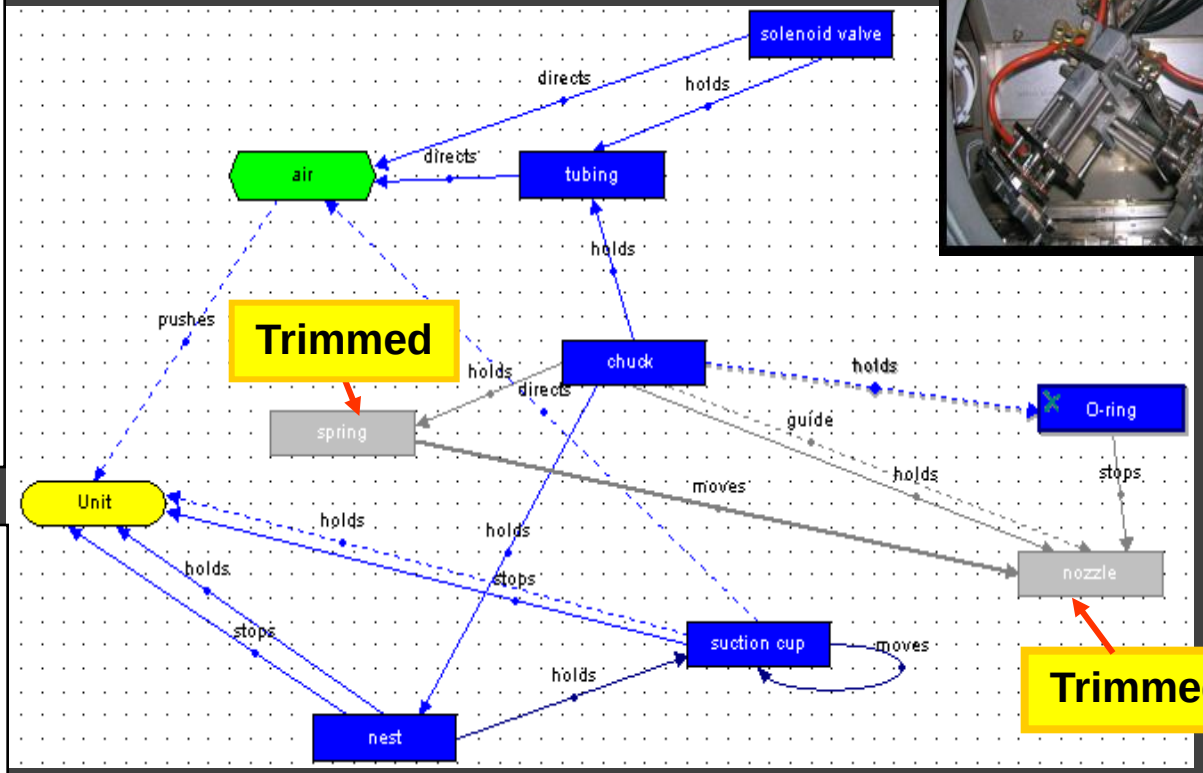


Results & case studies in next slides ...

Case #1: Pick & place suction force





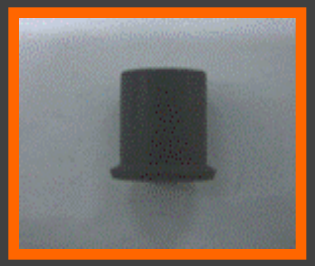


Trimming rules

Rule A: You don't need the function anymore
Rule B: The object performs the function itself
Rule C: Some other component does the function

Case #1: Changes Made

Before

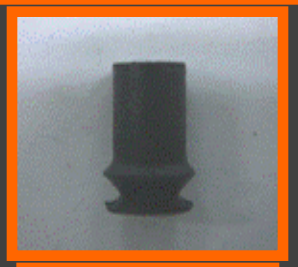


Eliminated the Compression spring and o-ring by transferring the spring effect to the suction cup

