Quality Assurance and Prevention of Problems

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Satisfaction and Safety of Customers and Society

⇧

Needs of Customers and Society

⇧

Systematic activities to ensure above needs by three "E"s

[Quality Assurance]

Three Es of Quality Assurance

1. Establish "Process" to satisfy customers' needs
   ･Grasp the needs of costumers and society
   ･Develop the products/service based on the needs
   ･Establish the process to satisfy customers' and society's needs
2. Execution of the process and Verification & Validation
   ･Satisfy the specification and standard
   ･Satisfy the needs of costumer and society at Genba
   ･Continuously grasping and checking the satisfaction
   ･Implement PDCA
3. Evidence for the third party
   ･ Clarify and satisfy the needs of customer and society
   ･ Make the documents of its contract
   ･ Show the evidence of that the needs of customers and a society are fulfilled and give them the confidence

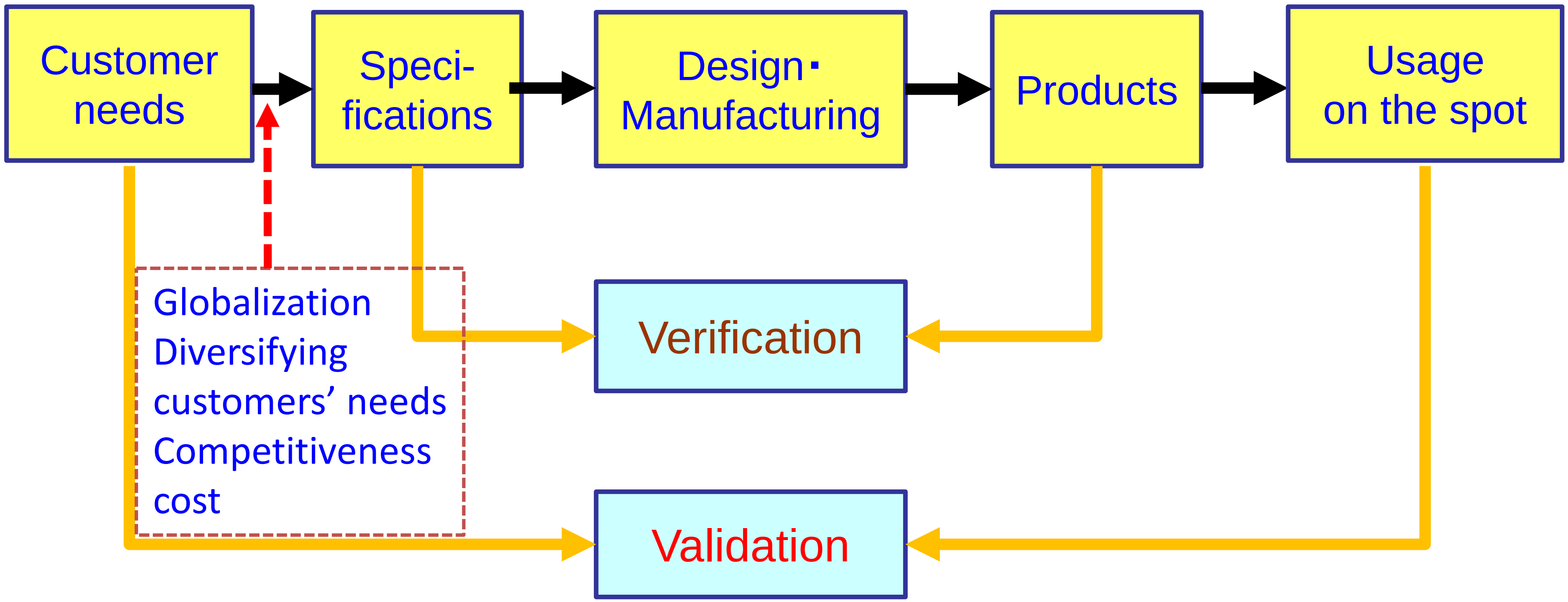

Fig 2. Verification for Specifications and Validation for Customer Needs

Kume, H.(2014), ed. By Kazuyuki Suzuki, New Reliability Handbook, JUSE Press

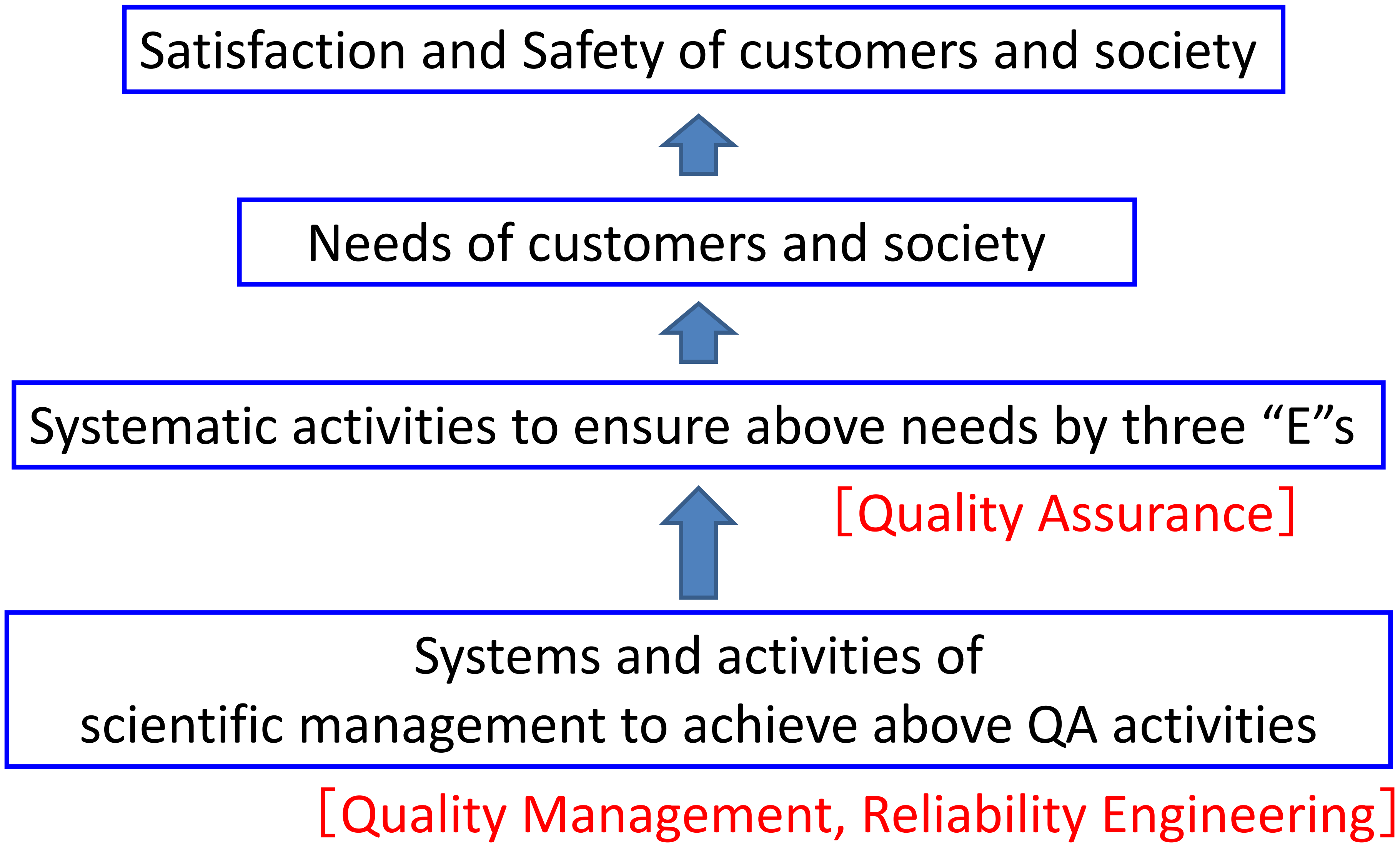

Fig 1. Relationships among quality assurance, quality management and reliability engineering

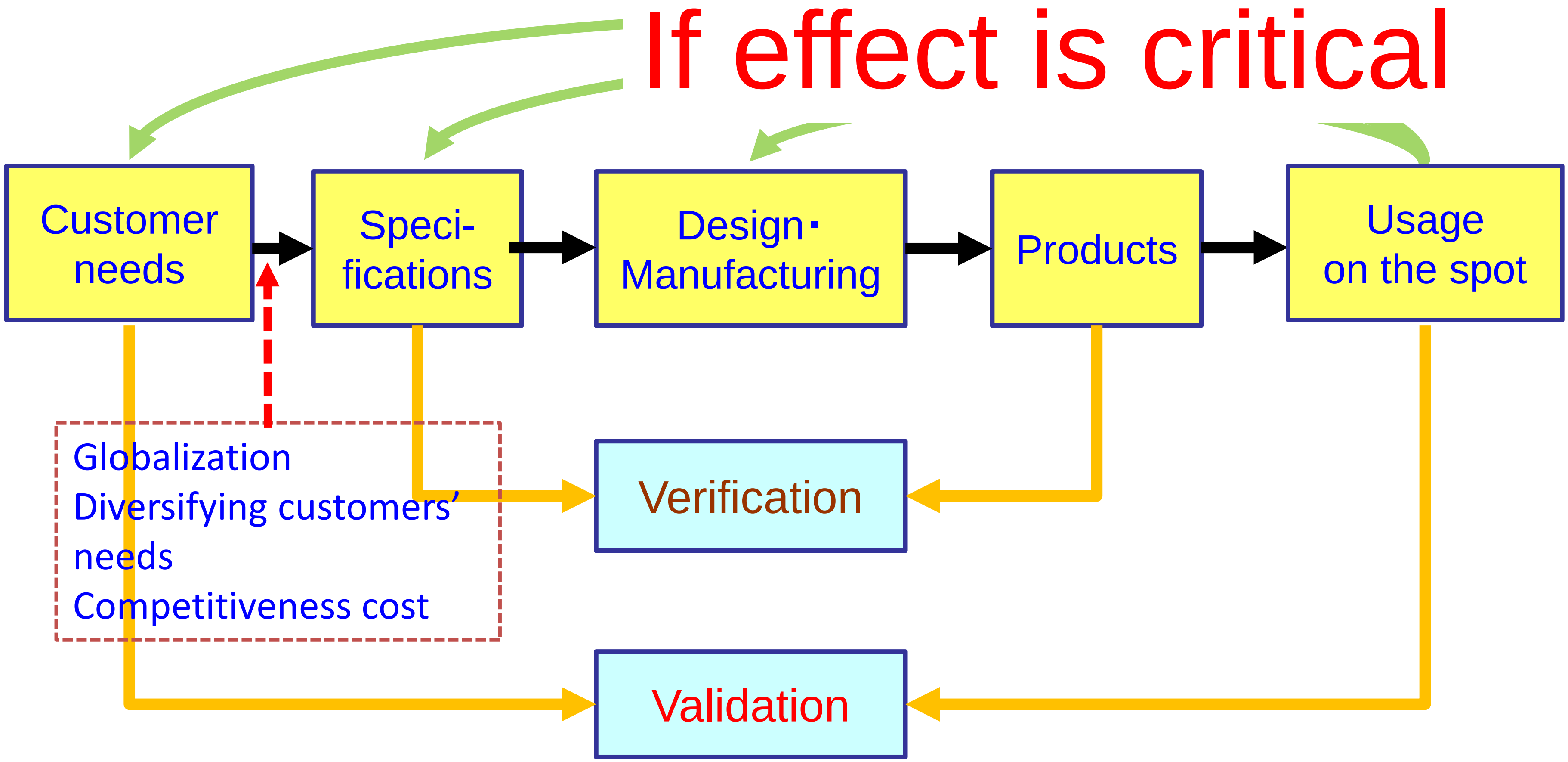

Fig 2. Verification for Specifications and Validation for Customer Needs

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Q1

What is the key to prevention?

(防患于未然的关键是什么？)

Prevention

Q1

What is the key to prevention?

"Prediction" --- Events that cannot be predicted cannot be prevented.

Q2

What problems must be avoided in your products/systems or research/education ?

Q3

What problems must be avoided in your organization?

