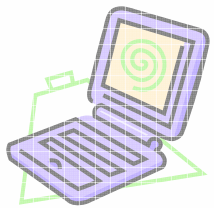
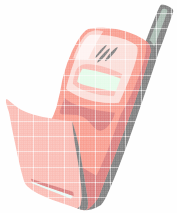
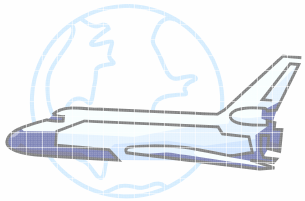
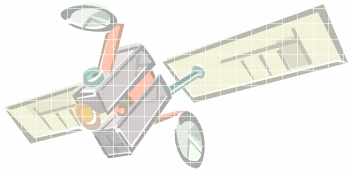
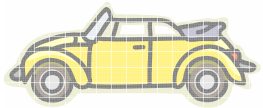
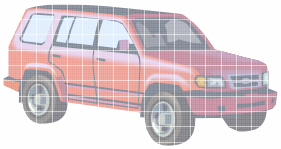
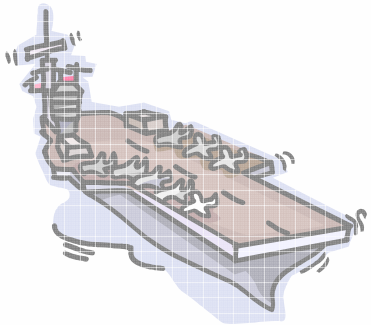
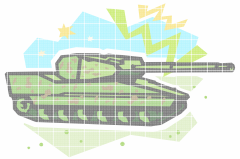
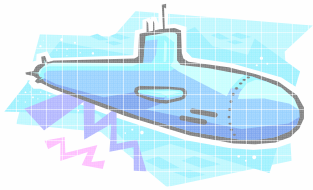
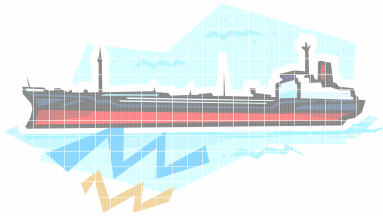





How to Create and Select High Value, Innovative, Competitive and Economic Concepts for New Systems?

An Integrated Methodology for the Conceptual Design of New Systems

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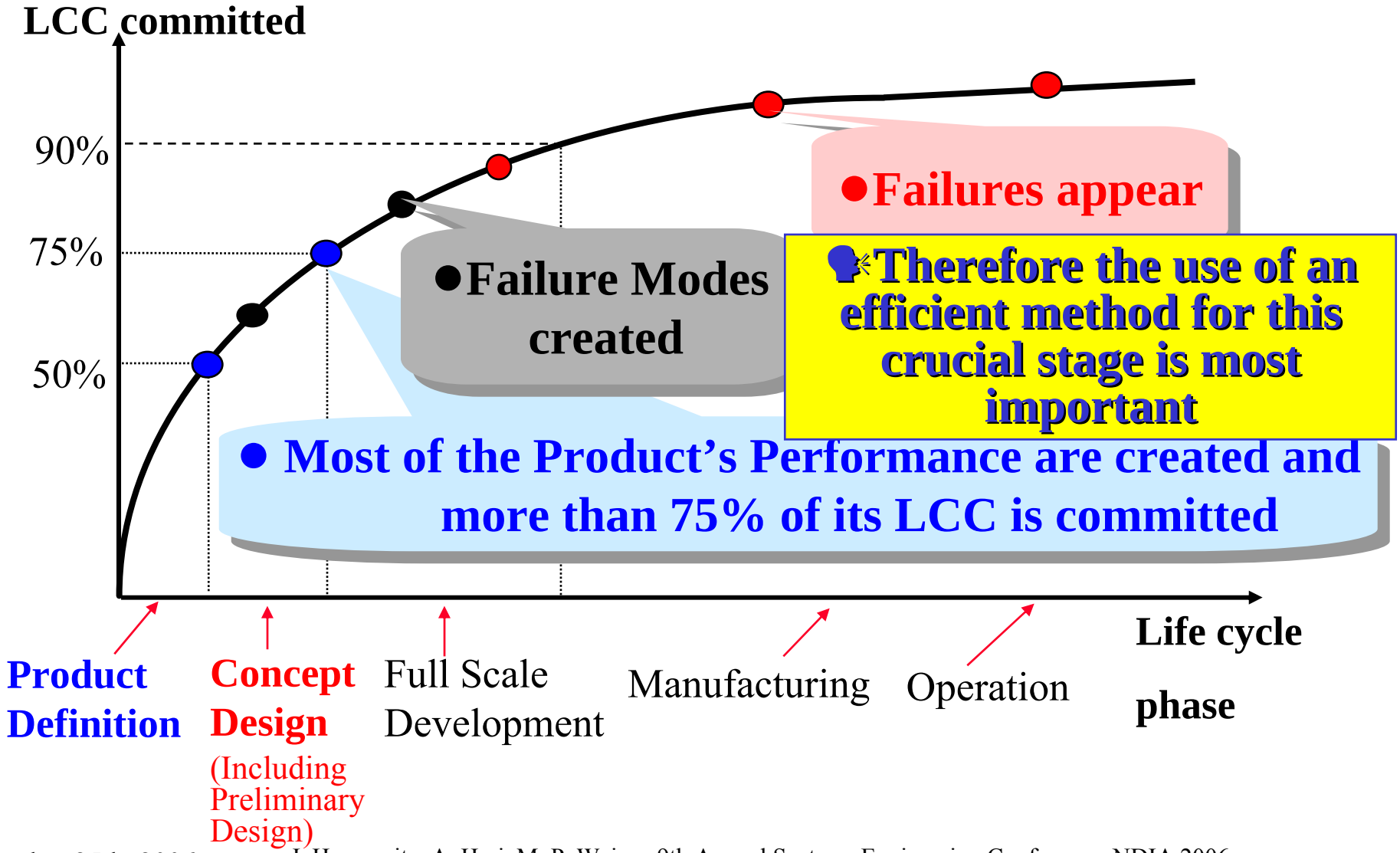
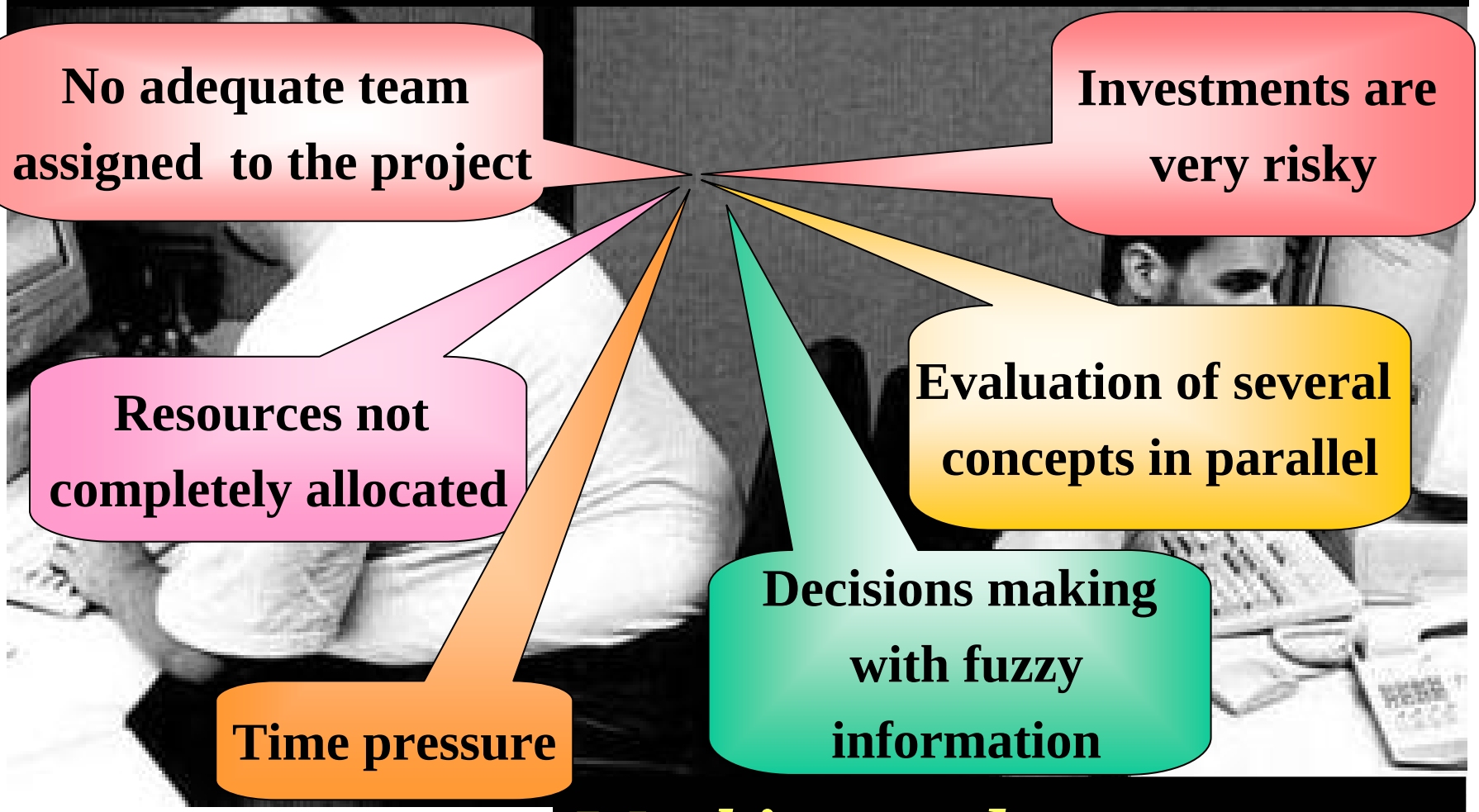
Topics

- **Introduction**
- Overview of ICDM
- Case Study
- Research
- Application of ICDM
- Conclusions

The Early Phases of the System Life Cycle Process are the Most Critical to the Success of a New System

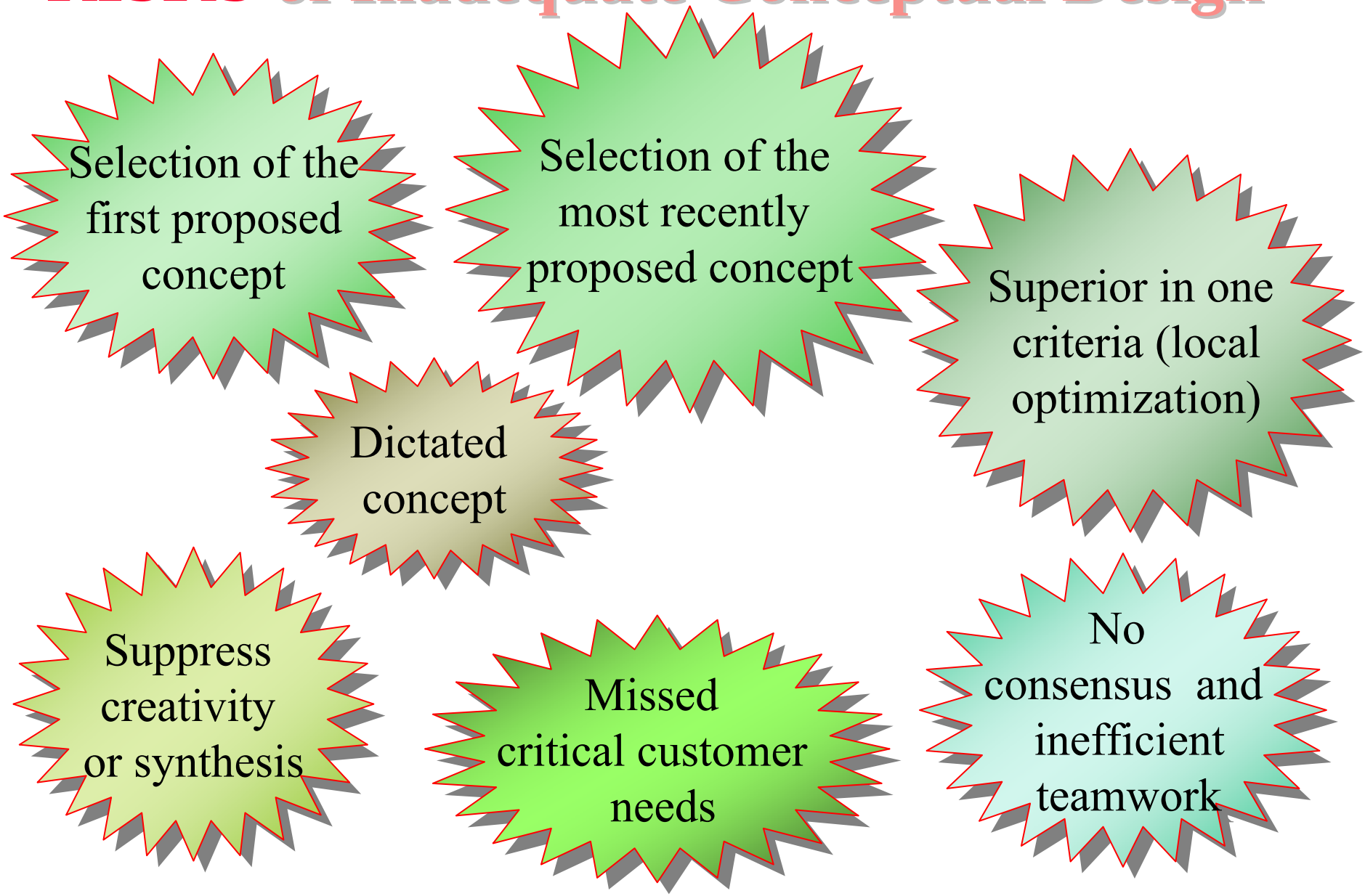


Common difficulties in the Conceptual Design Phase:

