

Safety Design and Engineering of Ships and Offshore Structures

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주요 약력

1. 부산대학교 조선공학과 학사 (1975~1981)
2. 일본 오사카대학교 석사, 박사 (1982~1986)
3. 한국기계연구원 선임연구원 (1987~1988)
4. 부산대학교 조선해양공학과 교수 (1989~)
5. 부산대 선박해양플랜트기술연구원장 (로이드선급재단 우수연구 센터장) (2008~)
6. 영국 런던대학교 (University College London) 석학교수 (2015~)
7. 영국 Strathclyde 대학교 명예교수 (2017~)
8. 영국 Aberdeen 대학교 명예교수 (2018~)
9. 중국 남방과학기술대 (Shenzhen) 명예교수 (2017~)
10. 국제저널 Ships and Offshore Structures 창간자 및 편집장 (2006~)
11. (사)화재폭발안전포럼 이사장 (2012~), 일본선급 한국기술위원회 위원장 (2013~)
12. 영국 왕립조선학회 William Froude 메달 (2015), 미국 조선해양공학회 David W. Taylor 메달 (2013) 수상, 경암학술 공학상 수상 (2013), 과학기술훈장 웅비장 수훈 (2014)
13. 벨기에 Liege 대학교 명예박사 (2012)
14. 영국 왕립조선학회 *Jeom Kee Paik Prize* (백점기 상) – 35세 이하 구조분야 최우수논문상

David W. Taylor Medal and William Froude Medal



부산대 선박해양플랜트기술연구원

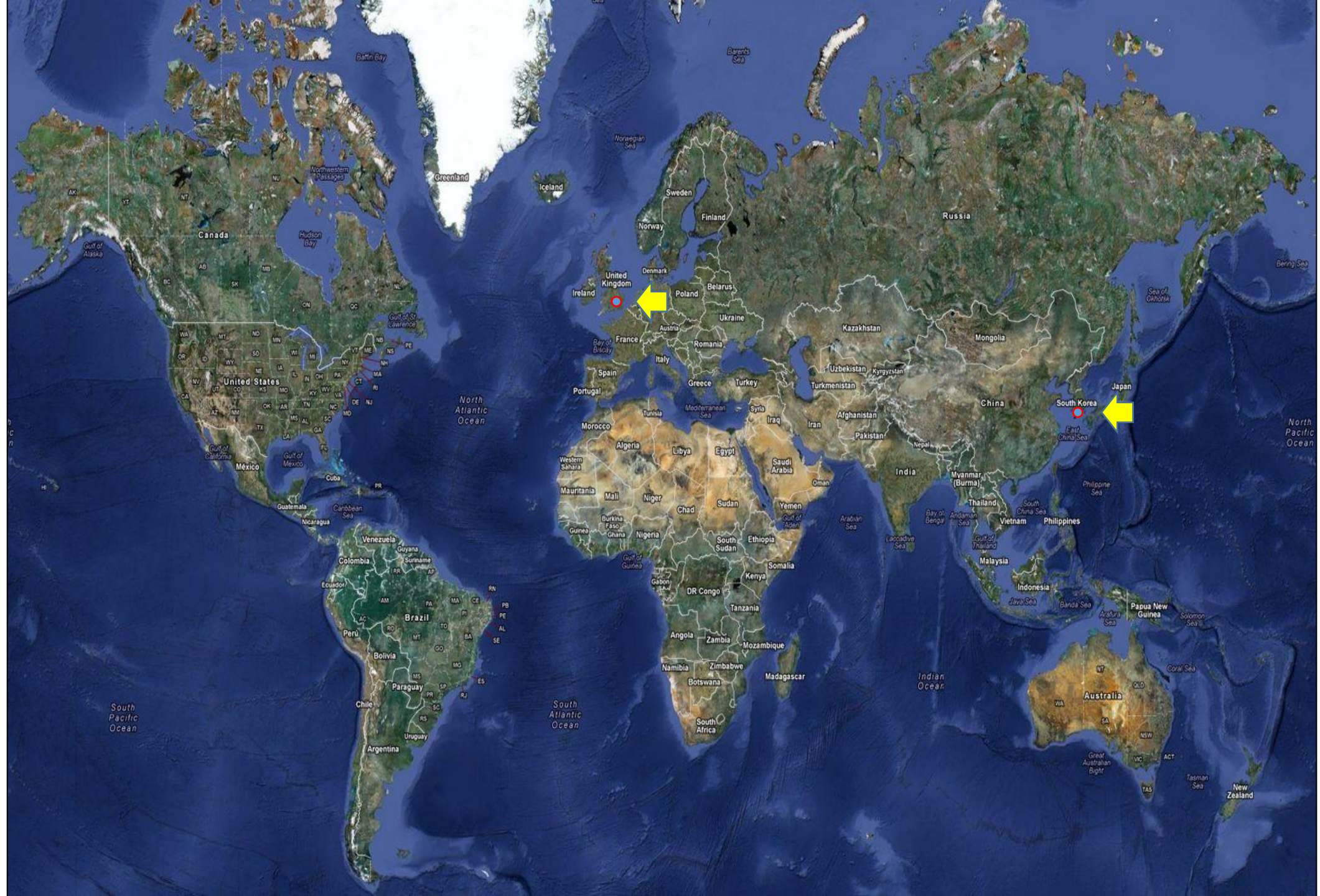
(로이드선급재단 우수연구센터, www.icass.center)