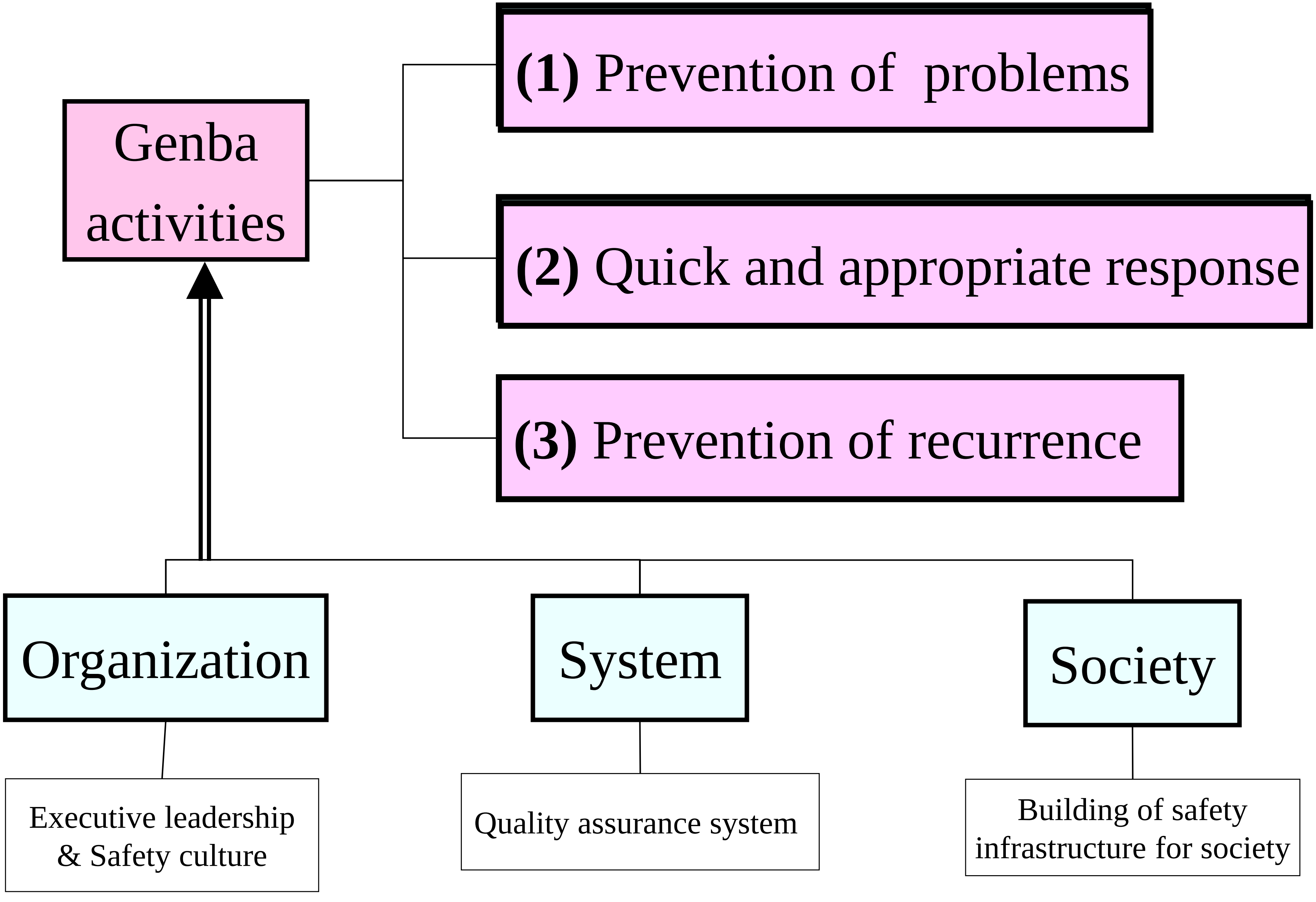


Fig. 3 Scheme for achieving reliability and safety

Prevention (What is important?)

"Prediction" --- We cannot prevent problems that cannot be predicted.

Inductive Approach （归纳法）

By collecting information from the person in confrontation with a similar problem in the world, we can better predict future problems, possibly more than 90% of them.

Deductive Approach （演绎法）

From scientific theories and principles, a particular future problem will be predicted.

"Up-stream management by top leadership"

- Inclusive (every department, employee, and group)
- Early stage discussion (e.g., building reliability & safety)

"Seven Viewpoints"

Activities on the spot: Prevent Problems Before They Occur

Change to new technologies, new materials, 5M1E…

Problems that cannot be predicted cannot be prevented.

- I. Attempt prediction
- II. Predict effectively and efficiently
- III. Share success experiences

(1) Sharing of problem information beyond organization

(2) Abstraction and generalization of respective problems / Implementation of PDCA cycle

} **Inductive Approach** (applies to items (1) and (2))

(3) Practical use of incident information

(4) Use of seven viewpoints

(1) Sharing problem-related information beyond organizational boundaries

Classification

a. have experienced

b. have not experienced

b1. have not experienced, but others have experienced

b2 one organization has not experienced, but another organization has experienced

b3. one industry has not experienced, but another industry has experienced

b4. no person, organization, or industry has experienced.

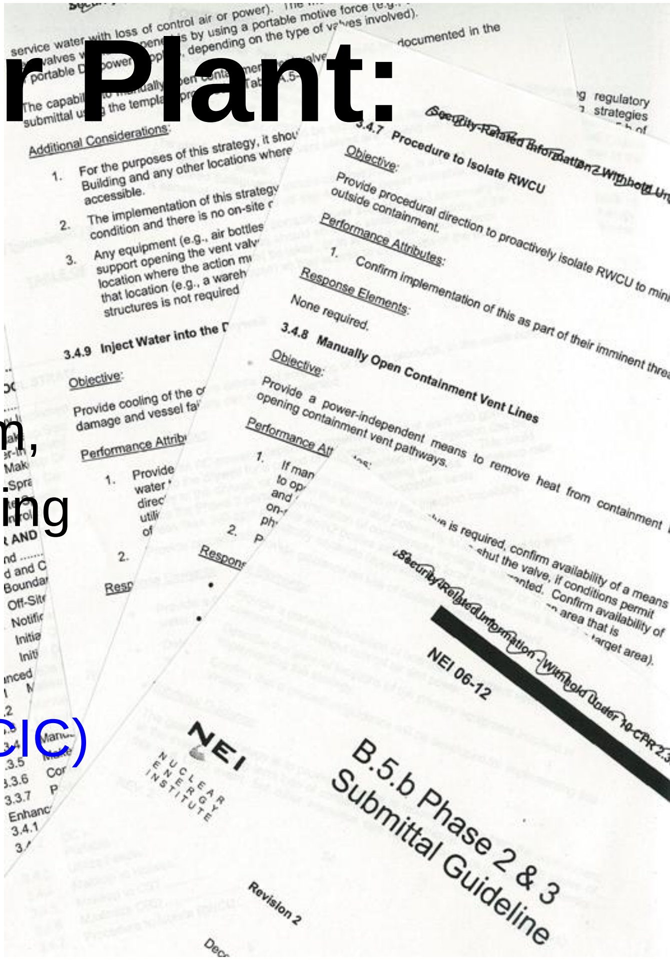
Share information

(2) Abstraction and generalization of respective problems / Implementation of PDCA cycle

Q. 5

B. 5. b

「B5b」Measures for attack on Nuclear Power Plant:



Dec., 2006 USA

For countermeasure to the attack of terrorism,

prepare cooling the core of nuclear reactor using

Isolation Condenser(IC),

非常用復水器

Reactor Core Isolation Cooling system (RCIC)

隔離時冷却系

by hand, without electricity

http://astand.asahi.com/magazine/judiciary/articles/2012012600008.html

3H Issues

Henka(Change)

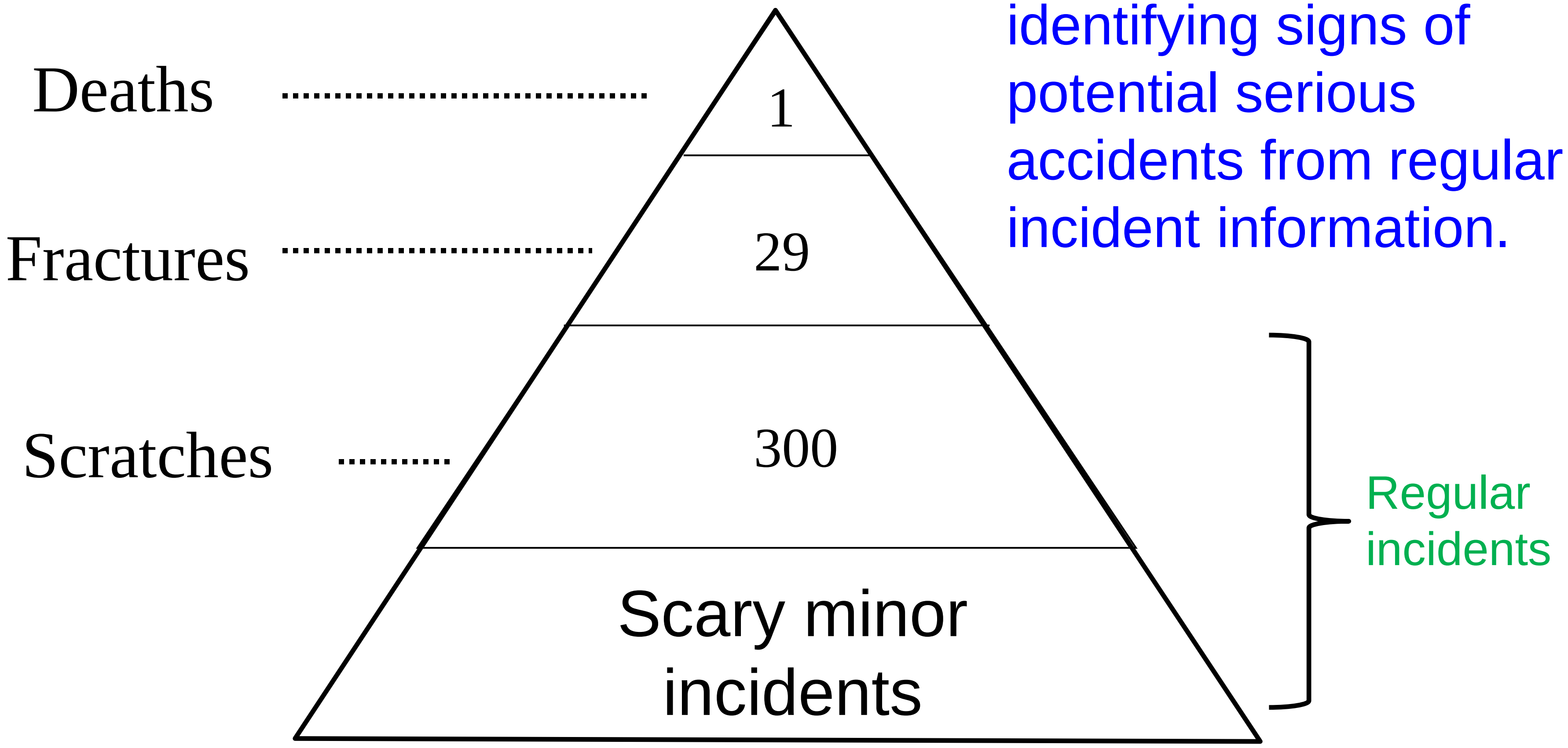
Hajimete(first time)

Hisashiburi(after long absence)