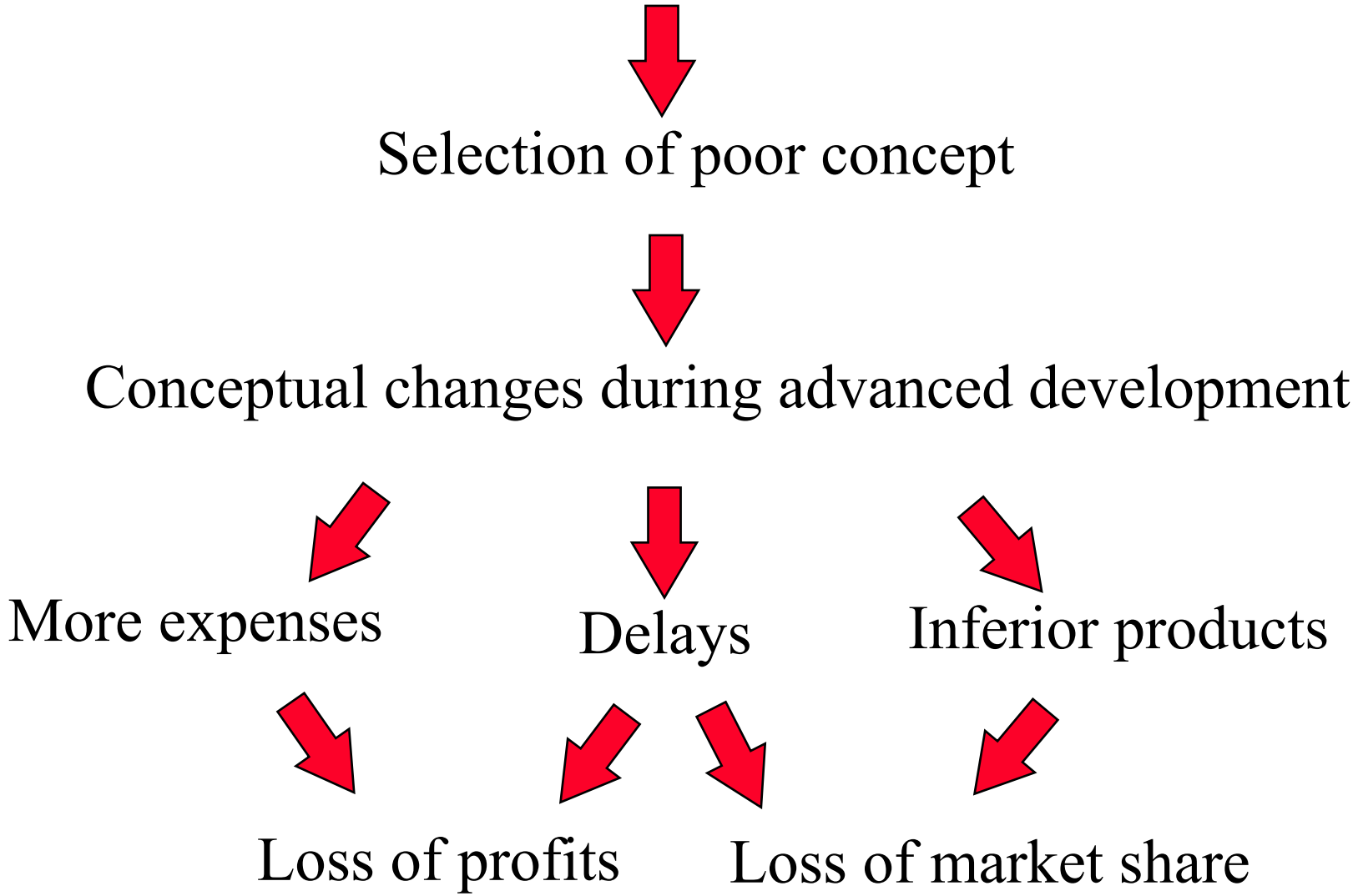


Working under pressure…

RISKS of Inadequate Conceptual Design

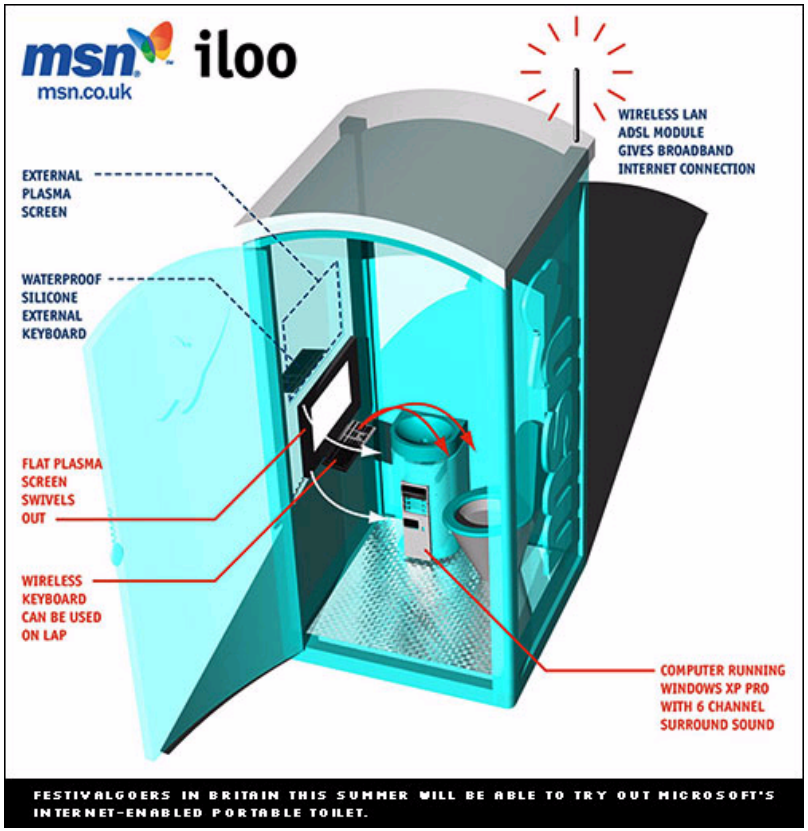


RISKS of Inadequate conceptual design (cont.)



Topics

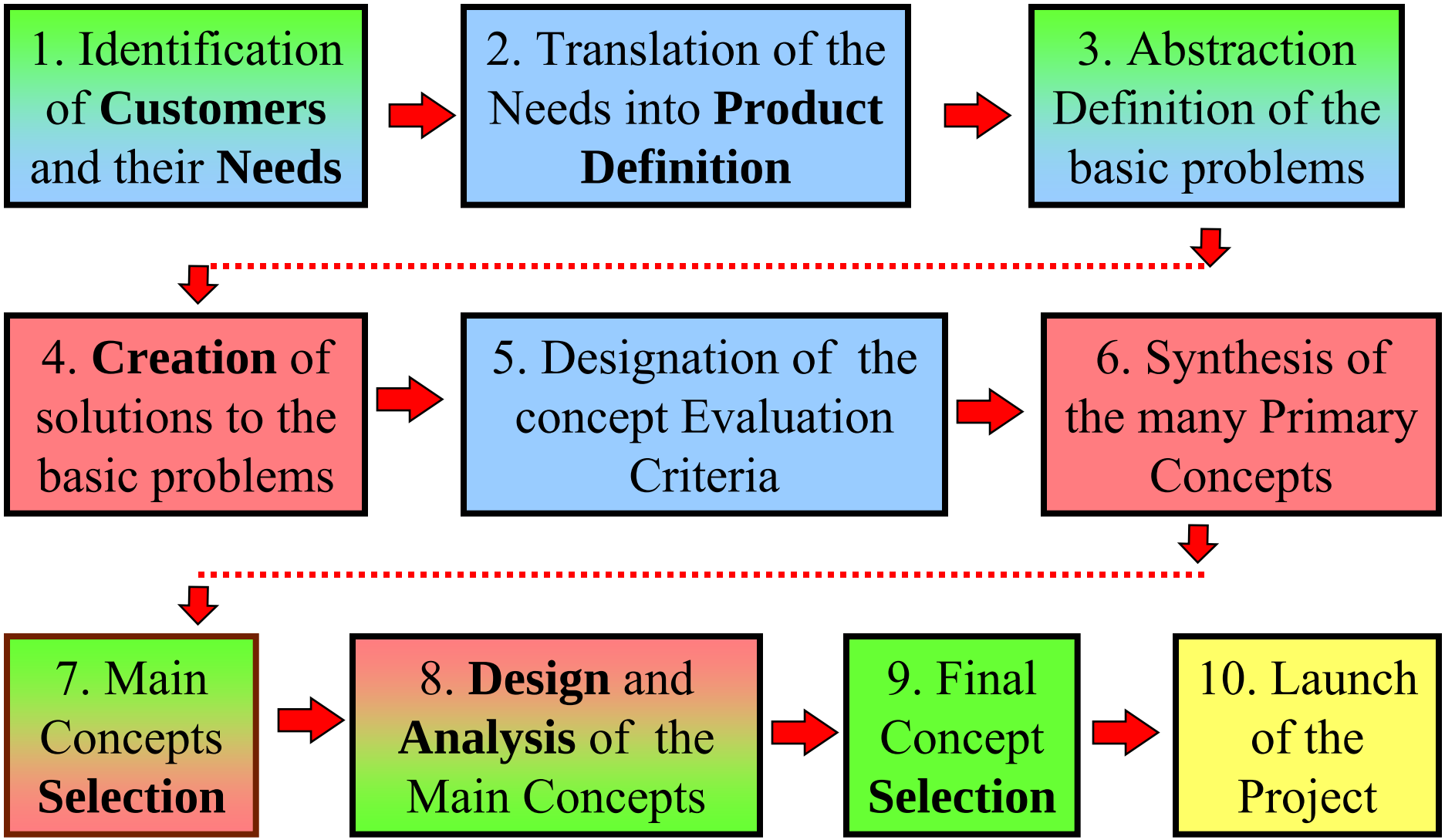
- Introduction
- **Overview of ICDM**
- Case Study
- Research
- Application of ICDM
- Conclusions



ICDM: INTEGRATED CUSTOMER DRIVEN CONCEPTUAL DESIGN METHOD

Covers the
entire process of the
conceptual design
and
preliminary design stages

ICDM: INTEGRATED CUSTOMER DRIVEN CONCEPTUAL DESIGN METHOD



ICDM: INTEGRATED CUSTOMER DRIVEN CONCEPTUAL DESIGN METHOD

1. Identification of **Customers** and their **Needs**

2. Translation of the

3. Abstraction finition of the asic problems

Integrates and modifies

methods and techniques, provides a selection of tools for each step

4. **Creation** of solutions to the basic problems

6. Synthesis of the many Primary Concepts

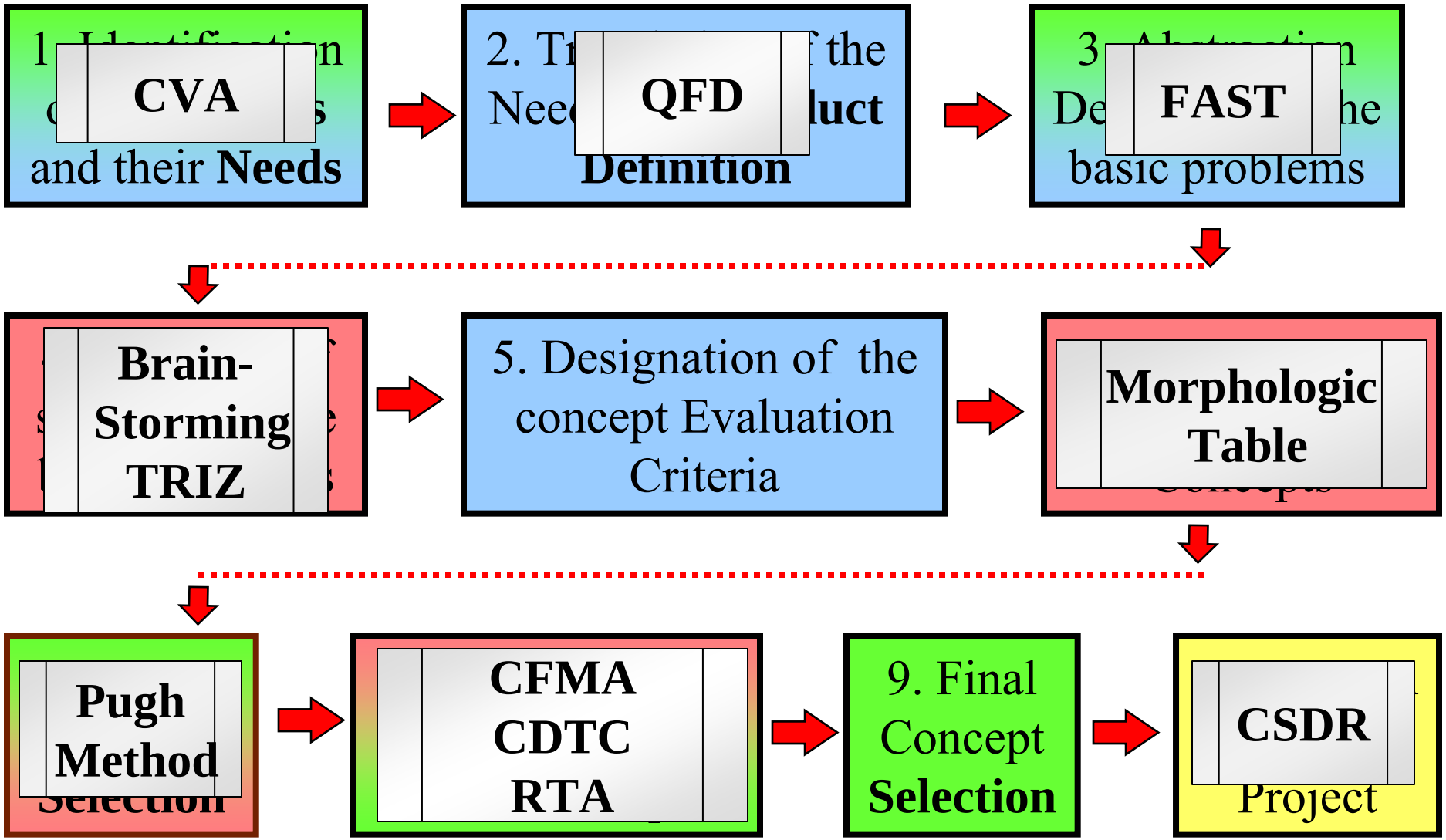
7. Main Concepts **Selection**

Analysis of the Main Concepts

Concept **Selection**

10. Launch of the Project

ICDM: INTEGRATED CUSTOMER DRIVEN CONCEPTUAL DESIGN METHOD



ICDM: INTEGRATED CUSTOMER DRIVEN CONCEPTUAL DESIGN METHOD

✶Tailoring Guidelines:

ICDM has an open architecture, is flexible and can be **tailored** to the unique needs of each case and organization.