Changed the current rigid suction cup to a bellows suction cup

Segmented the Nest to a 3-piece part

After



Case #2: Device shuttle in handler

Engineering Contradiction: ***If the shape of the cavity is able to cater for a particular package size, then it is able to handle that package but low flexibility/versatility when shuttle needs to change due to change in package sizes***

a) Improving parameter: Shape (12)

b) Worsening parameter: Ease of Mfg (32), Adaptability (35)

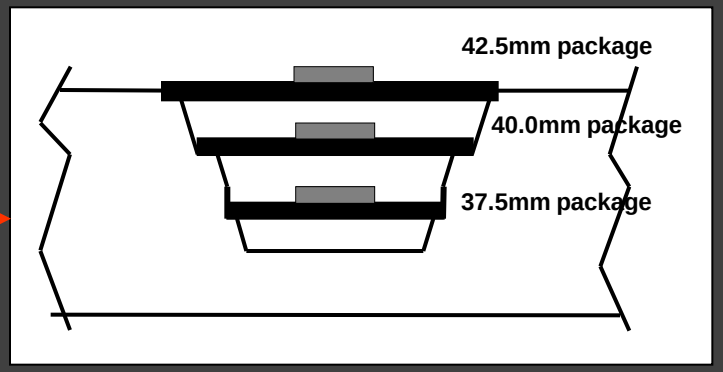
Inventive Principles suggested:

- 12/32: 1 (Segmentation), 32 (Color change), 17 (Another dimension), 28 (Mechanical substitution)

- 12/35: 1 (Segmentation), 15 (Dynamization), 29 (Pneumatics)

	Worsening Feature → / Improving Feature ↓	Ease of manufacture	Adaptability or versatility
		32	35
12	Shape	1, 32, 17, 28	1, 15, 29

Case #2: Device shuttle in handler



Principle used:
Another dimension: Use a multi-storey arrangement of objects instead of a single-storey arrangement

Phase 2 - Proliferation & Adoption

- **Challenge: How do you convince 10 ATM factories (i.e. 10 Factory Mgrs, 10 Assembly Eng'g Mgrs, 10 Test Eng'g Mgrs, ... in 6 sites, 4 countries) to adopt TRIZ?**
  - **Not all programs are tops down ("Just do it"). TRIZ is more bottoms up and sideways**
  - **Need factory commit for training**

- **Strategies**
  - **Seek Technical Steering Council & GM approval for proliferation**
    - **Based on pilot results, presented success stories and obtained approval to proliferate TRIZ to ATM**
    - **Instructors: CR (1) & MY (2). Fund travel to China/Philippines (3x/site)**

Use different techniques - not all will work all the time
Persistence is necessary. Networking is essential