---Dr. Kazuyuki Suzuki

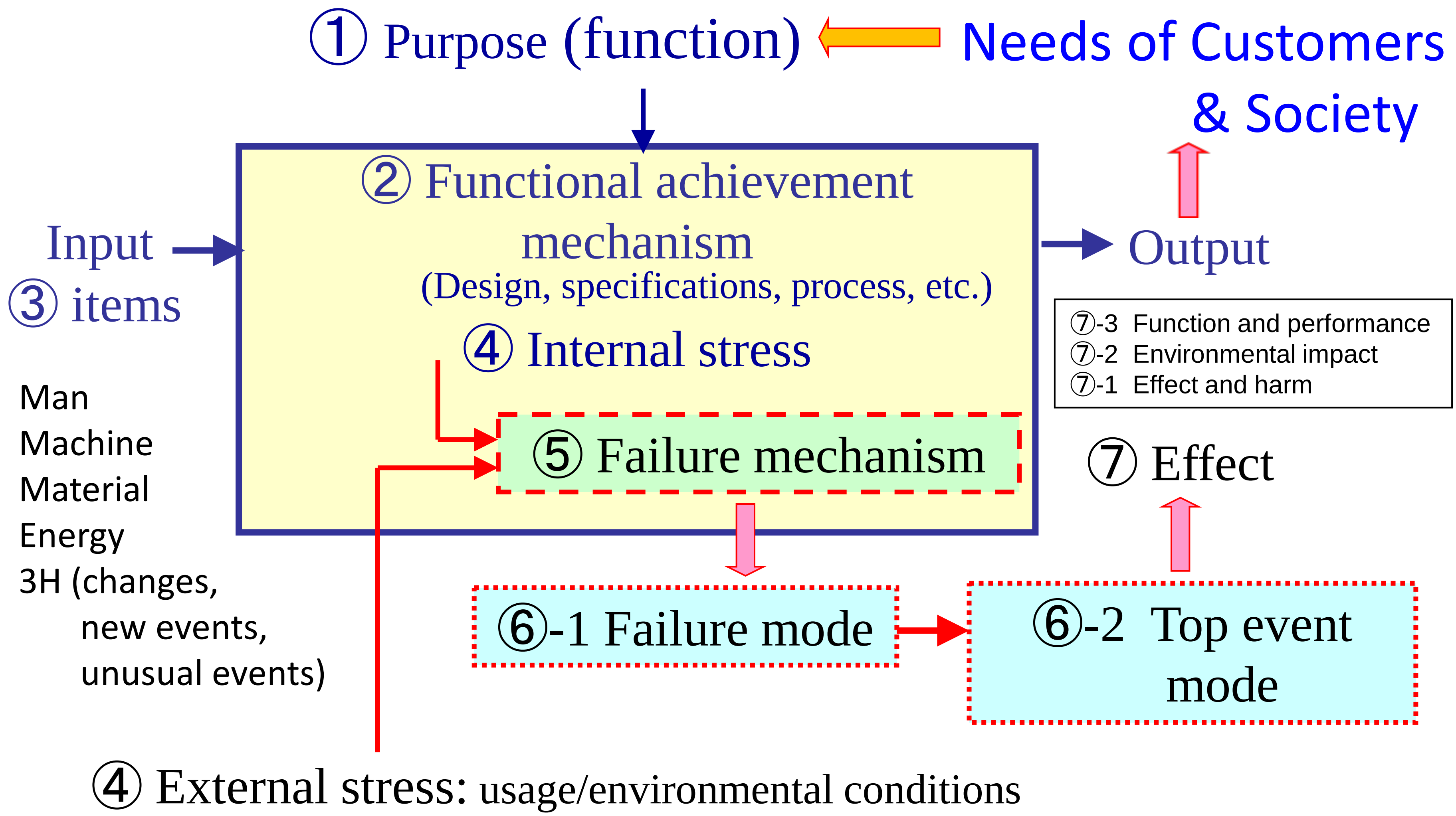
(3) Utilizing incident information

System is needed for identifying signs of potential serious accidents from regular incident information.

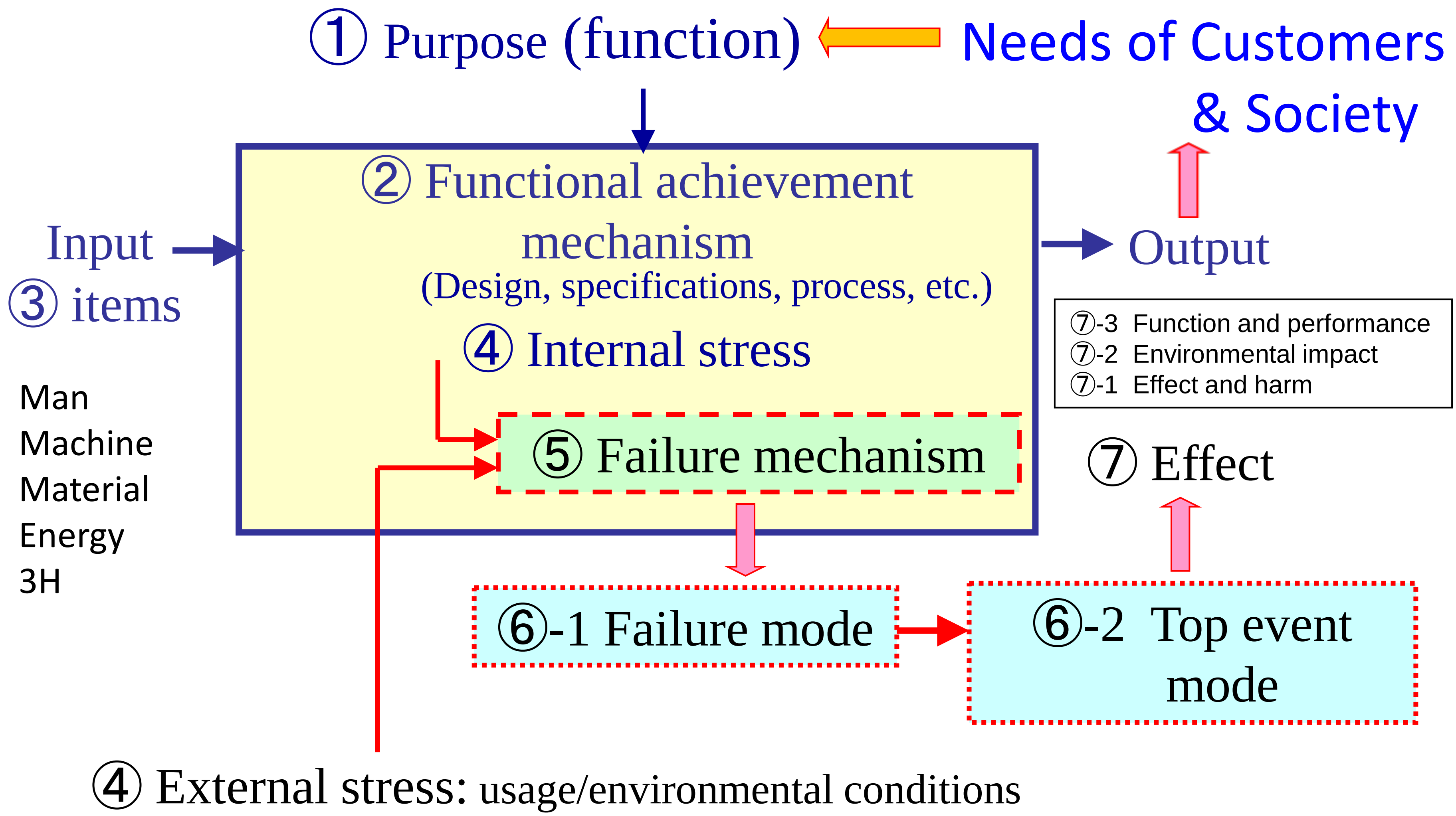


Heinrich's Law: 1:29:300

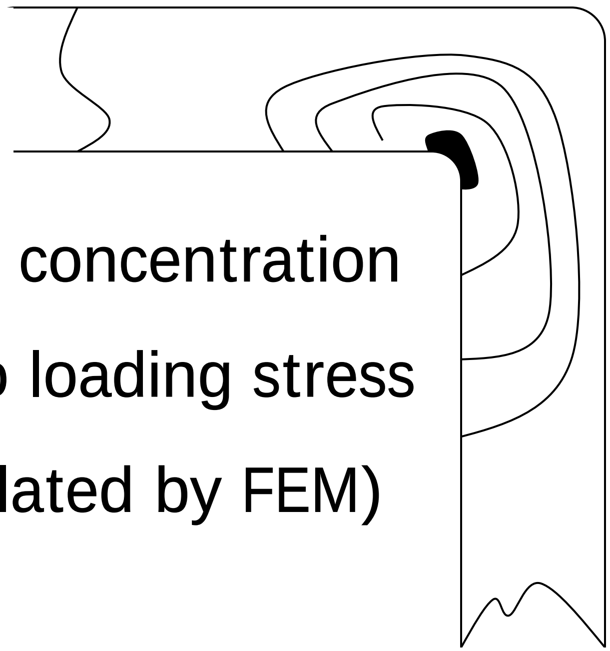
(4) Seven Viewpoints:



(4) Systems Approach: Seven Viewpoints



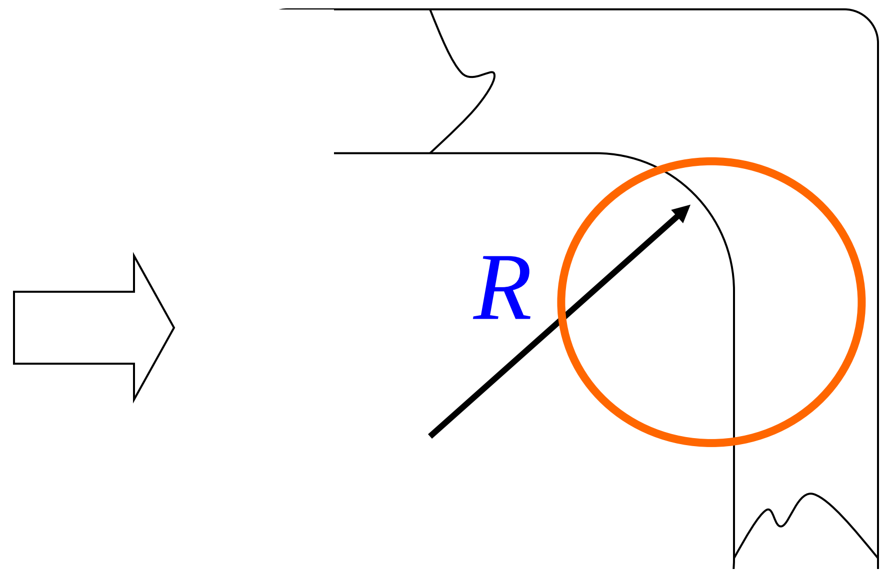
⑤Fracture Mechanism:
Loading Stress



Stress concentration

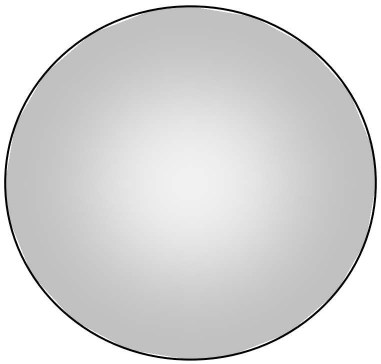
due to loading stress

(calculated by FEM)