✶The Human (soft) Aspect:

ICDM Provides the means to improve **motivation** and **creativity** of new product development teams

✶Design Quality Measurement (DQM)

ICDM includes an on-line customer value based **DQM system**

Topics

- Introduction
- Overview of ICDM
- **Case Study**
- Research
- Application of ICDM
- Conclusions

Step 1: Identification of Customers and their Needs

Problem Definition:

Due to repetitive cases in which anti-terrorist or infantry forces were injured by rifle shooting, from friendly forces, a need emerges for an identification device. This device will warn the shooter when he aims at his own forces.

Product to Design: *"PIFF2000"*

Personal IFF (Interrogator of Friend or Foe)

Customers

The users

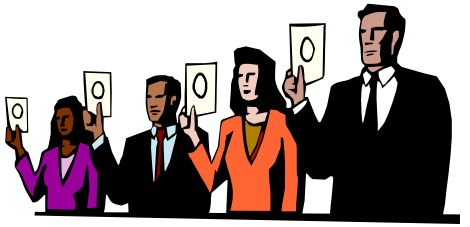
- Infantry combat teams
- Anti-terror squads

Stakeholders (Army):

- purchasing authorities
- logistics support authorities
- combat doctrine authorities

Stakeholders (Civil):

- Investors
- Regulatory & environment authorities



Customer Needs

Prevent firearms shooting on friendly forces

- Operate in reference scenarios
  - Warn shooter from friendly force
  - System works anywhere: (Urban areas, Dense jungles, Wilderness)
  - A friendly and hostile soldiers In close proximity and the system discriminates
- Easy to use
  - For shooter and target
  - Does not interfere with combat activity
  - Low weight
  - Integrate into combat gear
- Safe
  - Immune to spoofing
  - From shooting
  - Does not scratch, wound, hurt or press
- Works reliably
  - No false alarms
  - Works when needed
  - Resistant to rain, shocks, dust, moisture
  - Alarms when removed or unsafe install
- Maintenance
  - Simple service
  - Comprehensive self test
- Affordable
  - Purchasing
  - Service
- Delight the customer
  - Integrate in C4I networks
  - Compass, Navigation

Step 2: Translation of the Needs into Product Definition

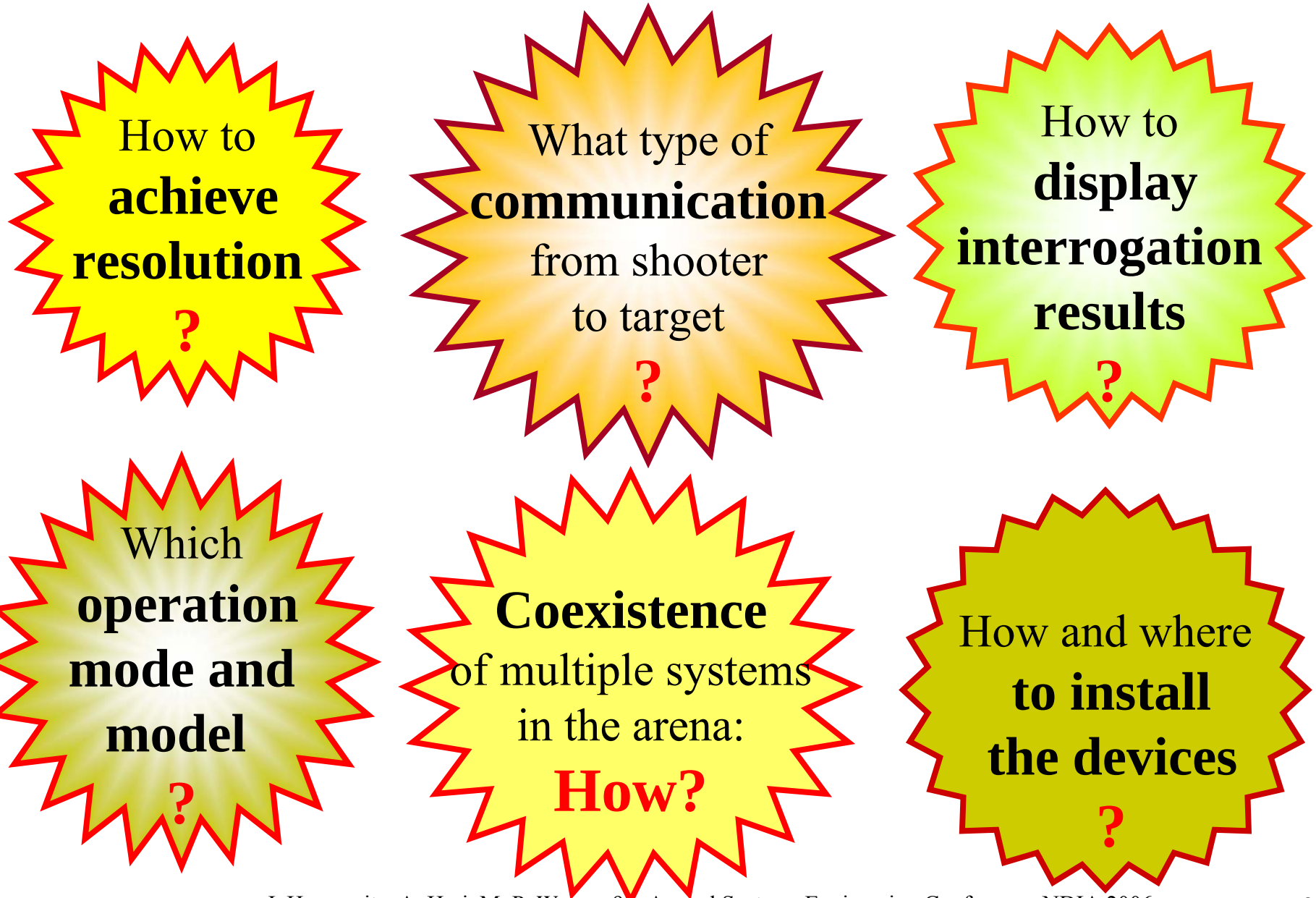
	Operation Range	Autonomy	Mounting time	Optical radiation	Electromagnetic radiation	False Alarm Rate (FAR)	Maintainance	Price	Continuous Operation	Resolution	Volume	Weigth	Importance	Binoculars	Wireless comm.
unit:	m	y/n	min	uJ/cm^2	W/cm^2	%	$/mo.	$	hr	m	cm^3	g			
Warn friend	●	○		●	○	●			●	●			5	2	2
Work anywhere		●		○	○	●			△		△	△	5	5	5
Discrimination	○			△	△	●		○		●	○	△	4	2	1
FOE at LOS	●			△	△	●				○			4	1	5
Easy in use		△	△			△					●	●	3	4	1
Safe	△			●	●								4	5	4
Reliable		○	△			○	○	○	○	△			4	4	3
Maintenance		△	●			○	○	△	△		○	△	1	5	3
Affordable	△		△				●	●	○				2	5	3
Rel. Importance	99	76	18	104	74	180	33	43	69	97	47	37	877		
Rel. Imp. %	11.3	8.7	2.1	11.9	8.4	20.5	3.8	4.9	7.9	11.1	5.4	4.2	100		
Rank	3	5	12	2	6	1	11	9	7	4	8	10			

Contribution: △ weak (1) ○ medium (3) ● strong (9)

Performance Based Specification Decision Table

	Spec	Weight	Trade offs	Wireless	Binoculars	Target value	Diff.	Cost	TTM	Concept
1	False Alarm Rate	20.5		N/A	N/A	$2 \cdot 10^{-4}$	●	●	○	No
2	Optical Radiation	11.9	1	0.0	0.0	0.5	△	△	△	Yes
3	Range	11.3	2	comply	comply	1000.0	△	○	○	Yes
4	Resolution	11.1		bad	bad	20.0	●	●	○	Yes
5	Autonomy	8.7		yes	yes	yes	△	△	△	No
6	EM Radiation	8.4	1,3	Over spec.	0.0	0.2	△	△	△	No
7	Cont. Operation	7.9	1,2,6	20.0	20.0	24.0	●	●	△	No
8	Volume	5.4	7,4	large	500.0	200.0	○	△	△	No
9	Price	4.9	1,2	expensive	cheap	750.0	○	○	○	No
10	Weight	4.2	7,8	large	500.0	200.0	○	○	△	No
11	Maintenance	3.8	9,5,2	moderate	cheap	50.0	○	△	△	No
12	Mounting time	2.1	8,9,11	N/A	N/A	5.0	△	△	△	No

Step 3: Abstraction, Definition of the Basic Problems

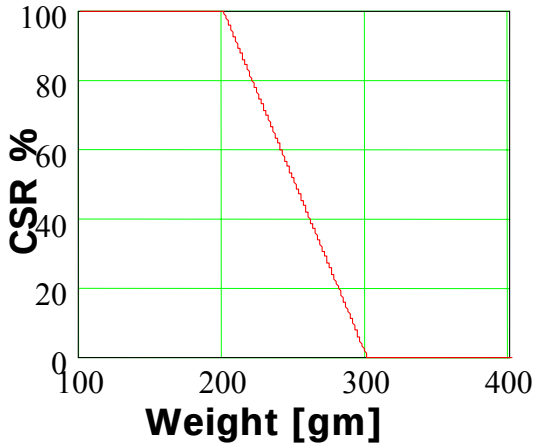


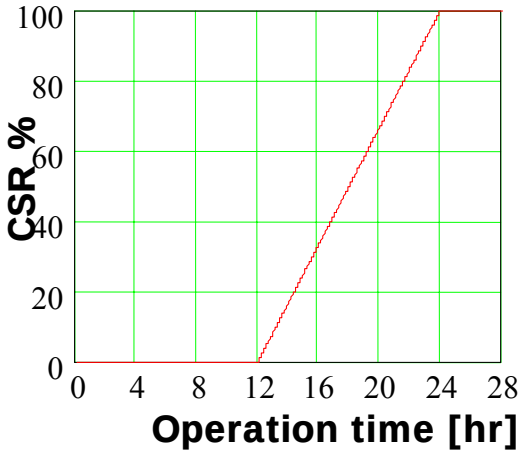
STEP 4: CREATING SOLUTIONS TO THE BASIC PROBLEMS

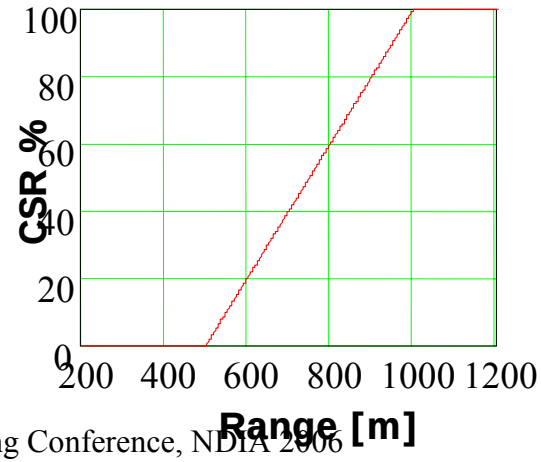
Problem	Solution	Potential Performance	Lack of dev. Problems	Selection
Resolution	ElectroOptics	5	5	++
	ElectroMagnetics	2	2	-
	GPS	5	3	+
	Triangulation with directional ant.	3	3	+
Communication Type	Radio	3	5	++
	Microwave	5	3	++
	Optics (laser)	5	5	++
Display	Graphics LCD	5	3	++
	LED	5	5	++
	Flag	5	3	++
	Speaker	2	5	+
	Buzzer	2	5	+
	Vibrator	2	3	-

STEP 5: EVALUATION CRITERIA

#	Criteria	A	B	Target value (QFD)
1	Technology gaps	+	+	
2	Mission reliability		+	**0.95**
3	FAR		+	**$2 \cdot 10^{-4}$**
4	Operation range	+	+	**1000 m**
5	Soldier suitability	+	+	
6	Radiation	+	+	**$5e^{-7}$ mj/cm^2**
7	Resolution	+	+	**20 m**
8	Operation cost		+	**50 $/month**
9	Volume/ weight		+	**200 cc / 200 g - target** **200 cc / 200 g - shooter**
10	Continuous operation		+	**24 hours**
11	Cost		+	**750$ total (250+500)**
12	Manufacturing capability	+	+	
13	Installation, removal and ease of use	+	+	**2 min preparation**
14	Customer attraction		+	
15	Serviceability	+	+	