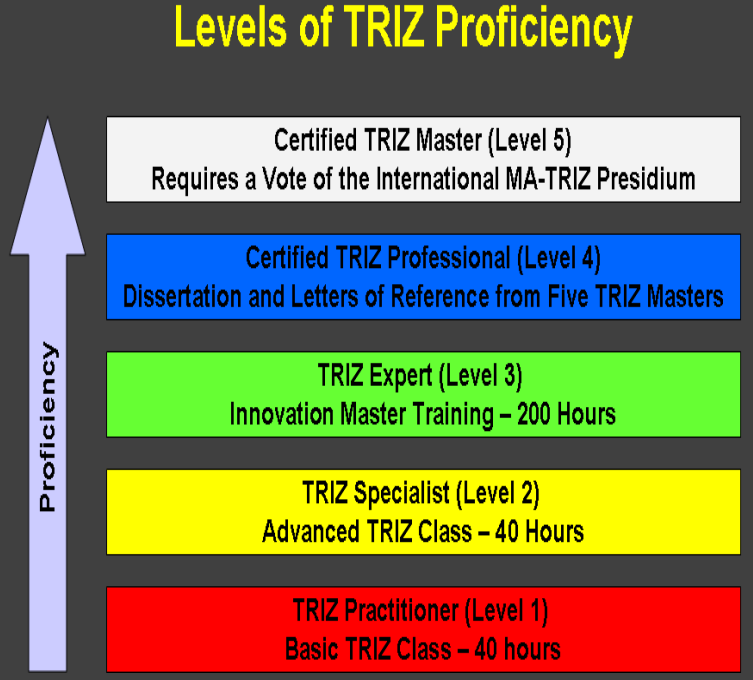
Phase 2 - Proliferation & Adoption

- **Strategies (cont'd)**
  - **Work with individual factories - different responses & needs**
    - Ability to generate innovative solutions even for >10 year old equipment & solid ROI are good motivators
    - Introduced 2 hour "TRIZ for Managers" class
  - **Arranged 1/1 either FTF or over phone with all FMs**
  - **If all else fails, use peer pressure**
  - **Other tactics: elevator, cafeteria, hallway, ... talk**

Use different techniques - not all will work all the time
Persistence is necessary. Networking is essential

Phase 2 - Proliferation & Adoption

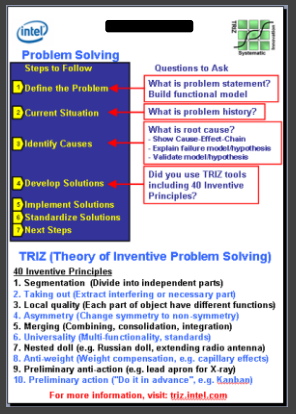
- **Result**
  - **All factories committed 100% module/equipment engineers to be trained in Basic TRIZ**
  - **Conducted 40+ five-day workshops, 500+ students (Intel's total ~1000), completed 32 projects and generated ~$13M ROI based primarily on sustaining manufacturing**



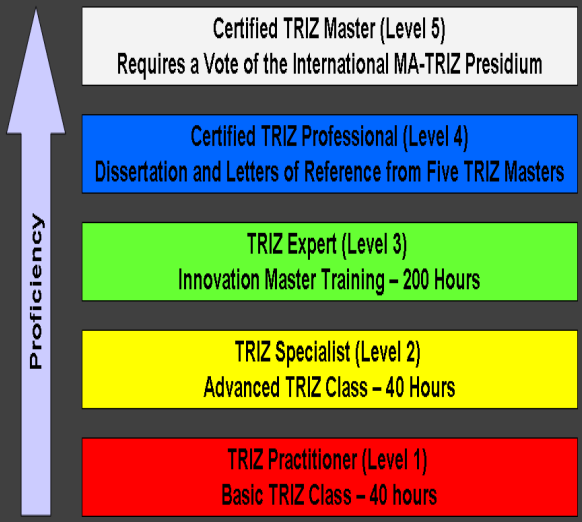
Phase 3 - Sustainability

- Challenge: How to make TRIZ a culture?
- Strategies
  - **Build infrastructure**
    - Identify factory champions. Grow local instructors for each site
    - Arrange regular management project review
    - Avenue for ad-hoc engagement when problems arise
  - **Need behavior change**
    - Link to factory programs
    - TRIZ for Managers class to create awareness
    - Get managers & engineers to pull
  - **Build TRIZ community of practice**
    - Conferences to share success stories & ROI
    - Badge cards
    - Proficiency stickers

TRIZ



Levels of TRIZ Proficiency



Pushing has a limit. Need management and engineer pull

Phase 4 - Proliferation to Others

- **Challenge: Which disciplines/orgs should TRIZ be proliferated to next?**
- **Strategies**
  - **Other organizations which could potentially benefit e.g. Facilities, Technology Development,...**

Pursue new, undiscovered opportunities. It's exciting!