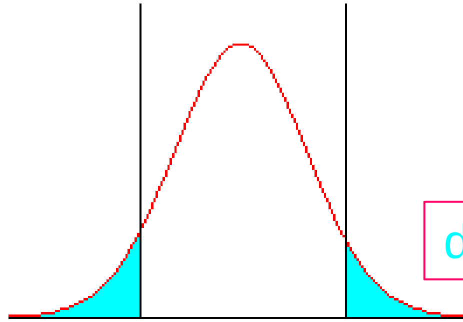
Decrease loading stress by increasing *R* (curvature radius)

high reliability of
Ball Bearing



真円度

Histogram

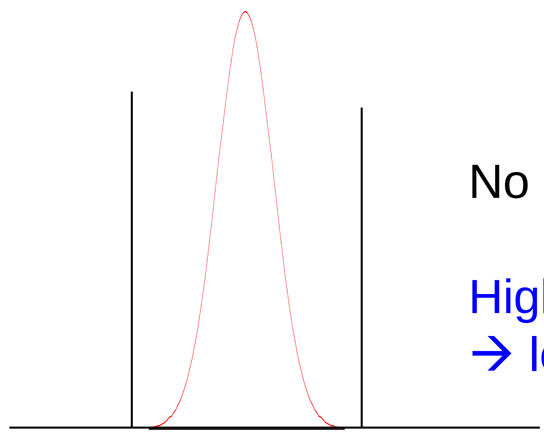


S_L lower limit standard

S_U upper limit standard

defective product

→ inspection is needed

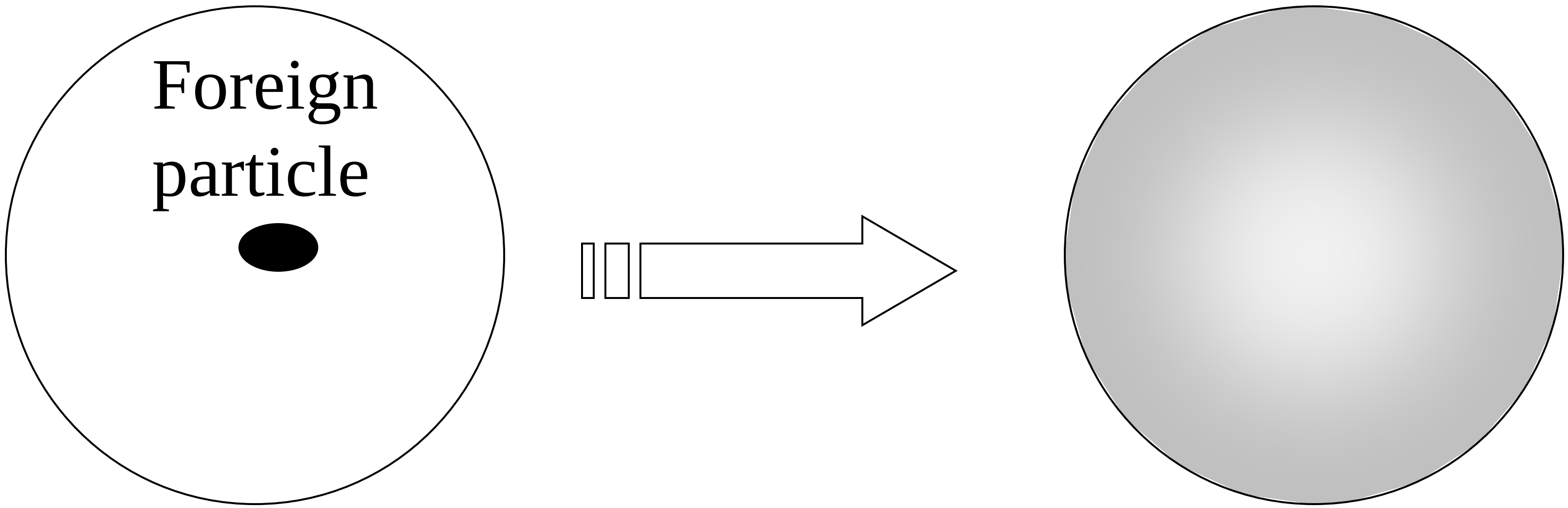


S_L S_U

No inspection

High-Accuracy → No burning
→ long life

Fracture Mechanism: Ball Bearing Life



Foreign particles contaminate ball bearings

Loading stress leads to cracking.

Prevent contamination by using vacuum fusion

(真空溶融法)

Stress (Usage, Environmental condition)		Failure Mechanism				Failure mode	Item/ Material
Major division	Minor division	Major division	Minor division	Phase Ⅰ	Phase Ⅱ	Phase Ⅲ	
Temperature	High temperature + Loading stress + time	Creep	(Plastics)	Atomic diffusion	A void, grain boundary crack generating	settling, crack, fracture	Spring, structure parts

	...ess + time	Creep	(Plastics)	Atomic diffusion	Avoid, grain boundary crack generation	Settling, cracking, fractu...	
			Creep brittleness	Crystal grain boundary bonding strength drop	Ductility drop	Cracking, fracturing	Cr-Mo steel
		Stress relaxation		Support to change in form	Relief of stress	Modification	
						Generation of residual stress	
		Racheting		Repetition of heat stress load	Accumulation of strain	Modification, breakage	Tube wall of internal pressure pipe
loading	Low-temperature + loading stress	Degradation	Wear				
		Cold brittleness	(Metal)	Strength reduction, toughness fall	Material embrittlement	crack, fracture	steel materials, body centered cubic crystal(Ca,Mo,W Etc,), close packed hexagonal crystals(Zn,Ti,Mg etc)and their alloys.
			(Plastics)	Strength reduction, toughness fall	Material embrittlement	Cracking, fracturing	Things (cellulose, vinyl chloride, etc.) that have high vitrification temperature and things (styrene, methyl methacrylate, urea-resin, etc.) that have ductility amorphous again and low at crystallinity.
		Contraction	Residual stress	Room Temperature cooling	Material hardening, contraction	Cracking, breakage	Resin
		Expansion	Freezing expansion	Volume expansion	Crack generation	Cracking, fracturing	Things that easily absorb moisture
	High temperature + loading stress		Evaporation expansion	Volume expansion	Crack generation	Cracking, fracturing	Package product of electron device, solder
			Popcorn phenomenon	Moisture evaporation	Expansion	-	Integrated circuits (packaged products)
			Thermal sparkling	Moisture evaporation	Expansion	Exfoliation, cracking	Concrete
		Thermal shock					
	High temperature + small vibration	Baking		lubrication impossible	Rapid increase friction	mechanical shutdown, destruction	

Stress (Usage, Environmental condition)		Failure Mechanism				Failure mode	Item/ Material
Major division	Minor division	Major division	Minor division	Phase Ⅰ	Phase Ⅱ	Phase Ⅲ	
Temperature	High temperature + Loading stress + time	Creep	(Plastics)	Atomic diffusion	A void, grain boundary crack generating	settling, crack, fracture	Spring, structure parts
	low-temperature + loading stress	cold brittleness	(Metal)	strength reduction, toughness fall	material embrittlement	crack, fracture	Liberty ship

					crack generation		
		Creep	(Plastics)	Atomic diffusion	Avoid, grain boundary crack generation	Settling, cracking, fractu	
	ess + time		Creep brittleness	Crystal grain boundary bonding strength drop	Ductility drop	Cracking, fracturing	Cr-Mo steel
		Stress relaxation		Support to change in form	Relief of stress	Modification	
						Generation of residual stress	
		Racheting		Repetition of heat	Accumulation of	Modification, breakage	Tube wall of internal pressure
							centered cubic crystal(Ca,Mo,W Etc,), close packed hexagonal crystals(Zn,Ti,Mg etc)and their alloys.
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Table List of stress failure mechanism failure mode

Stress		Failure mechanism				Failure mode	Item	Principles, laws of failure occurrence	Detection of failure mode	Main indus-try, fields
Major division	Minor division	Major division	Minor division	Phase I	Phase II	Phase III				
Temperature										
Stress										
Humidity										
Electronic field										
Gaseous contamination										
Special failure										
Optical radiation										
Fluid										
Special failure										

[5] Kazuyuki Suzuki (2004): "principle and system of prevention before it happens", JUSE