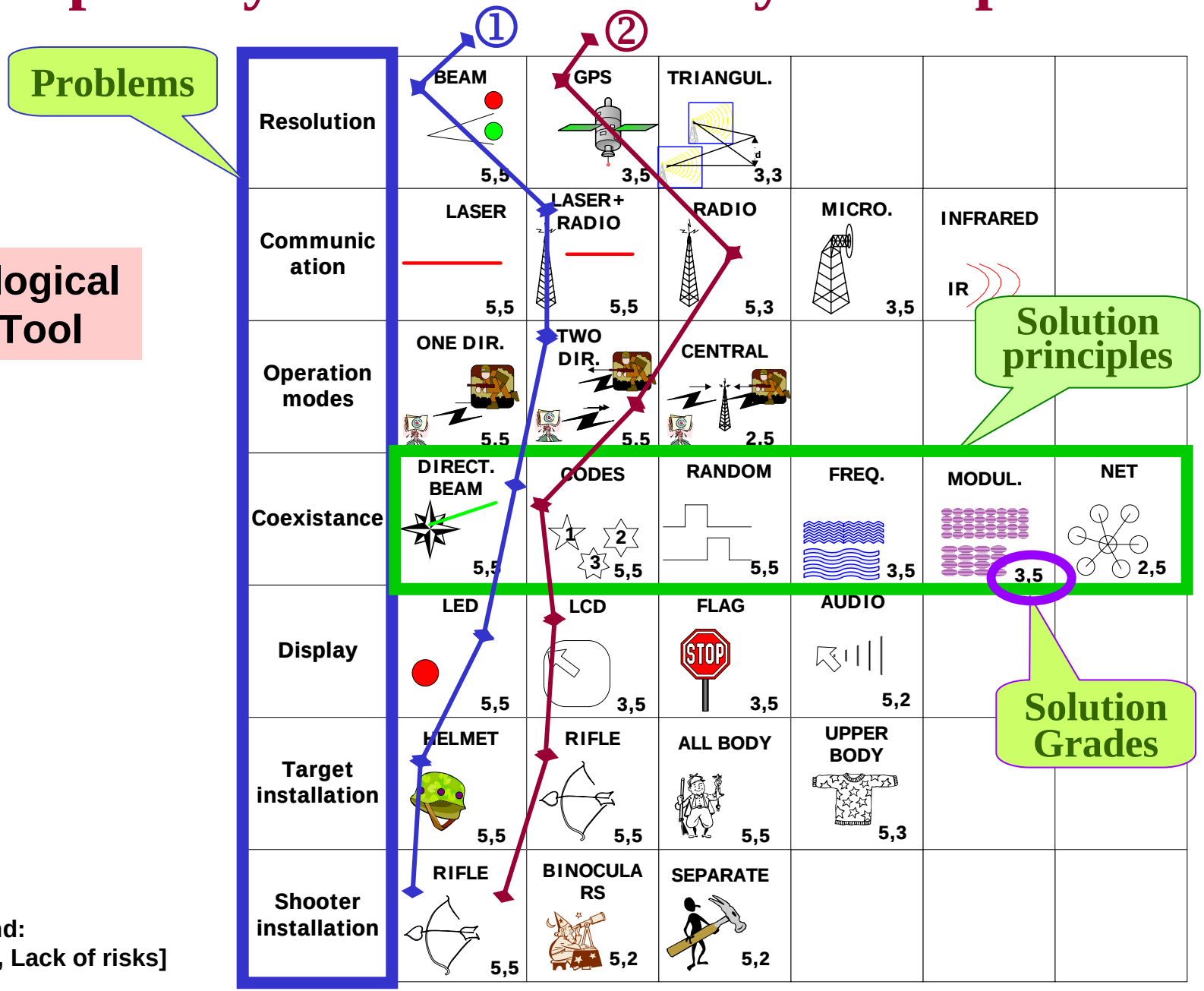






Step 6: Synthesis of Primary Concepts

Morphological Table Tool

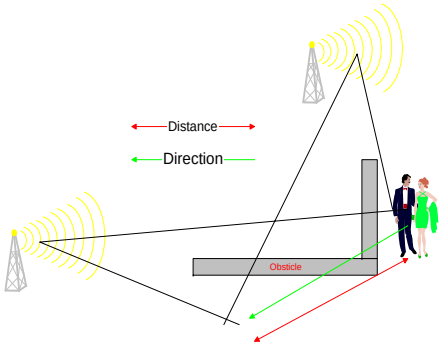


Grades Legend:
[Performance, Lack of risks]

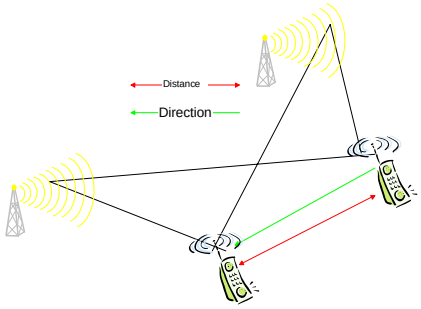
Step 7: Evaluation of the primary *PIFF* concepts using PUGH method

Concept / *Criterion*		Local Triangulation	Cellular Triangulation	Optical Helmet - Sensors	Optical Helmet - Fisheye	Optical Helmet - Fibers	Optical Helmet - Radio	Centralized GPS	Distributed GPS
Technology gaps	D	S	S	S	S	S	S	S	S
Performance:									
Operation range	A	S	- -	- -	- -	-	S	S	
Soldier suitability		S	+	+	+	+	S	+ +	
Radiation	T	S	- -	- -	- -	-	S	S	
Resolution		-	+ +	+ +	+ +	+ +	+	+	
Manufacture capability	U	S	+	+	+	+	S	+	
Inst., rem. and ease of use		S	-	-	-	-	S	+	
Serviceability	M	S	S	S	S	+	S	+	
Σ+		0	4	4	4	5	1	6	
Σ-		1	5	5	5	3	0	0	
Total		-1	-1	-1	-1	2	1	6	

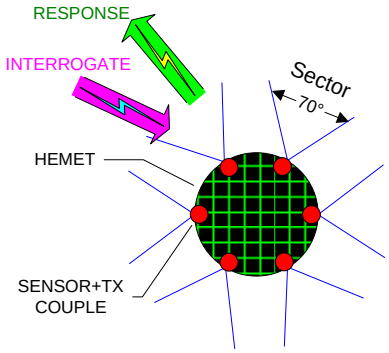
The Final Concepts



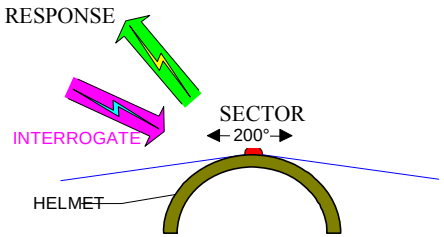
Local Triangulation



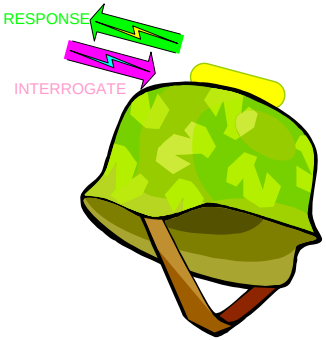
Cellular Triangulation



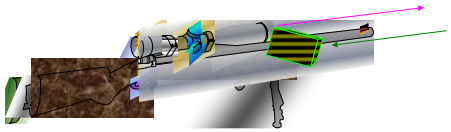
Optical Helmet - Sensors



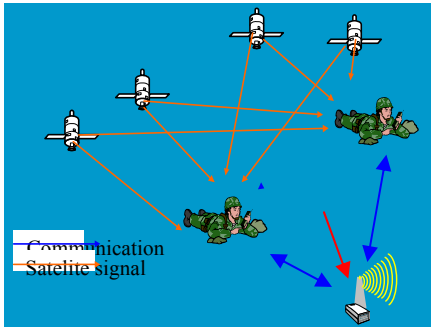
Optical Helmet - Fisheye



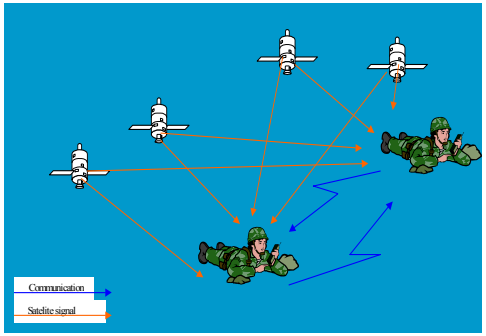
Optical Helmet - Fibers



Optical Helmet - RADIO



Centralized GPS

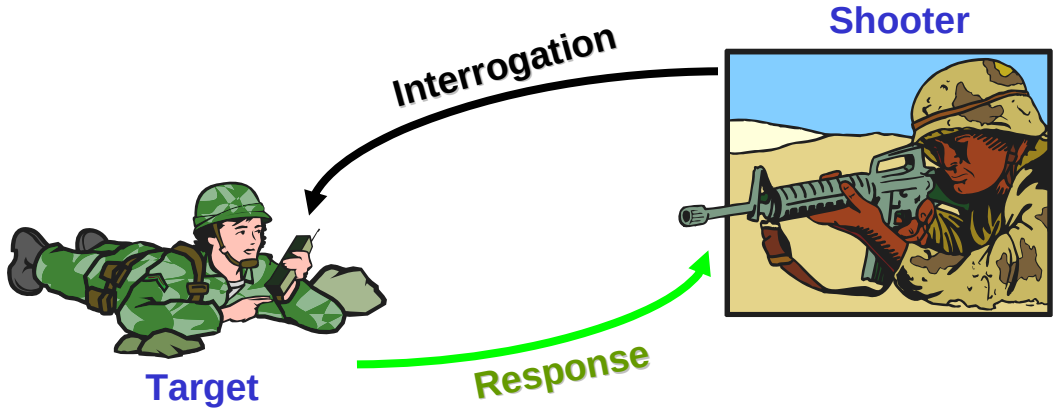


Distributed GPS

ICDM: INTEGRATED CUSTOMER DRIVEN CONCEPTUAL DESIGN METHOD

8. **Design** and **Analysis** of the Main Concepts

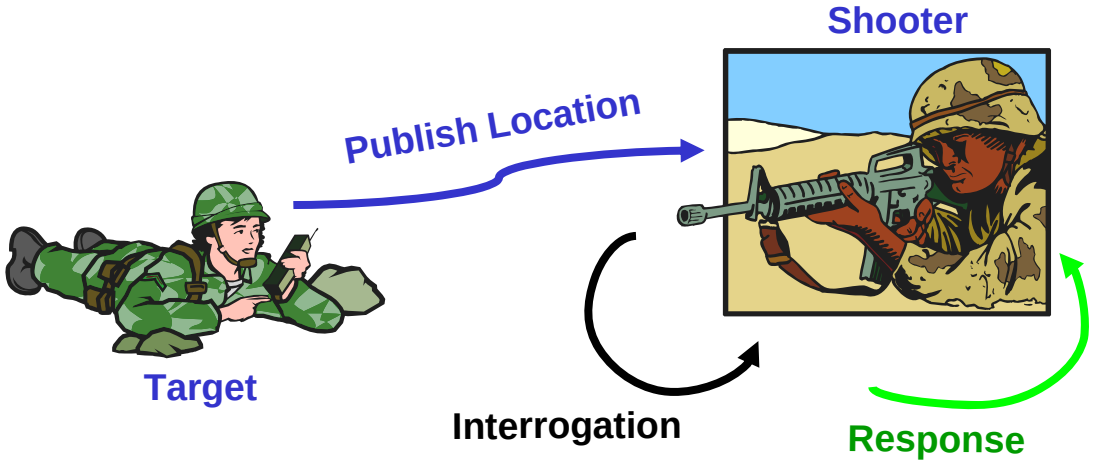
Conceptual Architecture and Operation Logic Design



Scenario

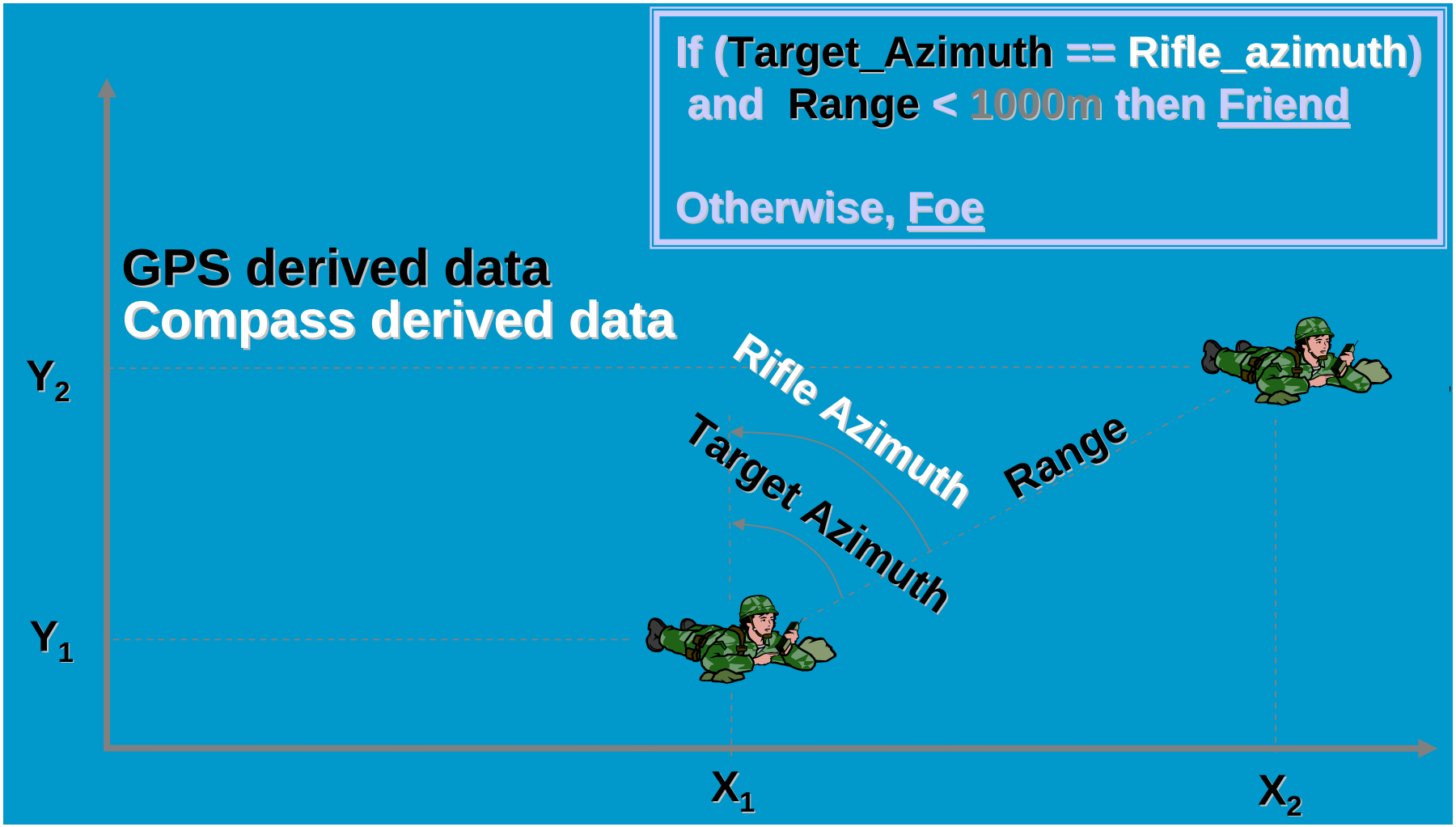
Shooter aims at ***target*** and interrogates
If FRIEND, ***target*** responds to shooter
If no response, then ***target*** is FOE