Key Learning

- If it's a new program with no track record, start with small wins. Need to show that program adds tangible value
- Constant & regular 1/1 with key stake holders is essential
- Networking is essential. It has to start now, not later
- Trust comes with networking and interactions based on proven track record. Programs can move relatively quicker
- Understand factory/customer issues, gear towards needs
- Disciplined follow-up/through: key to ensure sustainability
- Risk taking is a norm as success is not guaranteed
- Persistence is necessary
- Passion is key

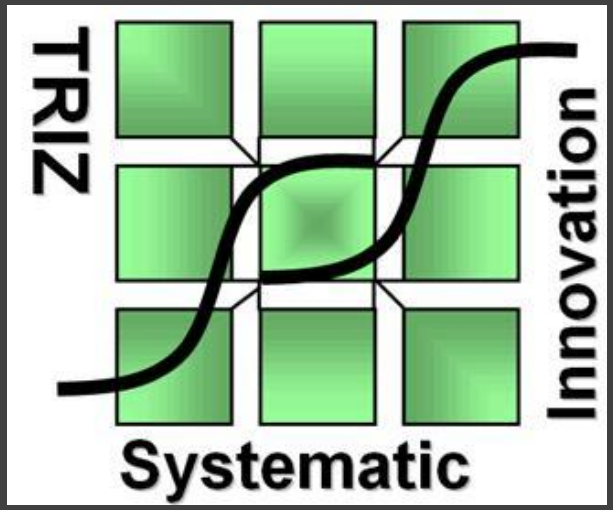
Networking, Persistence, Risk taking, Passion

Summary

- 4 phases for a new program implementation
  - Phase 1: Initial stage - pursue small wins
  - Phase 2: Proliferation & adoption - need softskills & networking
  - Phase 3: Sustainability - need customer pull
  - Phase 4: Proliferation to others - pursue new opportunities
  - Key learning: Need to have networking, persistence, risk taking, passion
- Impact
  - TRIZ provides additional tools for engineers to generate innovative solutions which are low cost but effectively solves problem in shortest amount of time
- Future plans
  - Proliferation to other organizations

Conclusions

- A Journey of a thousand miles begins with the first step!
- TRIZ is a key systematic innovation for Intel into the 21st century!
- Intel uses TRIZ effectively
- Process and systems improvement is just the beginning of TRIZ potential for companies!



Acknowledgements

Amir Roggel
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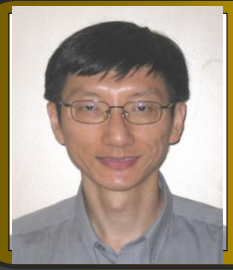

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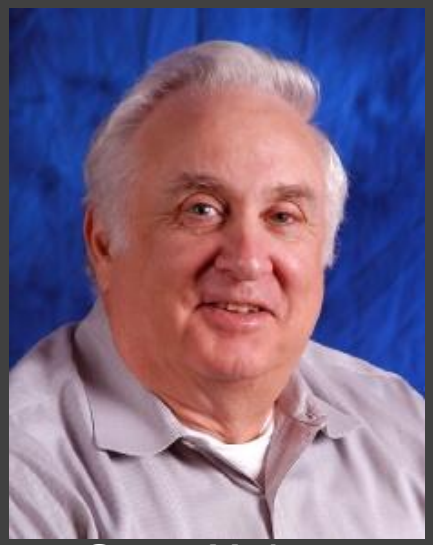