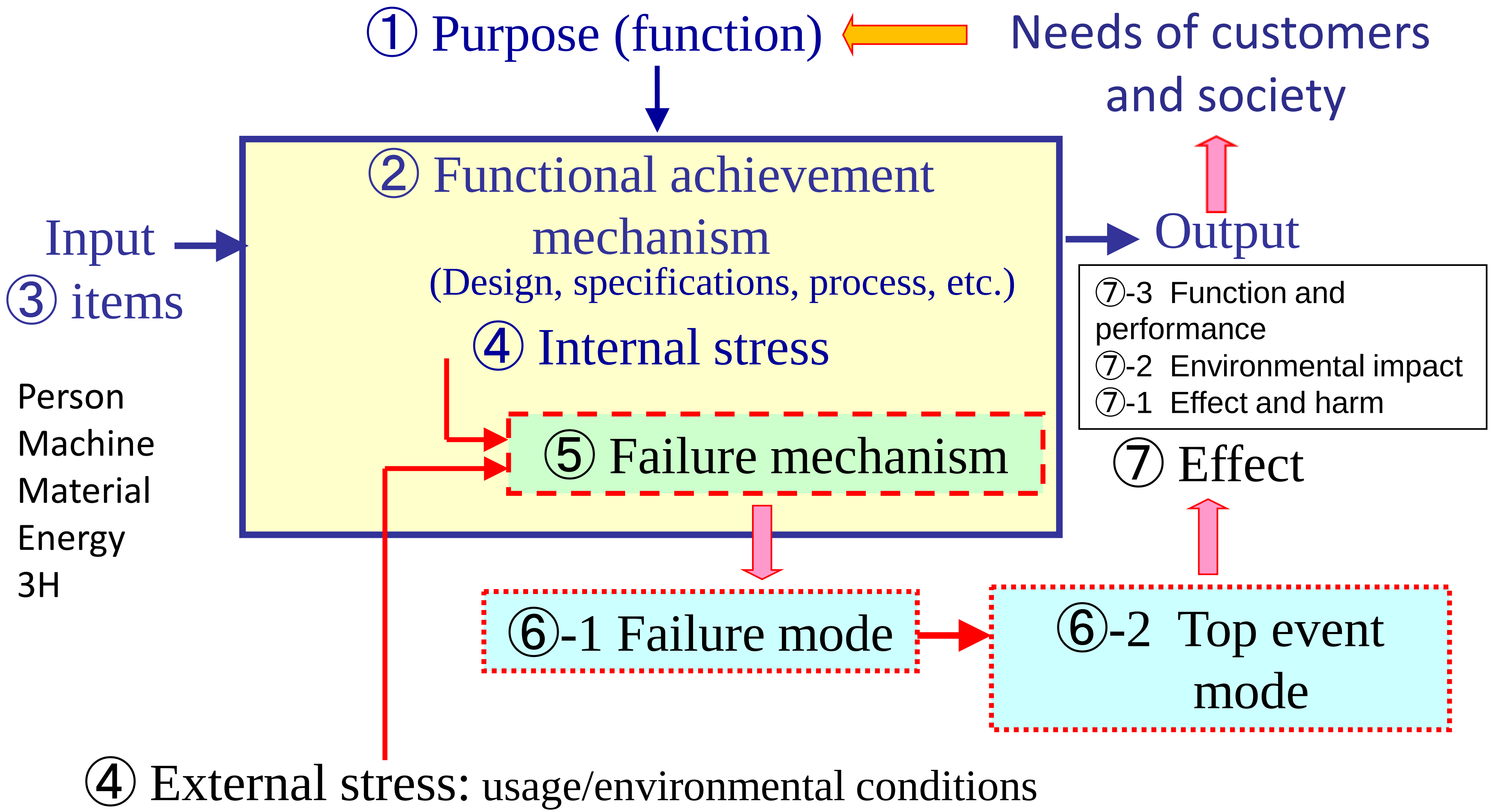


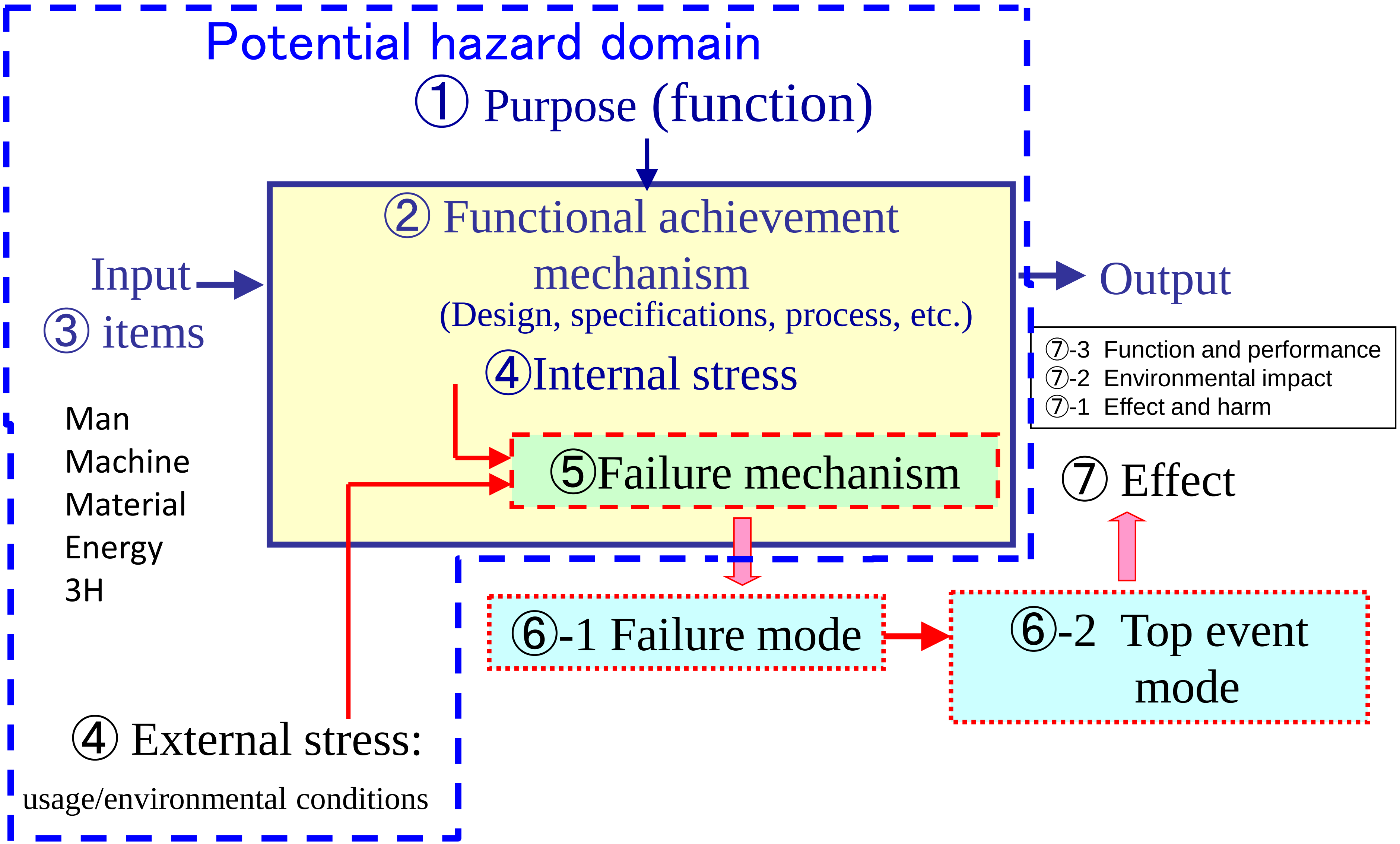
Fig. 4 Seven viewpoints for prevention

What is Safety(安全)? [Professor I. Kuroda]

- "There is no safety in this world.
- There exist only potential hazards and the relating risks to them.
- Safety is a state in which there is no trouble; it is attained only by continually making efforts to prevent potential hazards.
- Without such efforts, even for just a second, safety disappears."

Hazard: [Hajime Makabe (2002)]
The potential situation, factor and scenario which lead to harm and damage.

Hazard: The potential situation, factor or scenario which leads to harm or damage. Makabe(2010)



Path from Hazard to Effect

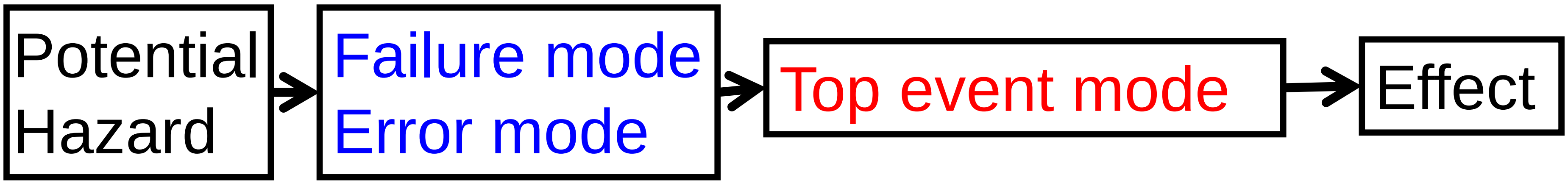


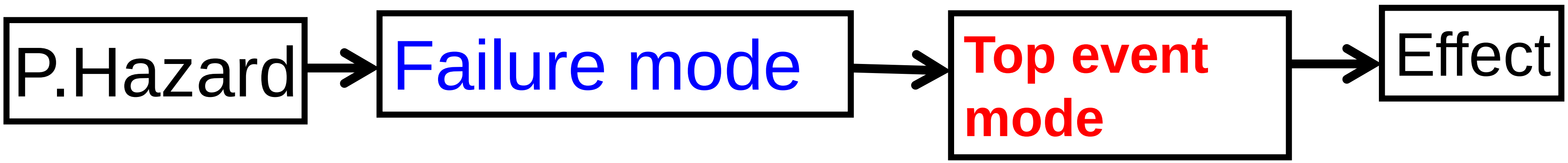
Fig. 5 Path from potential hazard to effect

⑥-1 **Failure mode**

"Failure mode" refers to generalized types of unfavorable phenomena or events that may affect system or product components. Failure modes are made abstract and general so that they can be used for predicting possible faults.

Ex.) Pipe; cracking, fracturing, and clogging

--- nuclear power plants, drainpipe, blood vessels



<u>“**Error mode**”</u>

Example; prohibited, with something on, omit, insufficient

<u>abstract and general expression to alert for human’s inappropriate action and deviation from rules・standards in order to prevent unfavorable behaviors during the use at work・in daily life.</u>

Table 2. List of Failure Modes based on 27 Articles

Fracture	82	Slack	2
Crack	65	Electric discharge	2
Degradation	25	Delay	2
Surface Damage	21	Radiation injury	1
Thinning	19	Contamination	1
Deforming	18	Blister	1
Short circuit	16	Liquefy	1
Ignition Heat Emitting smoke	14	Decarbonization	1
Opening/Disconnection	11	No output	
Noise	9	Excessive output	
Dielectric breakdown Insulated degradation	7	Too little output	
Exfoliation	6	Output instability	
Omission	6	Vibration	
Fading/discoloration	4	Loss of function	
Insulated degradation	4		
Leak/short circuit	5	Total)	323

Table 4. Error Mode and Error

Error Mode	Error	Number
prohibited	utilization for other purpose, installation in the prohibited place, sleep near the source of heat, inappropriate (ignition/fuel/remodel), heating without using a specialized pan	33
with something on	Refueling without extinguishing fire, leaving a thing unattended with heat	19
insufficient	Insufficient cleaning, Insufficient ventilation	14
incomplete	Incomplete closing of a lid, utilization with breakdown/deterioration, incomplete repair	13
heat the prohibited thing	heat/dry towels with oil	11
non confirming	heat/dry without checking oil removal after washing towels	3
over durability years	use with the state of being incomplete from long use (from 11 to 27 years)	7
excess	use over quantity of electricity	5
unstable	unstable installation place	3
blocking	blocking inlet port/exhaust port	3
	Total)	111

⑥-2 Top Event Mode

"Top Event Mode" refers to events that occur just before critical events or accidents, which effects should be avoided. Top Event Modes are extracted from a sequence of occurrences and generalized and unified so that they can be used to analyze various systems, products, and constructions.

a nuclear power plant： all power supply loss→melting
vehicle: sudden start forward moving against backward moving
→ collision with a human
combustion apparatus： combustion･ignition･abnormal combustion→fire
airplane： halt every engine･out of control→crash
railroad (RR)： 錯誤現示→collision
錯誤転換→collision
錯誤解錠→derailment

P. Hazard → Failure mode → **Top event mode** → Effect

錯誤現示

錯誤転換

http://blogs.yahoo.co.jp/makinosike/21924903.html http://minkara.carview.co.jp/smart/userid/205631/car/94284/2733407/photo.aspx

Serious Product Accidents* [May 2007 - Jan. 2012]
[E1 misuse, E2 carelessness]

Product category	Top event mode
Combustion appliances** (79)***	
Home appliances** (32)	
Furniture/household articles (88)	
Vehicles/vehicle articles (46)	
Personal effects/items (25)	
Paint (3)	
Kitchen/table products (5)	
Infant articles (2)	
Leisure goods (7)	

*NITE (National Institute of Technology and Evaluation) www.nite.go.jp/index-e.html/
**based on E1 misuse ***number

Serious Product Accidents* [May 2007 - Jan. 2012]

[E1 misuse, E2 carelessness]

Combustion appliances (79)*****

e.g. Oil heater, Gas clothes dryer

Home appliances (32)**

e.g. IH cooker, Electric clothes dryer

111

Ignition: supply fuel without putting out a fire

（引火、引发火情）

(51)

Self-ignition :（発火、着火）

keep heating when a visitor comes

(36)

Abnormal combustion (16)

（異常燃焼, 异常燃烧）

Fire(103)

Prod	
Comb appli	),
Home (32)	
Furni articles	gnition (3) contact (1), a burst (1)
Vehicles articles	(15), brakes are impossible (3), s operation (2), loss of control (2),
Persona (25)	ition (4), loss of balance (3),
Paint (3	
Kitchen/table products (5)	
Infant ar	
Leisure goods (7)	Orbital deviation (3), inserted(2) , loss of balance (1), ignition (1)

*NITE (National Institute of Technology and Evaluation) www.nite.go.jp/index-e.html/

**based on E1 misuse ***number

Table 3. Serious Product Accidents* and Top Event Mode

[E1 misuse, E2 carelessness] [May 2007 - Jan. 2012]

Product category	**Top event mode**	**Effect**
Combustion appliances** (79)***	Ignition (46), self-ignition (16), abnormal combustion (15)	Fire broke (77)
	incomplete combustion (1), skin contact (1)	Others (2)
Home appliances** (32)	Ignition (6), self-ignition (20)	Fire broke (26)
	incomplete combustion (6)	Others (6)
Total (111)		

*NITE (National Institute of Technology and Evaluation) www.nite.go.jp/index-e.html/

**based on E1 misuse ***number

⑥ Failure Mode and Top Event Mode （故障模式与顶事件模式）

"Failure mode" refers to generalized types of unfavorable phenomena or events that may affect system or product components. Failure modes are abstract and general so that they can be used for predicting possible faults.

Ex.) Pipe; cracking, fracturing, and clogging

--- nuclear power plants, drainpipe, blood vessels

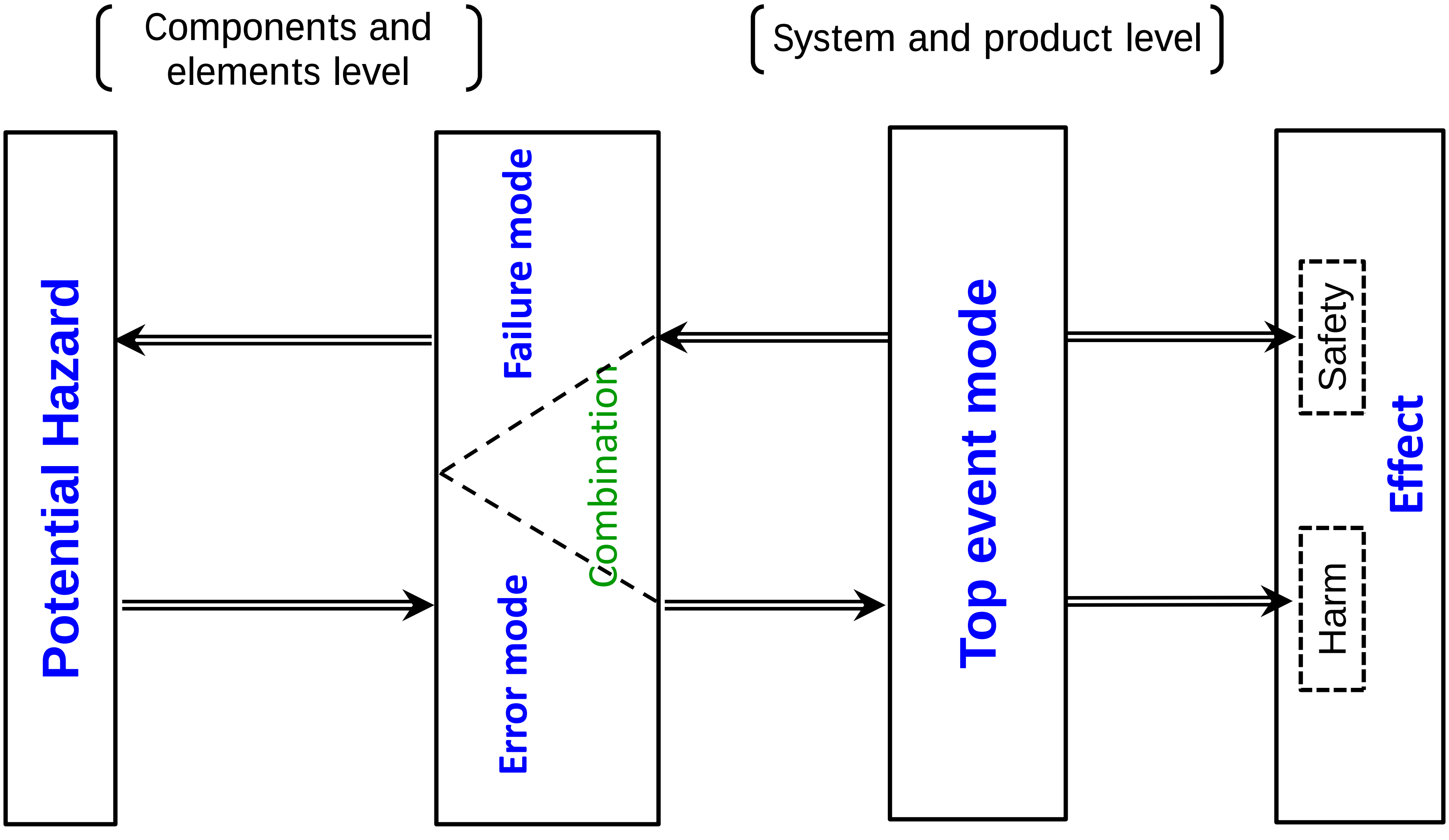
P. Hazard → Failure mode → **Top event mode** → Effect

"Top Event Mode" refers to events that occur just before critical events or accidents, which effects should be avoided. Top Event Modes are extracted from a sequence of occurrences and generalized and unified so that they can be used to analyze various systems, products, and constructions and generalized and unified so that they can be used to analyze various systems, products, and constructions.