Basic Principles of IFF System

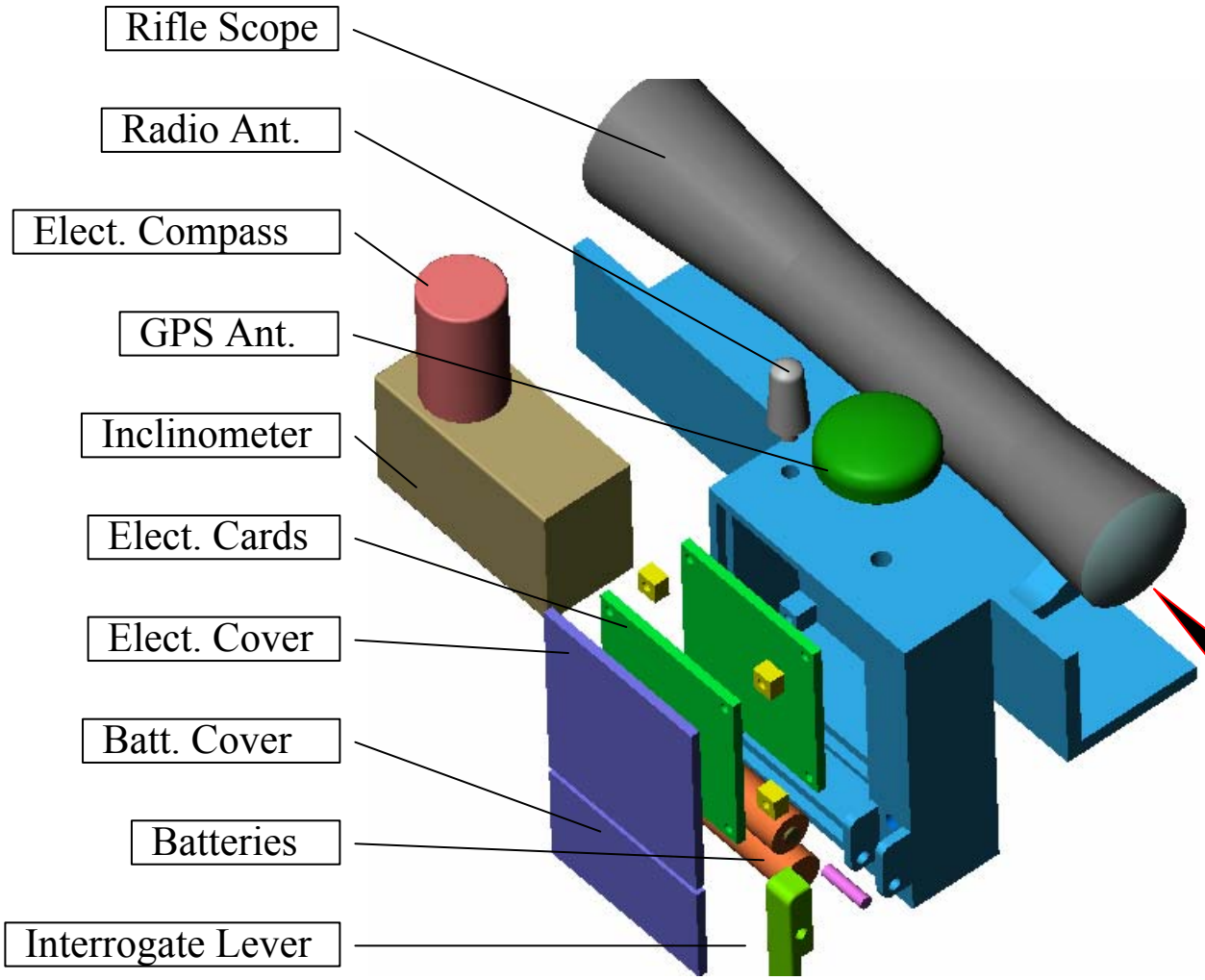


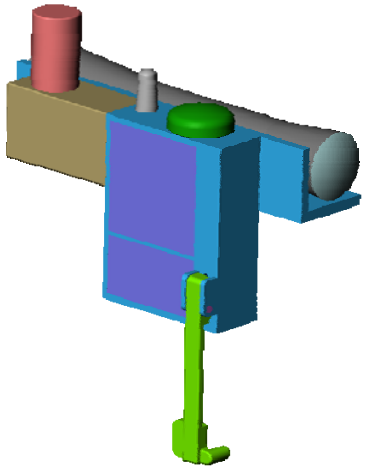
Architectural Concept in Distributed GPS PIFF

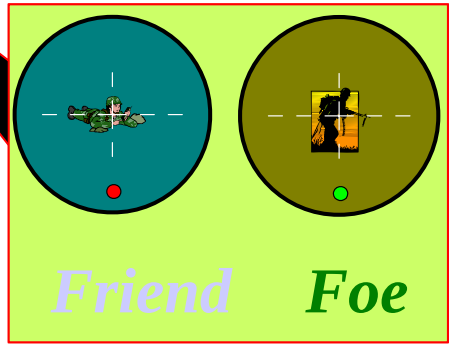
Distributed GPS IFF – Principle of Operation