Gene Meieran

Our Teachers

Our Sponsor

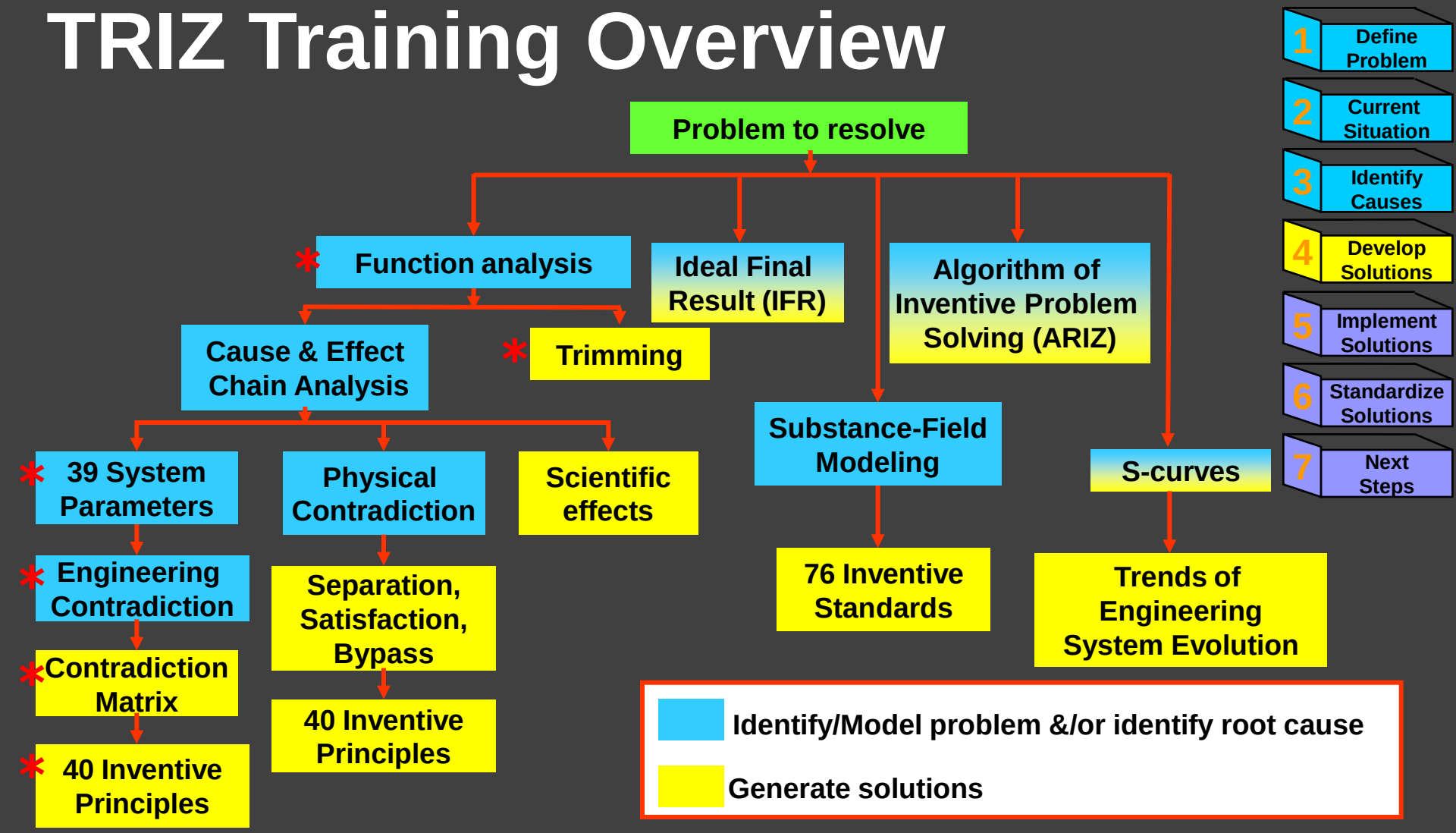
THANK YOU

Q&A

"You can wait a hundred years for enlightenment,
or you can solve the problem in 15 minutes with these principles"
--- Genrich Altshuller, TRIZ

Back Up

TRIZ Training Overview



Toolbox which contains root cause analysis and solution generation tools

Sharing TRIZ - 2008

- With customers -2008 IDF Shanghai
- TRIZ community
  - TRIZCON
  - TRIZ-Japan
  - AMETRIZ
- Internal
- Academia:

  Taiwan Intel Academic Forum

"TRIZ in Manufacturing" book

July 2009 - TS Yeoh, TJ Yeoh, Chia Li Song