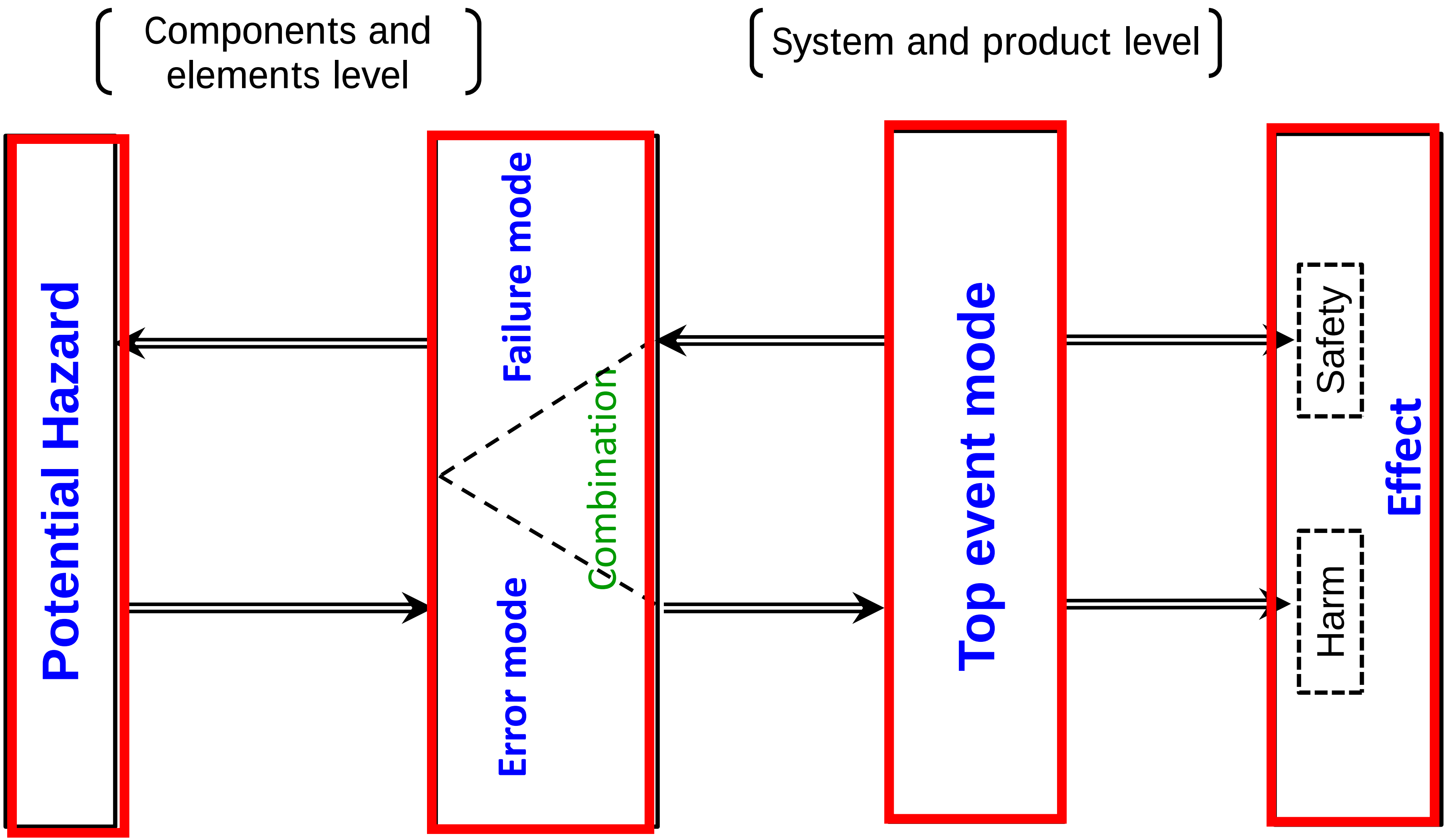
Ignition (51) → Fire(103)

Self-ignition (36) → Fire(103)

Abnormal combustion (16) → Fire(103)



Path from Hazard to Effect



Path for Preventing Problems

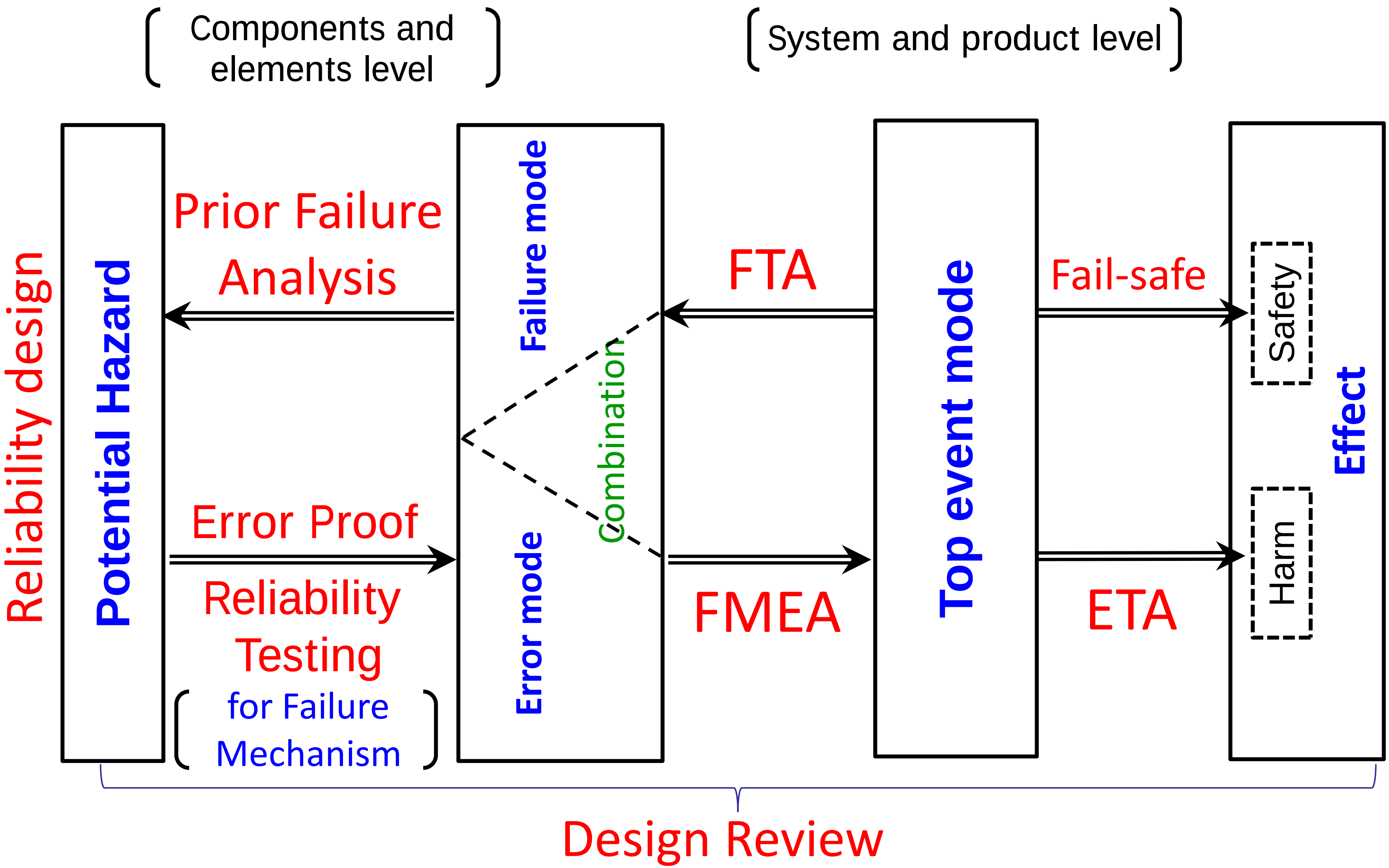


Fig. 6 Schemes for Preventing Problems and New Reliability Engineering Methods

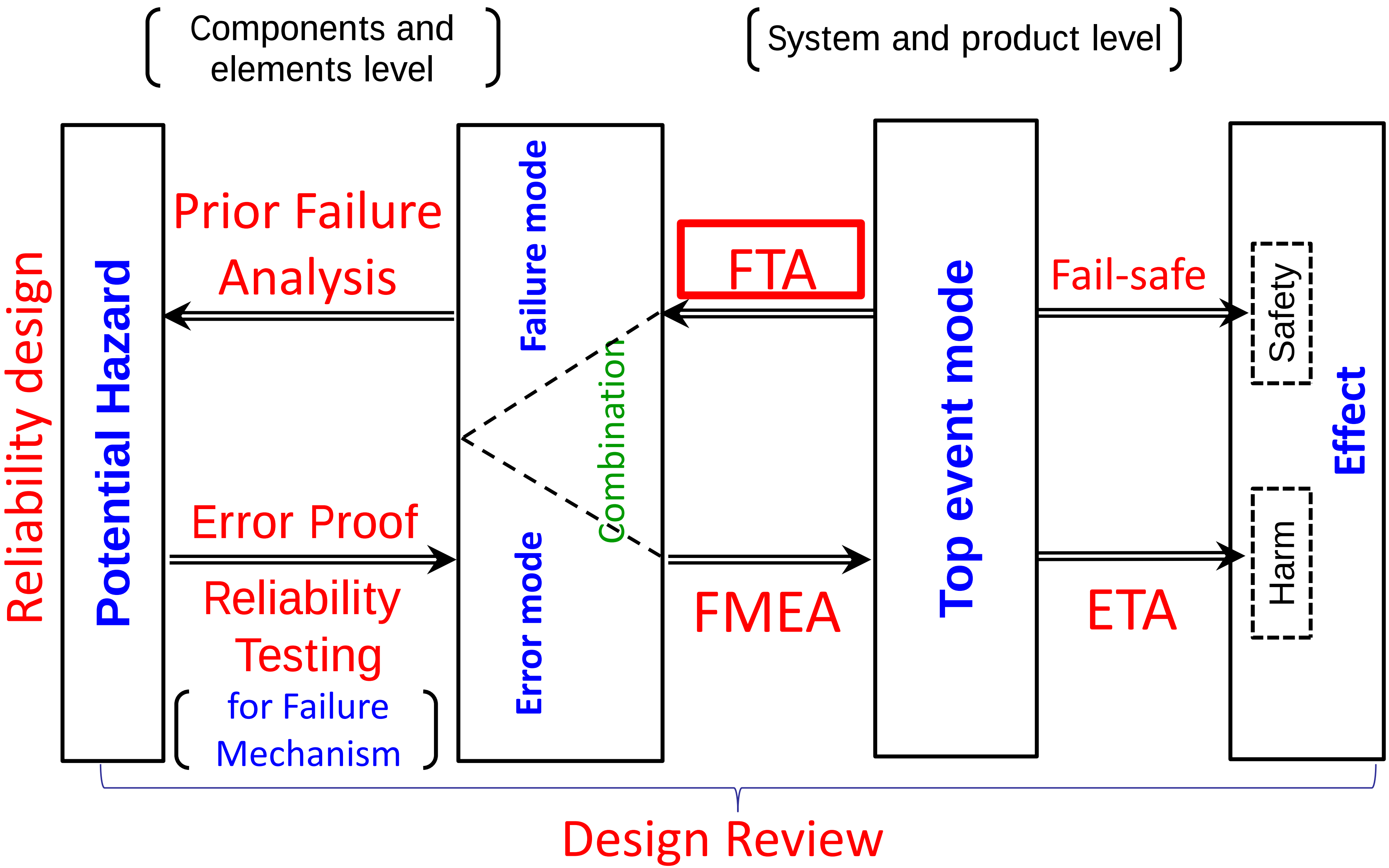


Fig. 6 Schemes for Preventing Problems and New Reliability Engineering Methods

FTA（gas cooking stove）

Structure and relationship among effect, top event mode and failure mode (error mode)