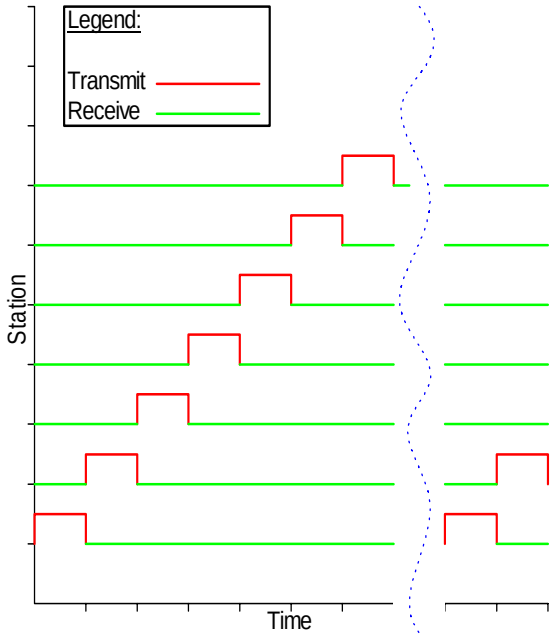
Mechanical Conceptual Design

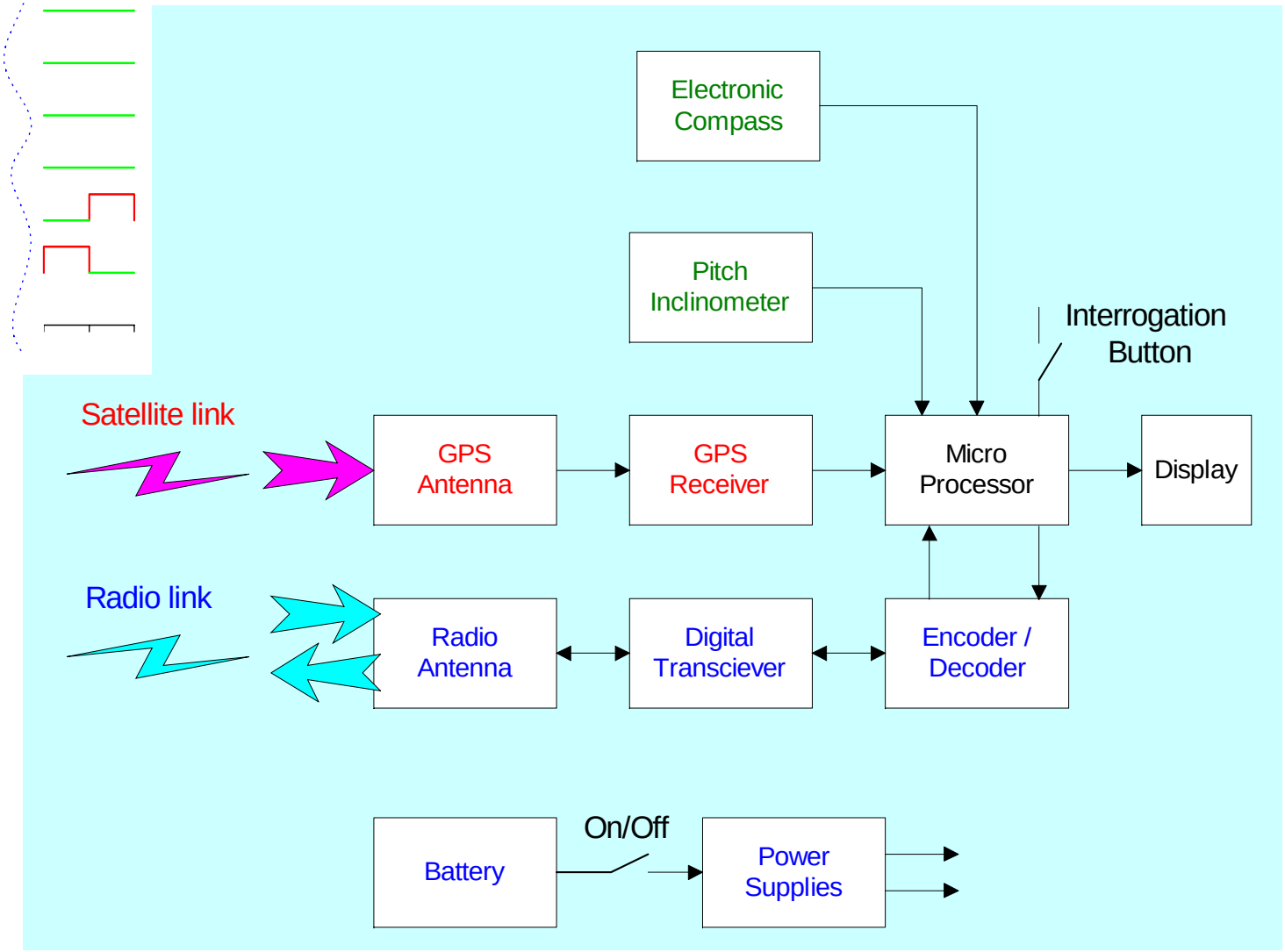




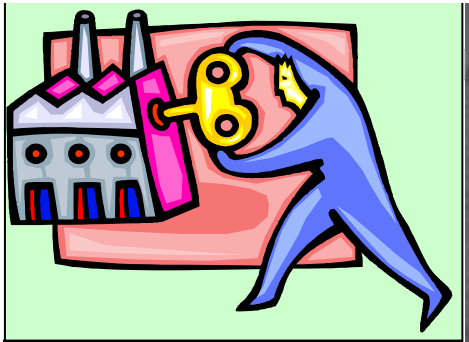


Electronics Principle





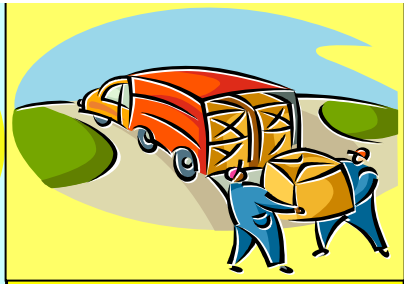
Conceptual Operation and ILS Decisions



Manufacturing and Assembly concept

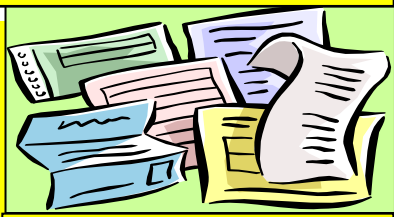
Operation and Usage concept

Personnel – skills requirements and training policy

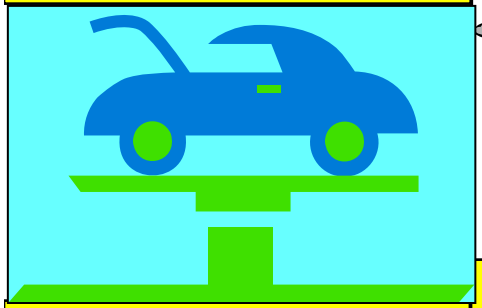


Transportation, handling and packaging concept

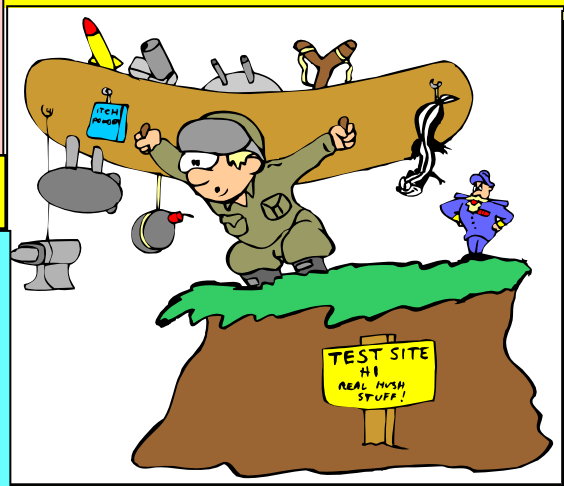
Installation concept



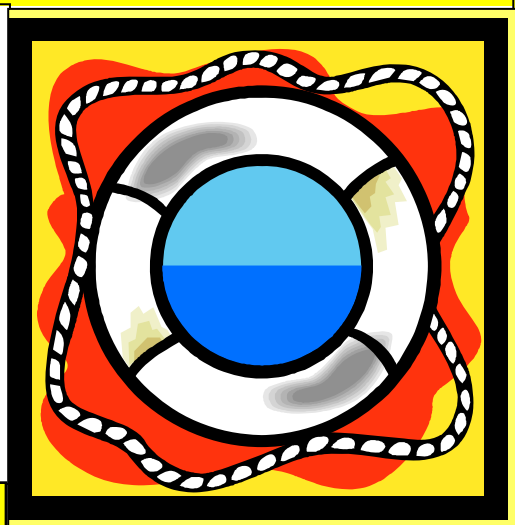
Documentation concept



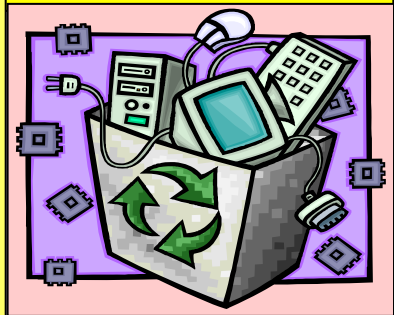
Maintenance policy



Verification, Validation and Test concept



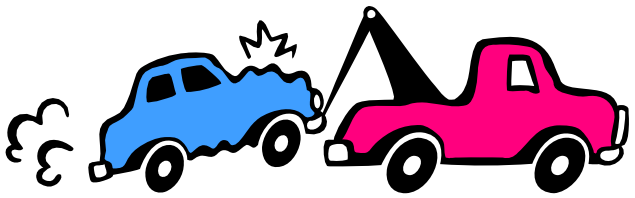
Safety requirements



Disassembly and Recycling concept

CFMA Table for "*Interrogation*" Function

Failure mode	Failure Result	S	Failure causes	F	Ways to detect	D	SFD	Corrective action	New SFD
No Transmission	Mission Failure	8	Weak Batt.	1	Data sheet	1	8		
		8	Faulty PS	3	Samples testing	4	96	Env. Test for samples. D=2	48
		8	Optic. Dirt	7	Test prototype	5	280	Add protectors: F=5 Detector Self test: S=3 Build a prototype: D=4	60
		8	Faulty Switch	4	Test prototype	5	160	2 switches: F=1	40
		8	**Faulty Trans.**	**4**	**Test first batch**	**5**	**160**	**Continuous self test: F=1 Env. Test for prototype: D=2**	**16**
		8	Faulty PC	3	Test first batch	5	120	Add watch-dog: F=1 Env. Test for prototype: D=2	16
Weak Signal	Perform. Degrad.	6	Faulty Trans.	5	Test first batch	5	150	Self test: F=1 Env. Test for prototype: D=2	12
		6	Optic Dirt	10	Test similar systems	7	420	Add protectors: F=5 Detector Self test: S=3 Build a prototype: D=4	60
No GPS Fix	Mission Failure	8	No vis. Sat.	6	Analysis and Simulation	2	96	Manual location	72



Improved Design After CFMA

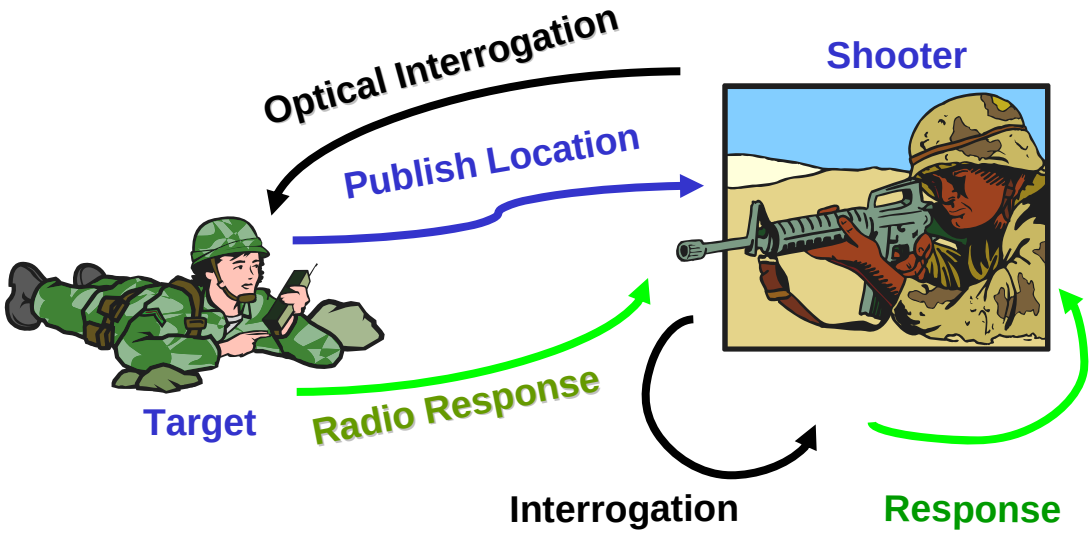
Insert REDUNDANT mechanisms:

- Original: Geolocation with GPS
- Add: *Optics* interrogation with *Radio* response
- Combined logic: perform an AND check from both sub-systems.

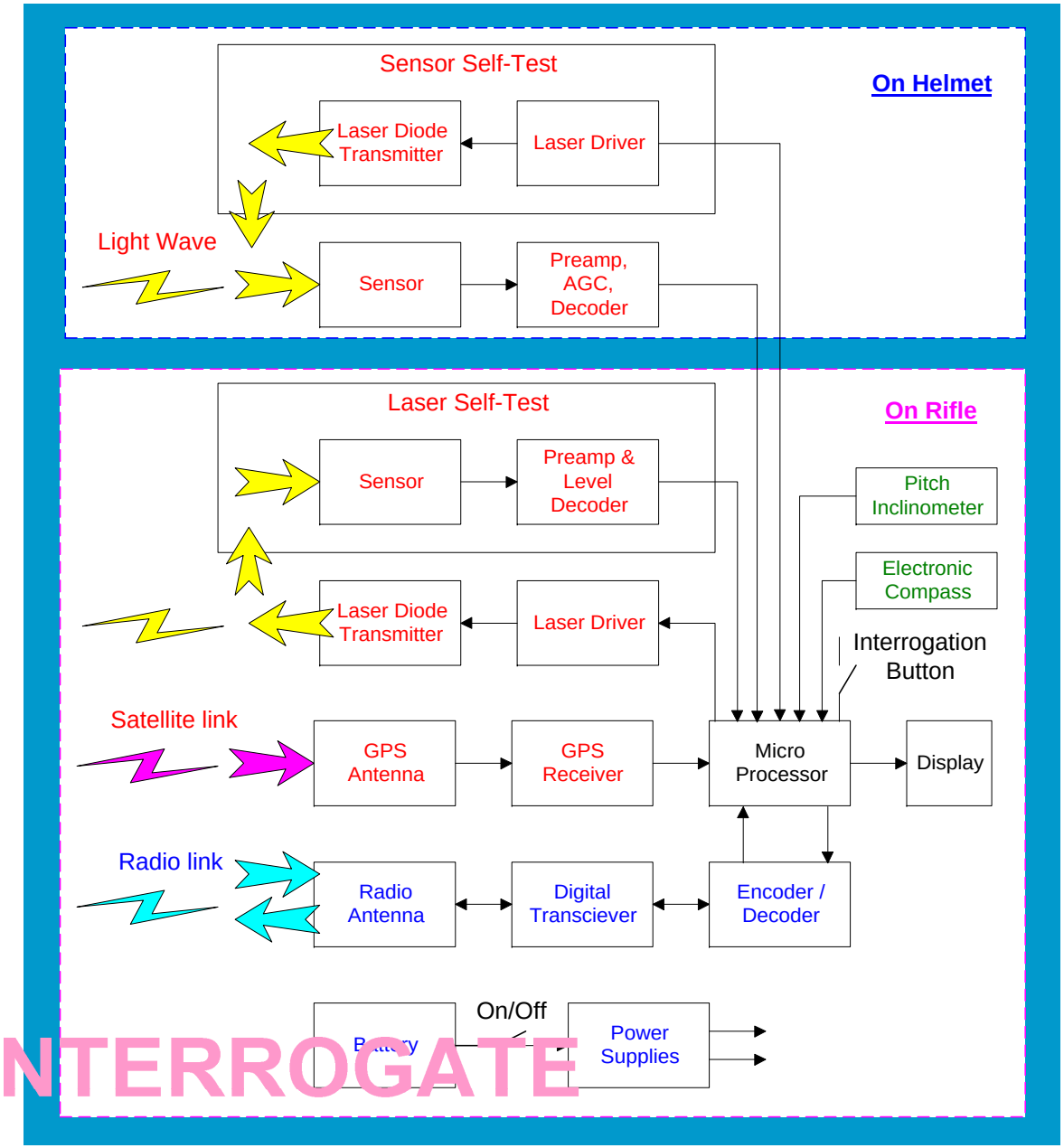
Result: Improvement in RELIABILITY (both Type 1 and Type 2)

Improved redundant performance:

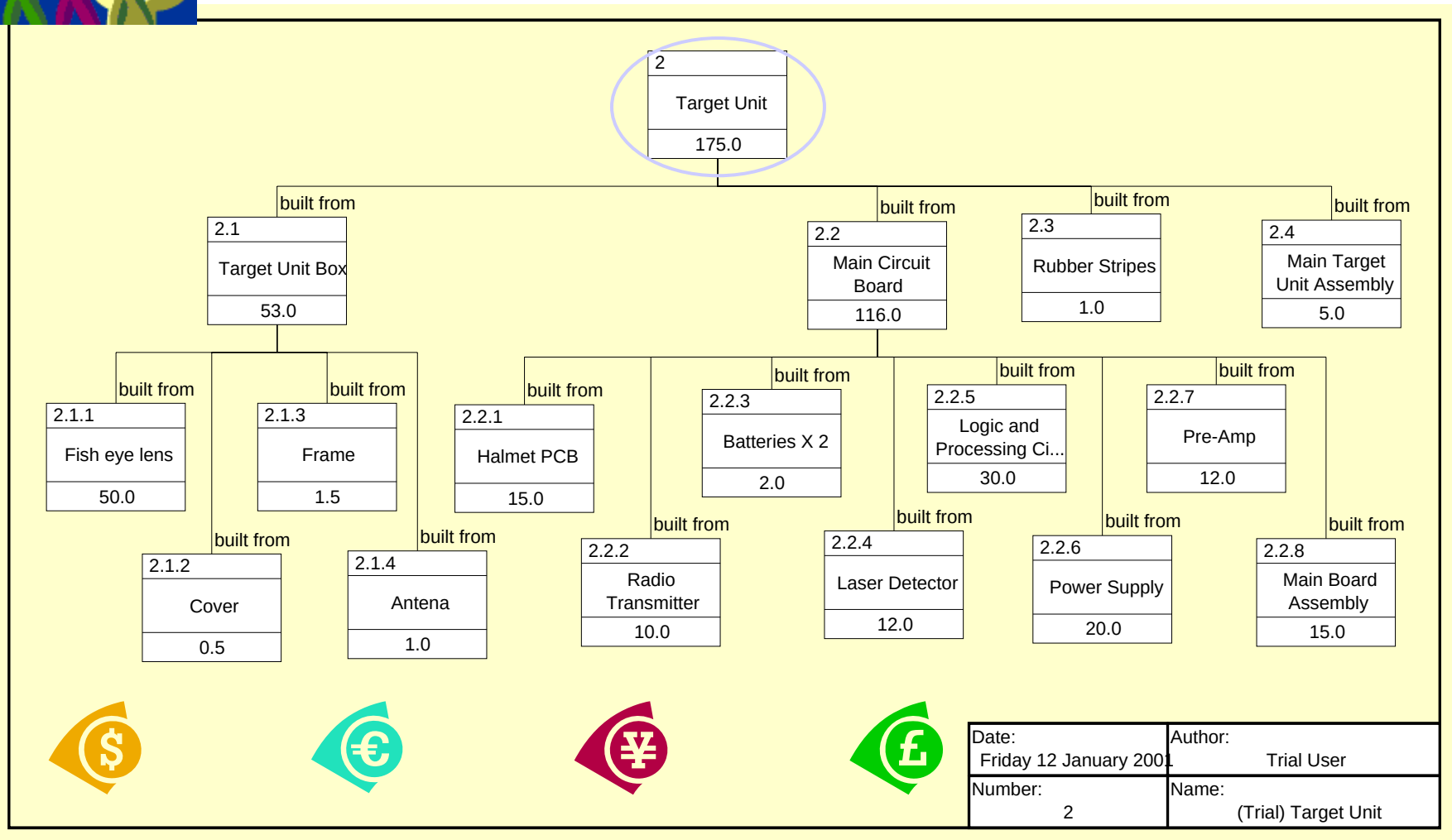
- In urban areas, GPS may not receive adequately. Laser will perform.
- In open battlefield, Laser beam may be obstructed by smoke, dust, etc. GPS will perform.

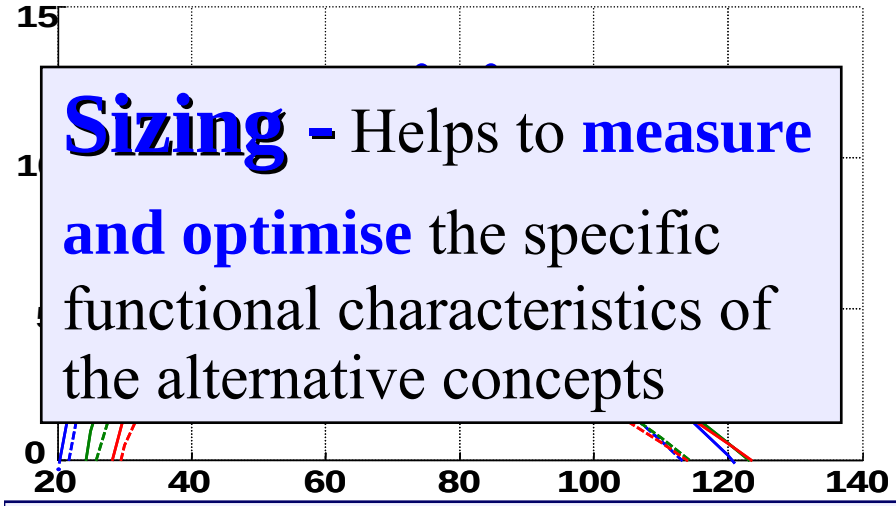


Improved Concept Principle - Add Self-Test

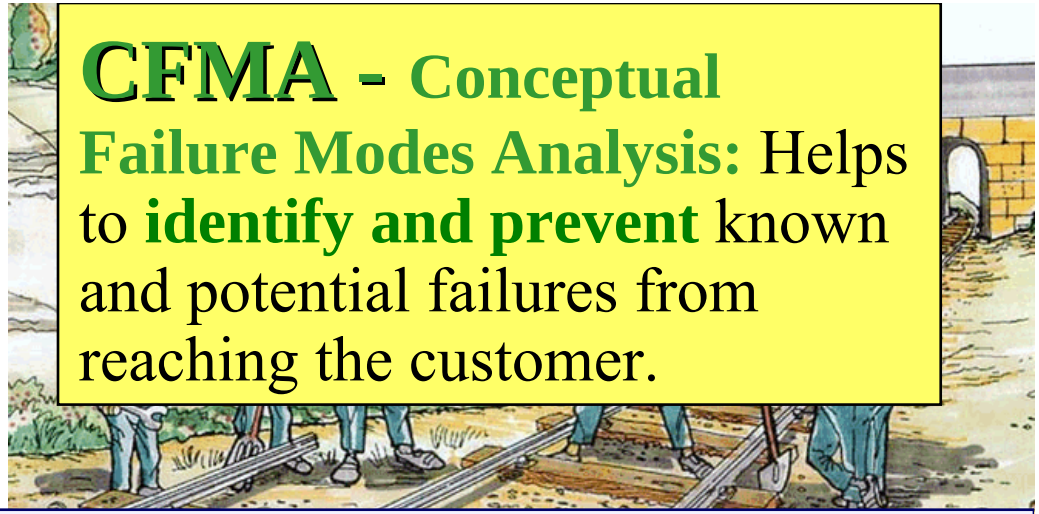


Cost Estimation



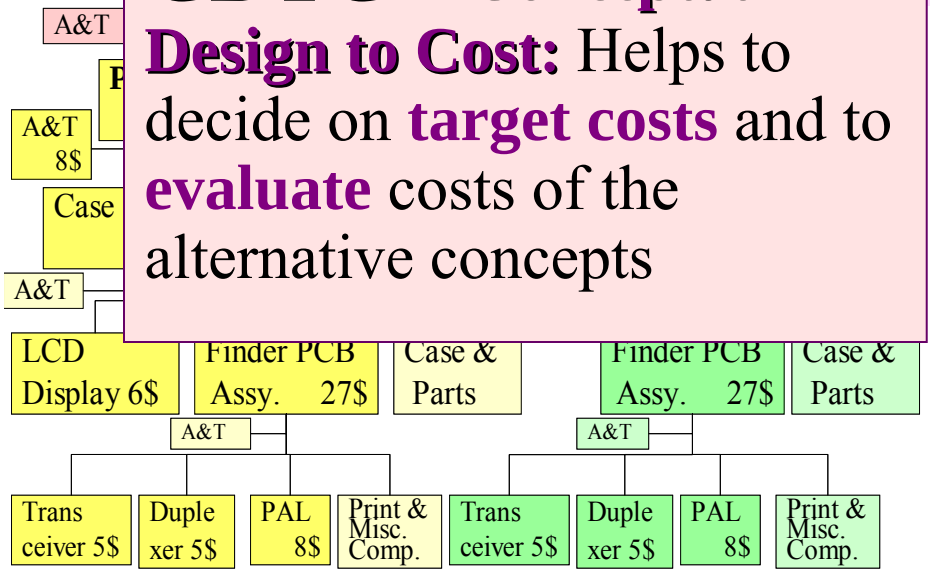


Sizing - Helps to **measure and optimise** the specific functional characteristics of the alternative concepts



CFMA - **Conceptual Failure Modes Analysis:** Helps to **identify and prevent** known and potential failures from reaching the customer.

Methods for Analysis, Improvement and Evaluation of the Alternative Concepts



CDTC – Conceptual Design to Cost: Helps to decide on **target costs** and to **evaluate** costs of the alternative concepts

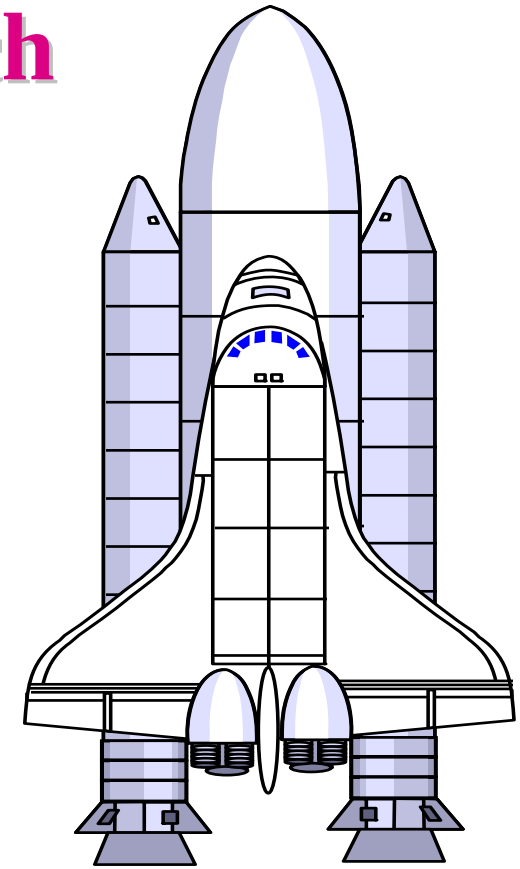
RTA-Risk & Time to Market Analysis: Helps to define and analyze **Risks, Plan** the development process and **evaluate** the TTM of the alternative concepts

Step 9: Final Concept Evaluation

	Spec	Weight	Target value	Result Achieved	CSR
1	FAR	20.5	$2 \cdot 10^{-4}$	10^{-6}	100
2	Radiation .Opt	11.9	510^{-5} [J/cm^2]	< 15 μJ/cm^2	100
3	Range	11.3	1000 [m]	1000	100
4	Resolution	11.1	20 [m]	< 20 m	100
5	Autonomy	8.7	Full	Full	100
6	Radiation .EM	8.4	0.2 [w/cm^2]	0.024	100
7	Cont. Operation	7.9	24 [h]	20.0	60
8	Volume	5.4	200 [cm^3]	245	70
9	Price	4.9	750 [$]	454	100
10	Weight	4.2	200 [g]	200	100
11	Maintenance	3.8	50 [$/month]	50	100
12	Mount / Dismount	2.1	5 [min]	< 5	100

Total: 94.5%

Step 10: Project Launch



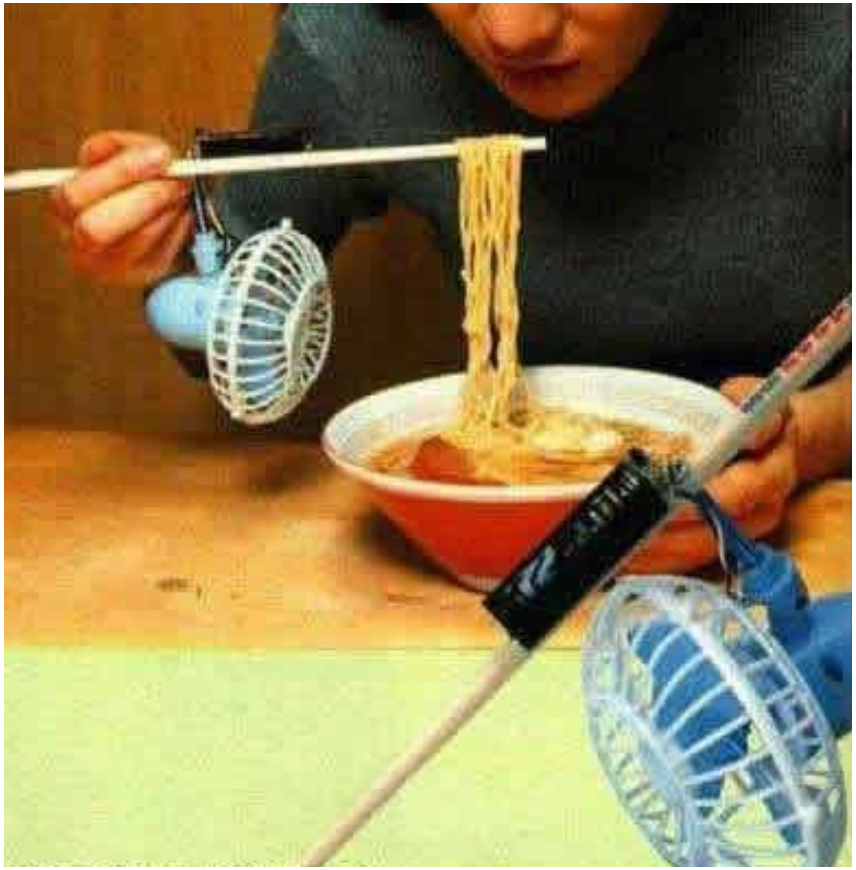
Goals:

1. To approve the specification and the concept
2. To approve the resources required for the full scale development.

When complex system is involved, **step 10 serves as the starting point of the next lower tier in the Systems Engineering Process (SEP)**.

Topics

- Introduction
- Overview of ICDM
- Case Study
- **Research**
- Application of ICDM
- Conclusions



29 new product development teams (129 members) were instructed to apply the **ICDM** methodology step by step and evaluate the results by the **DQM** (Design Quality measurement) system.

Which approach created higher CSR (better concepts)

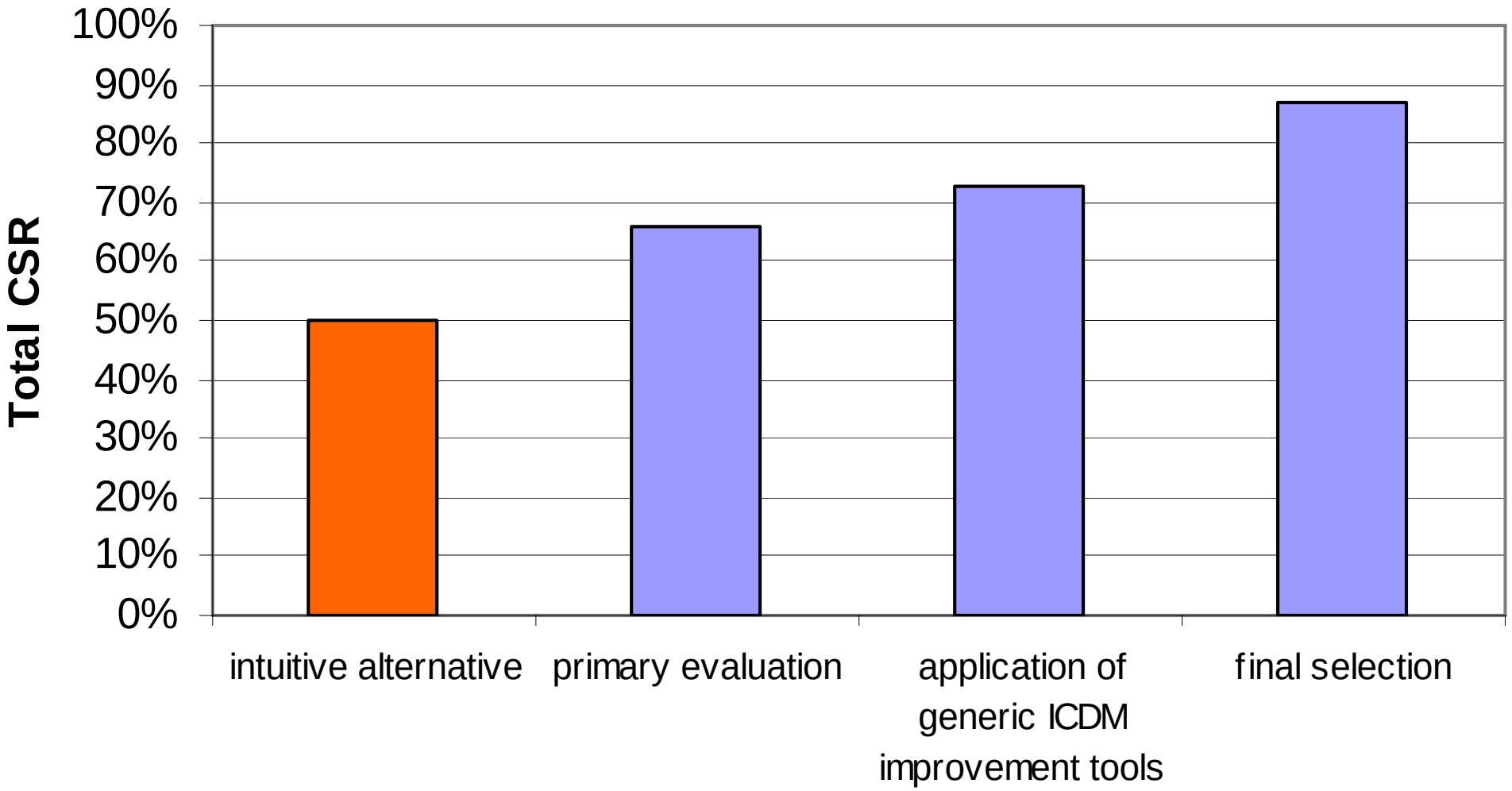
Intuitive Concept

or

concept created by using ICDM

?