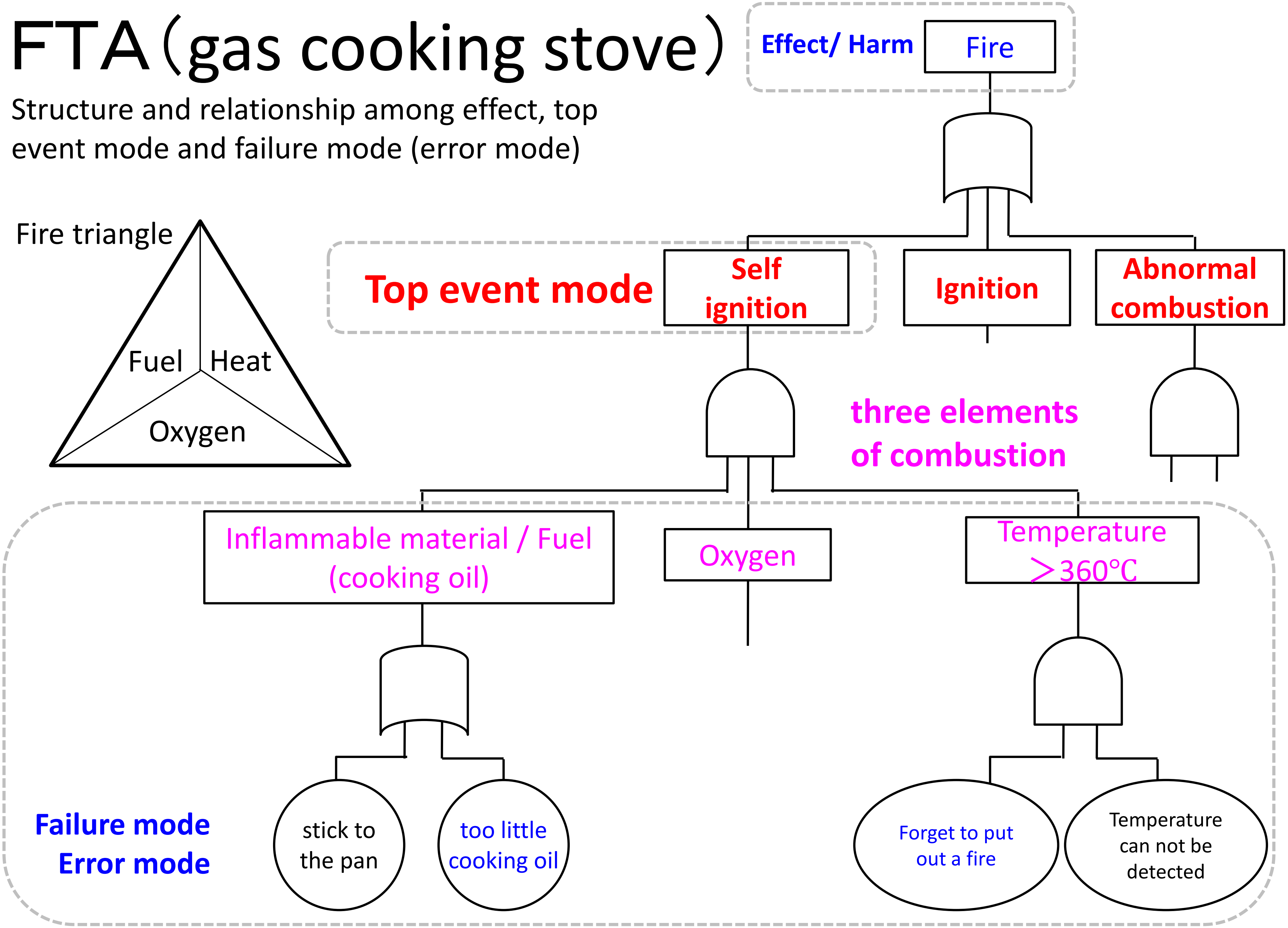


Fig. 10 FTA for Gas coking stove

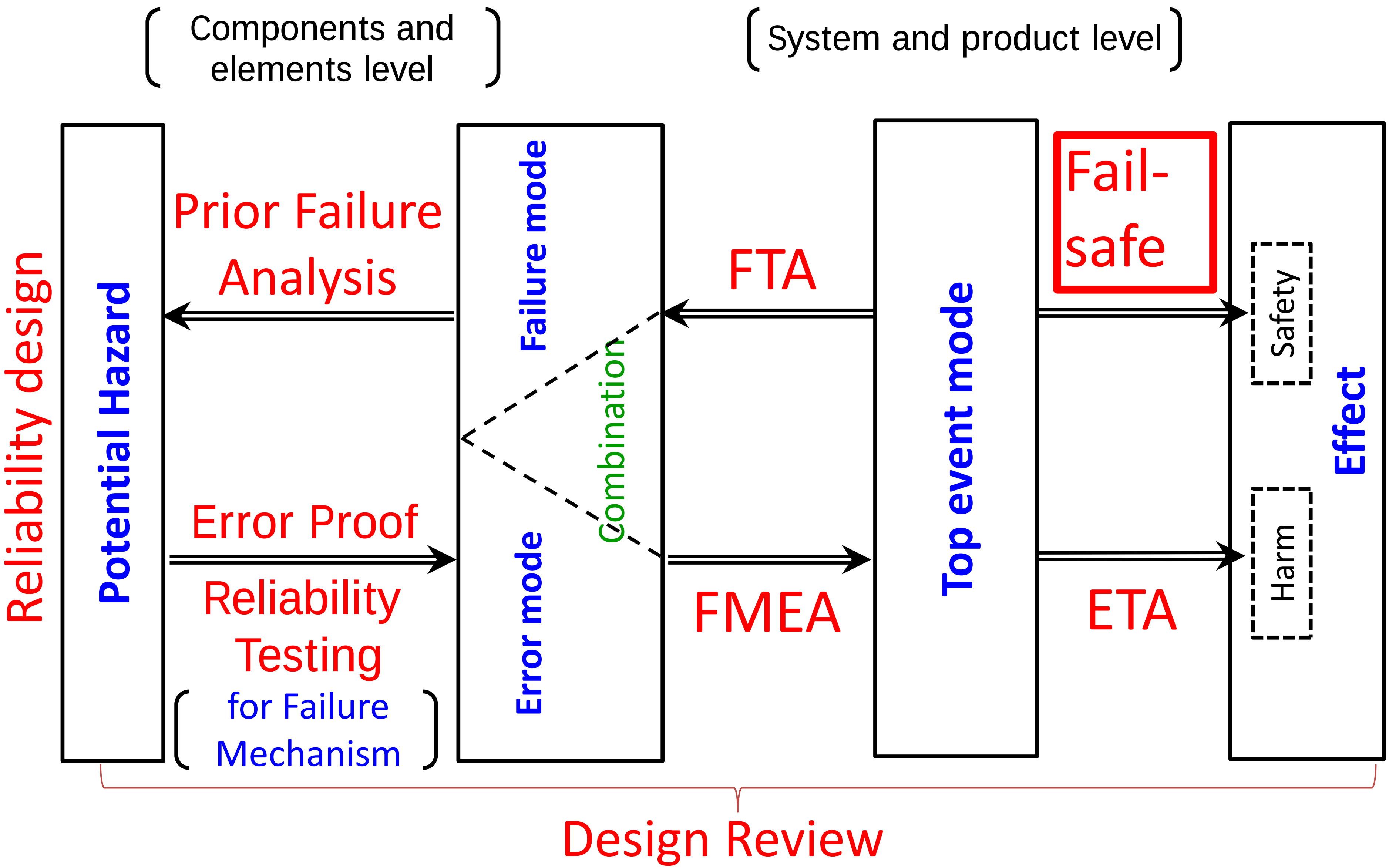
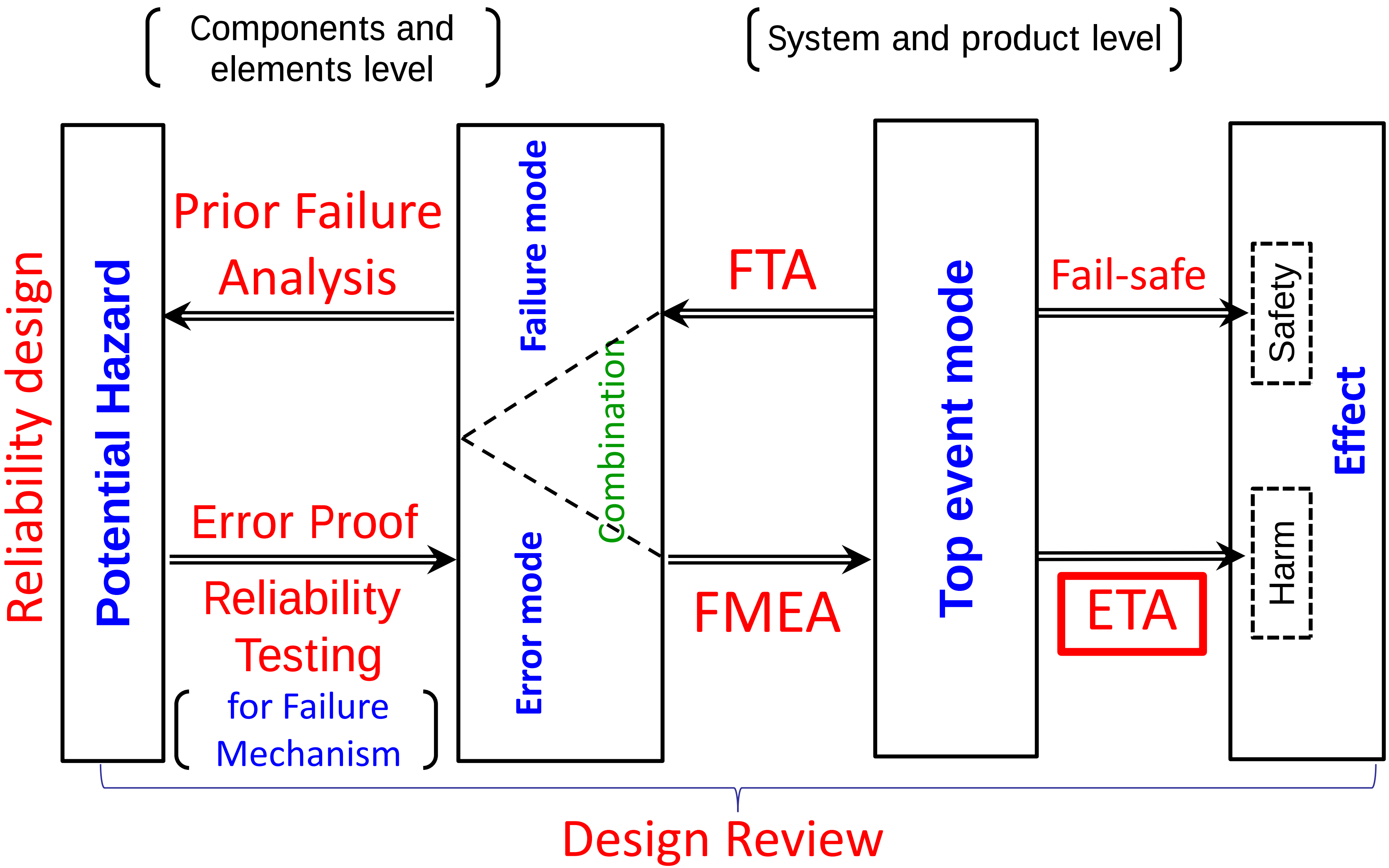