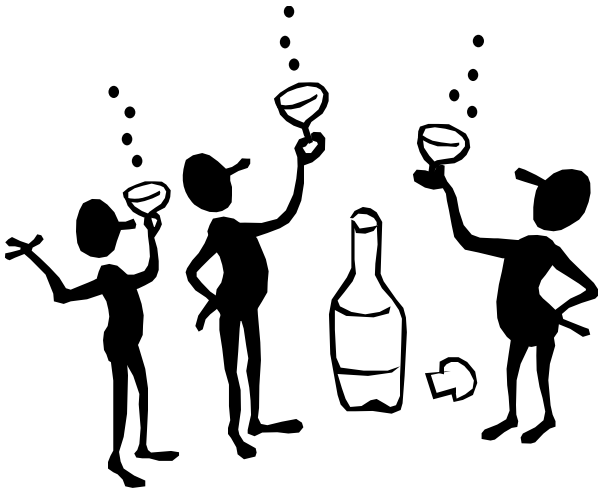
❶ The quality of a concept achieved by **ICDM** was on the average **1.75 times better** than the **intuitive alternative**.



The Paradigm Shift (1)

The Traditional Paradigm:
Intuitive concepts are **the best**

The New Paradigm:
Methodology can help in creating **better** concepts

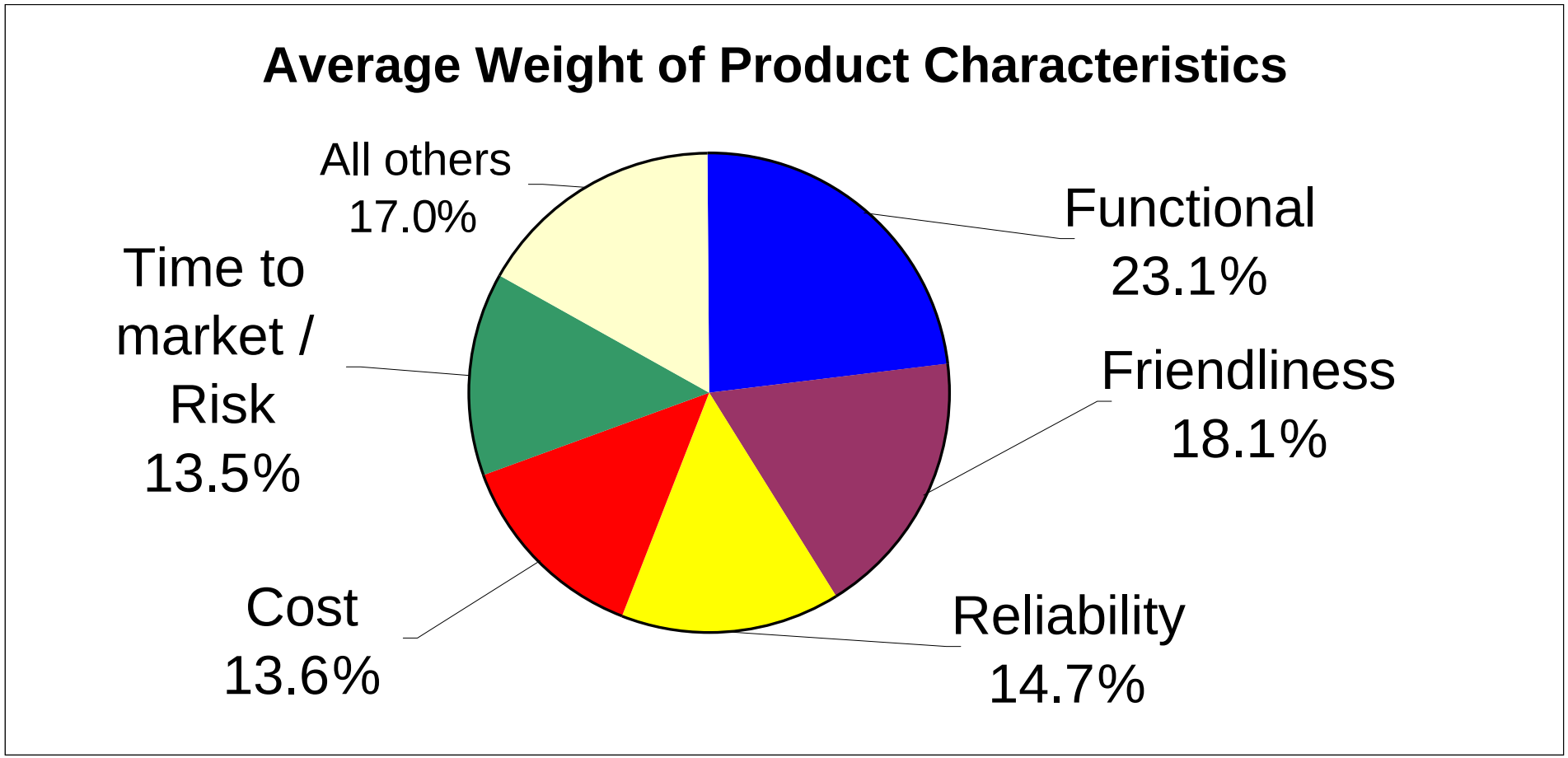


What types of metrics were used by most of the teams

?

- Safety
- Functional
- Design level / aesthetics
- Interface and compatibility
- Environment Friendliness
- Manufacturability
- Cost
- Time to market / Risk
- Reliability
- Maintainability & Support
- Friendliness
- Operation time

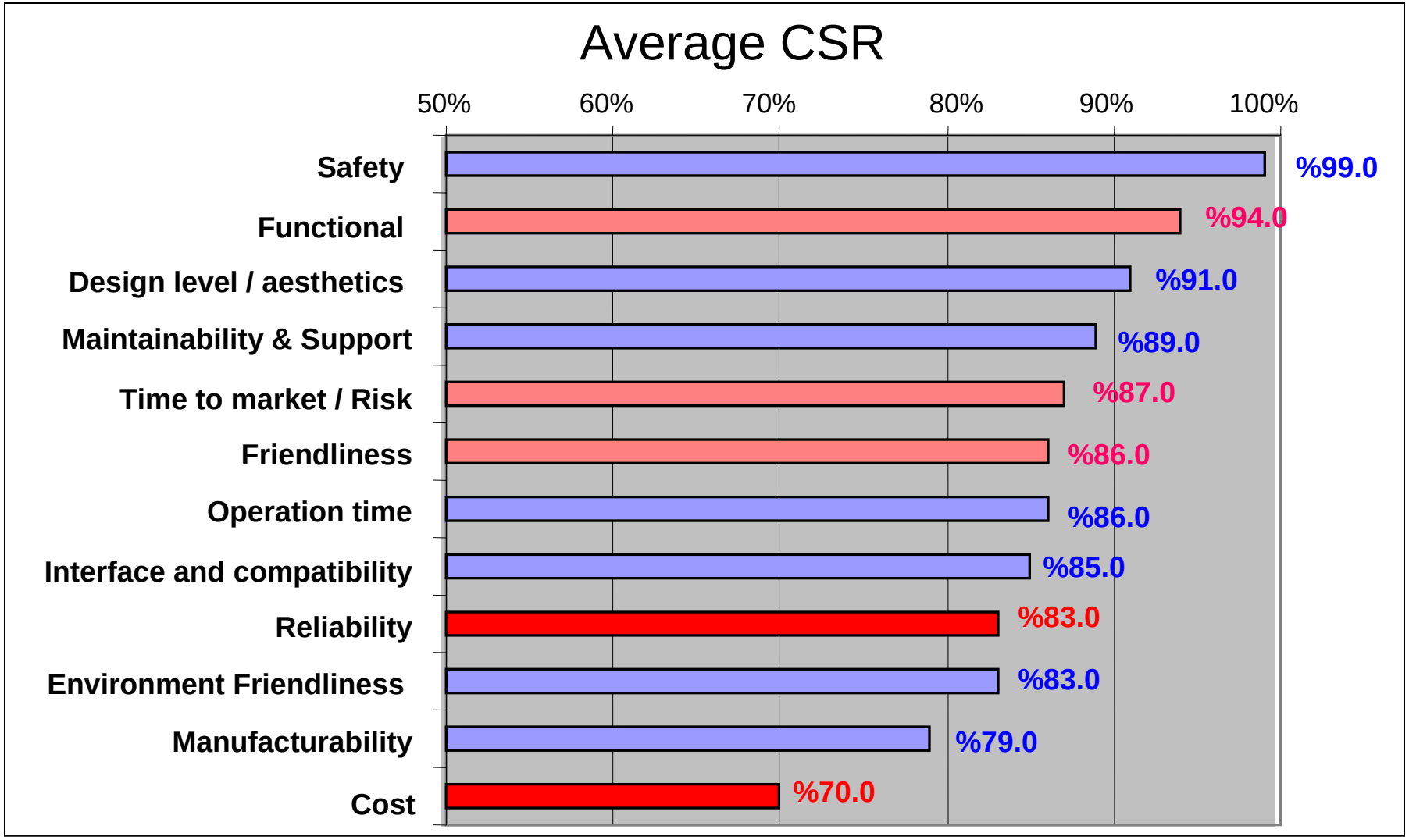
❷ The 5 metrics that were used by most of the teams covered, on average, **more than 80%** of the customer satisfaction.



- **Which type of metrics achieved the highest Customer Satisfaction Rating (CSR) ?**
- **Which type of metrics achieved the lowest Customer Satisfaction Rating (CSR) ?**

- Safety
- Functional
- Design level / aesthetics
- Interface and compatibility
- Environment Friendliness
- Manufacturability
- Cost
- Time to market / Risk
- Reliability
- Maintainability & Support
- Friendliness
- Operation time

❸ The teams achieved the best scores for the functional and safety metrics on account of other Product Characteristics like: user friendliness, reliability, cost and time to market.



❹ The Design Quality Measurement system detected **cost, reliability and risk problems** very early in the design process, when it is relatively **easy to correct** them and **prevent them from reaching the customers.**

❺ The research revealed that the generic tool of **Conceptual Failure Mode Analysis (CFMA)** reduced the criticality of the selected concept by more than 50%.

The Paradigm Shift (2)

The Traditional Paradigm: **Cost, reliability and risk problems can be solved** only during the Full Scale Development **(FSD)** phase

The New Paradigm: We can **detect , prevent and correct cost, reliability, and risk problems** during the Conceptual Design Phase **(CDP)**

Topics

- Introduction
- Overview of ICDM
- Case Study
- Research
- **Application of ICDM**
- Conclusions

Special Application of ICDM

Formal SE requires time and resources which are not always available and therefore SE processes are sometimes totally skipped

Two options for **short and cost effective processes**

- **Agile** workshop (Agile SE): 2-3 Month

Steps 1,2	Steps 3 - 7	Step 8	Step 9	Step 10
1- 4 weeks	**2-5 days**	**1-6 weeks**	**1-2 days**	**2 half days**

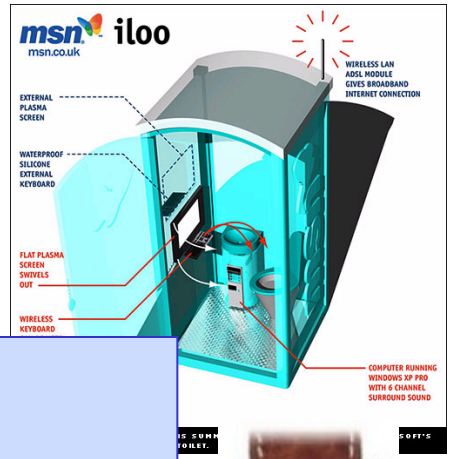
- **Slim** workshop (Slim SE): 5 Days !!!

Day 1: Needs and Requirements	**Day 2:** Benchmark and Abstraction	**Day 3:** Solutions and Concepts	**Day 4:** Design and Analysis	**Day 5:** Selection and Verification

Training Options

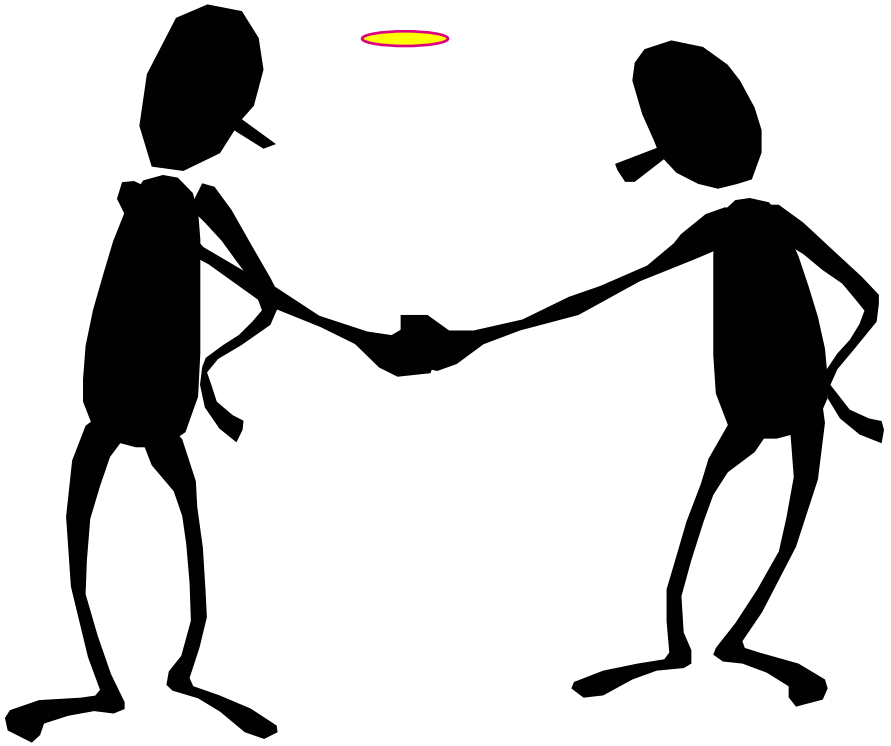
- One day ICDM overview
- Two days workshop on new product definition (NPD) and Conceptual Design
- Two days workshop on ICDM methodology and tools
- 5 days class action learning workshop - ICDM applied on the company project
- One semester academic graduate and undergraduate course on ICDM

Conclusion



- **ICDM - I**ntegrated **C**ustomer **D**riven **C**onceptual **D**esign **M**ethod.
- **ICDM** is a proven method for performing the critical task of **conceptual design in the SE process** and to make the best choice.

Thank You, Questions?



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