Fig. 6 Schemes for Preventing Problems and New Reliability Engineering Methods

Temperature Sensor detects the critical temperature



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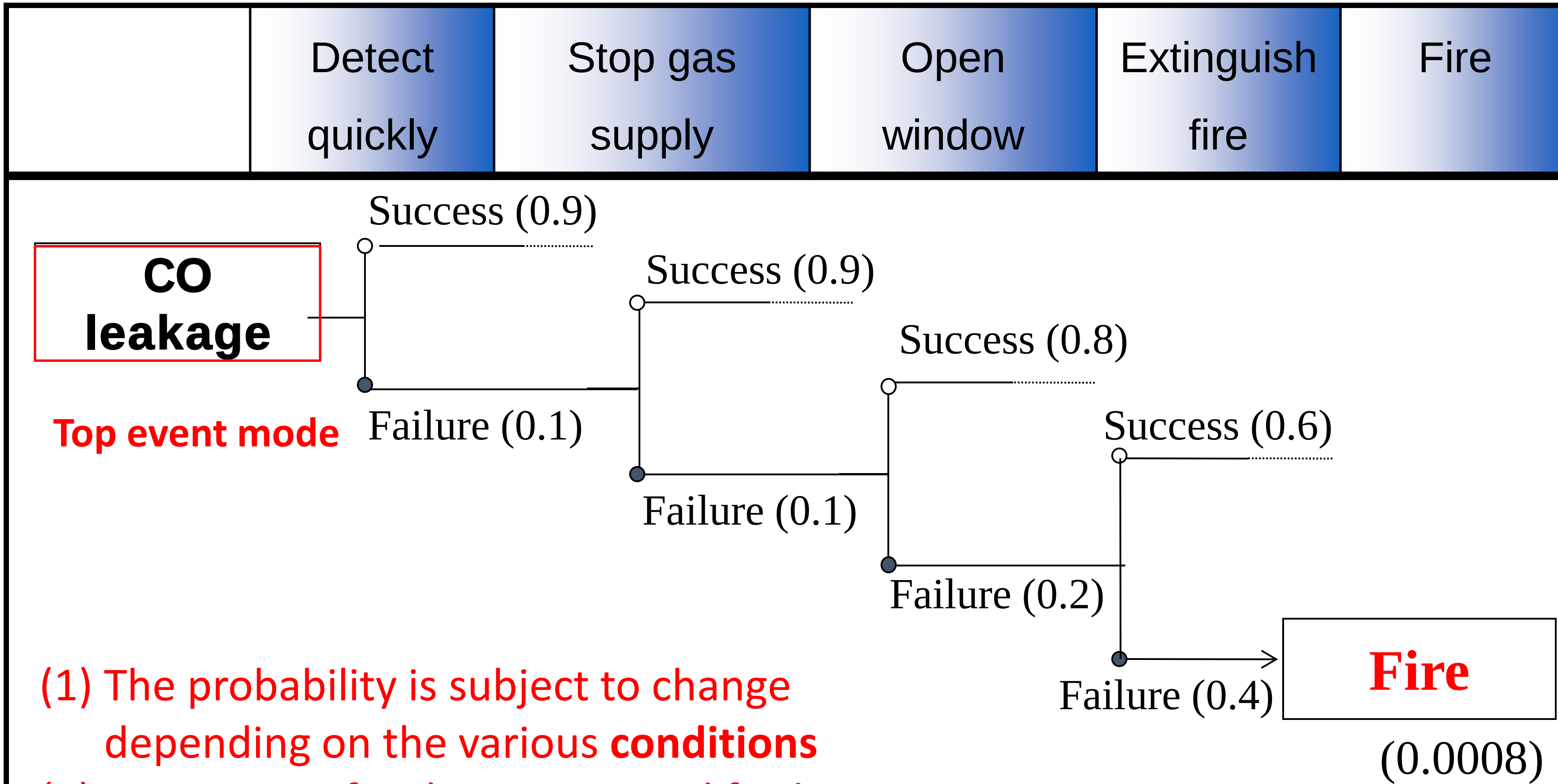
ETA (Event Tree Analysis)



(1) The probability is subject to change depending on the various **conditions**

(2) Preparation for the unexpected fire!

Three Es of Quality Assurance

1. Establish "Process" to satisfy customers satisfaction
   - ･Grasp the needs of costumers and society
   - ･Develop the products/service based on the needs
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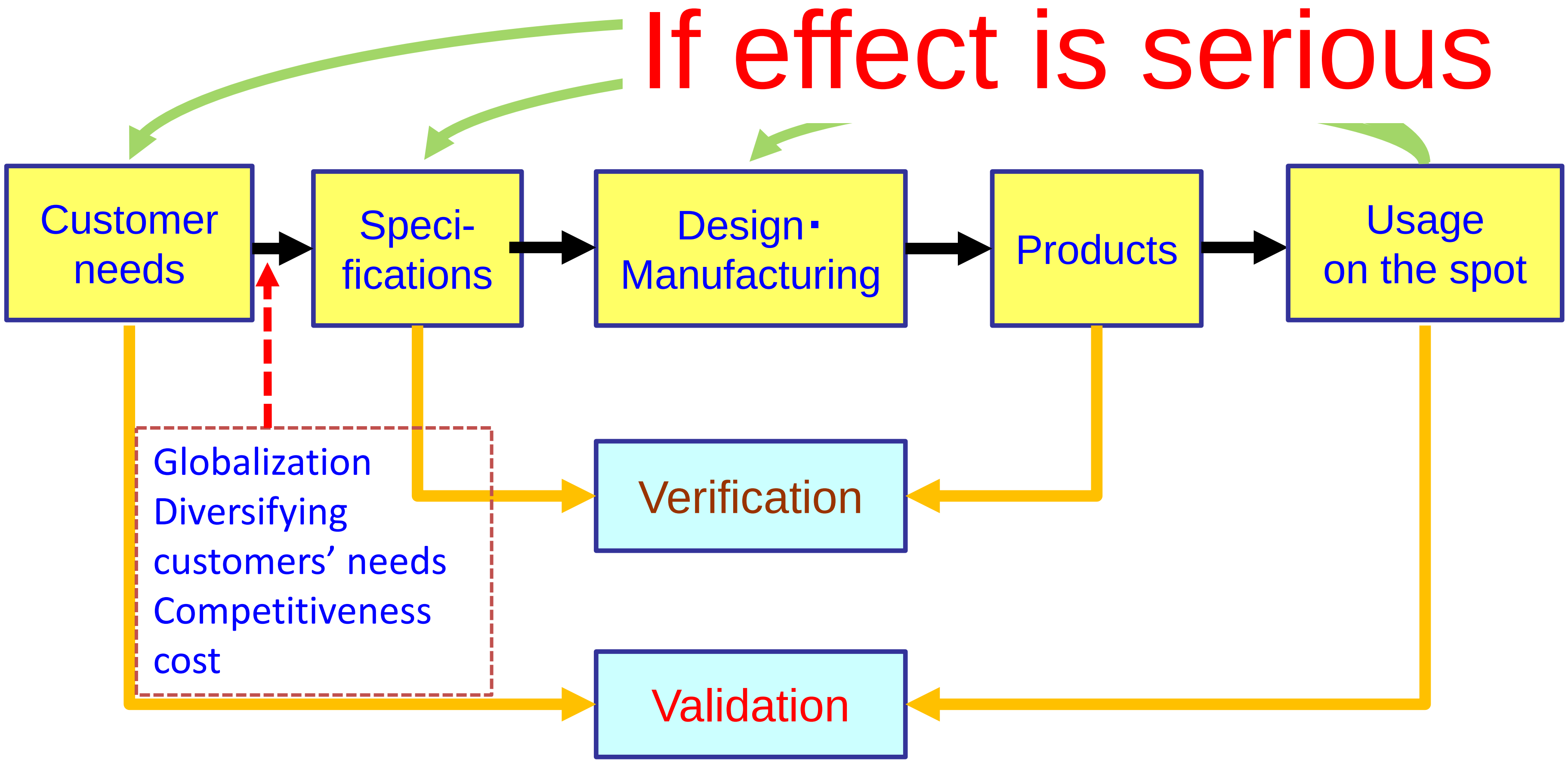

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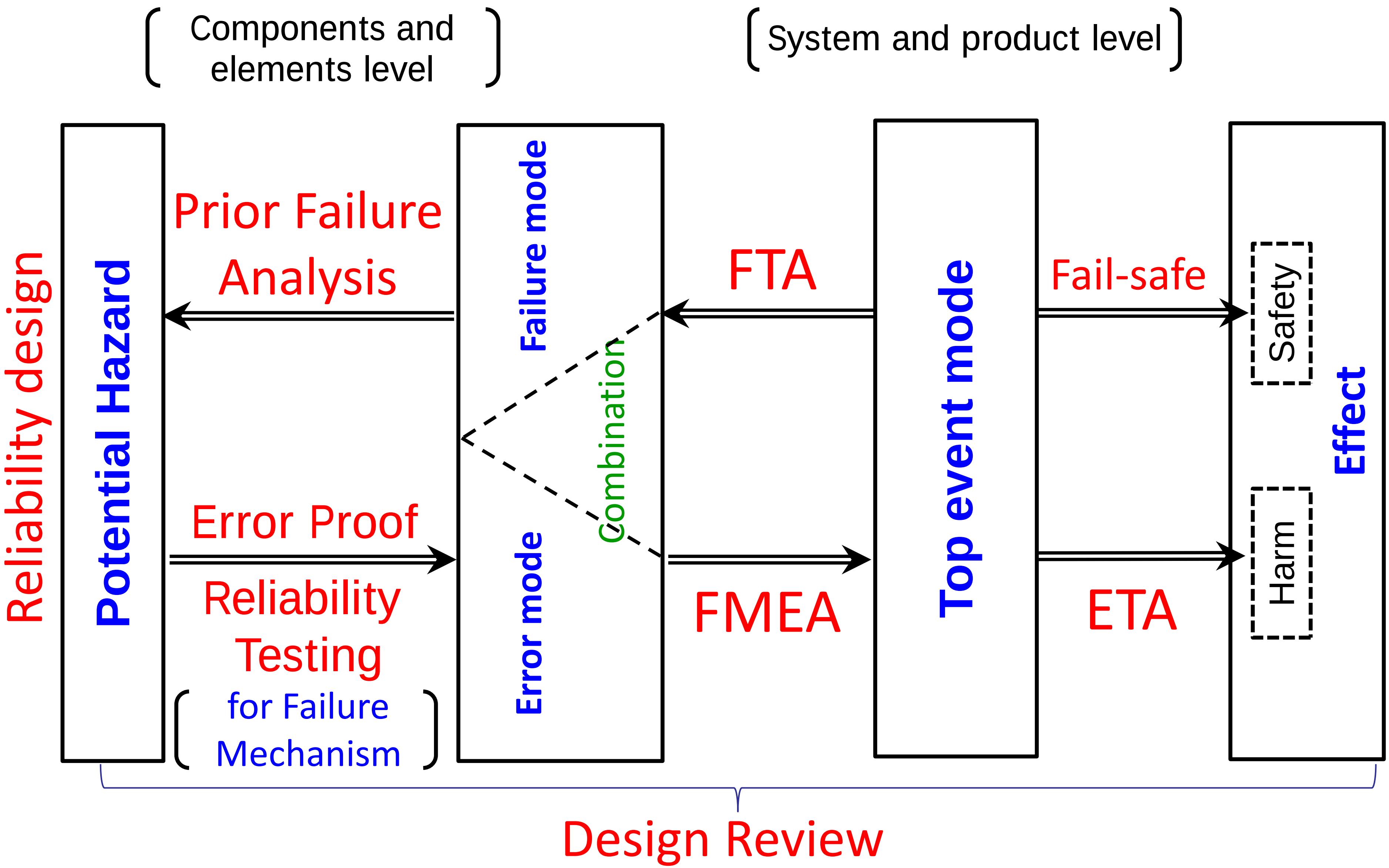

Fig. 6 Schemes for Preventing Problems and New Reliability Engineering Methods

Reference

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