As of April 2019



Staff		Number
Faculty Member		4
Chair Professor		1
Research Professor		4
Research Engineer		8
Post Doctoral Scholar		2
Graduate Student	PhD	18
	MSc	18
Administrative		3
Total		58

Overseas: India 1, Turkey 2, UK 1



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- 0. To begin with ...**
- 1. Types of ships and offshore structures**
- 2. Types of extreme conditions and accidents in ships and offshore structures**
- 3. Multidisciplinary approaches**
- 4. Advanced computational models**
- 5. Large-scale physical modeling testing**
- 6. To finish ...**

0. To Begin with...

The Ten Grand Challenges



What and how are you willing to contribute to resolving the challenges?

1. Types of Ships and Offshore Structures

Types of Ships



Boat



Motorboat



Yacht



Yacht



Yacht



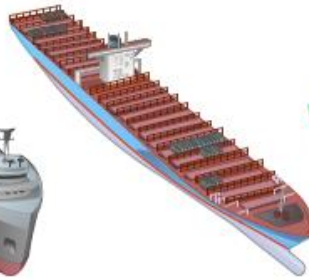
Sailing ship



Passenger vessel



Dry cargo vessel



Container ship



Oil tanker



Passenger ship



Regular ship



Multipurpose ship



Reefer



Handysize bulk-carrier



Car carrier



Capesize bulk-carrier



Gas ship



Lighter aboard ship



Battleship



Submarine



Reefer vessel



Container ship



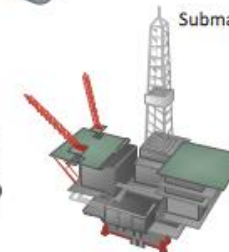
Tugboat



Oil ship



Dry cargo ship

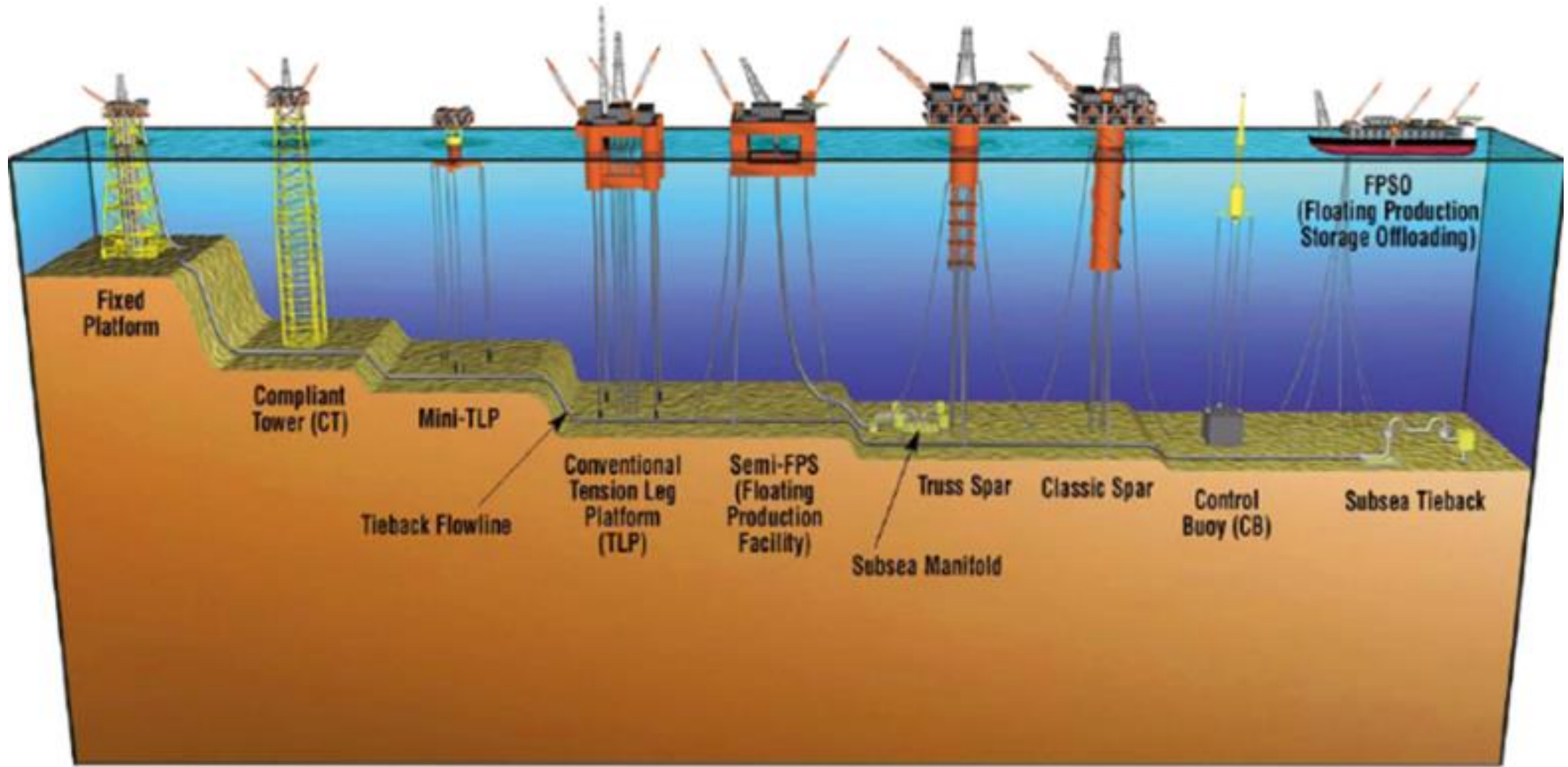


Offshore oil platform

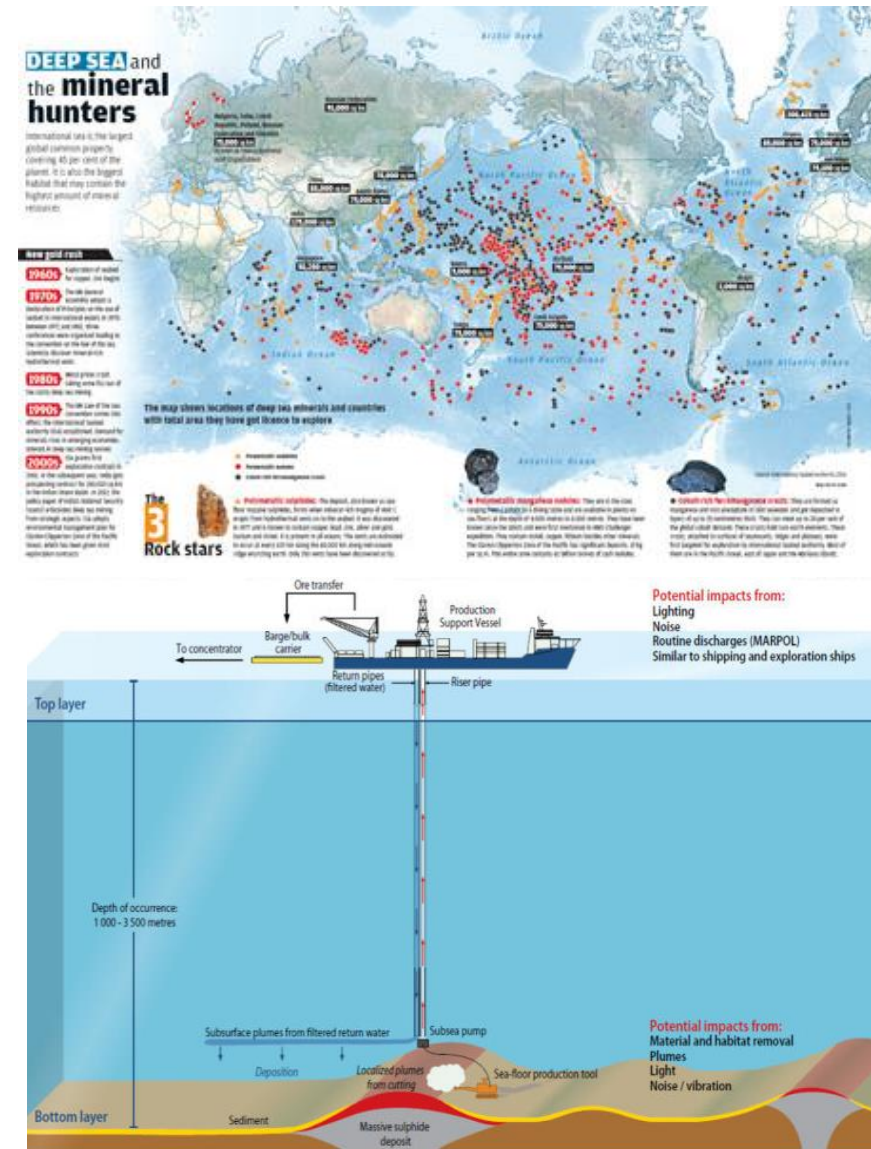
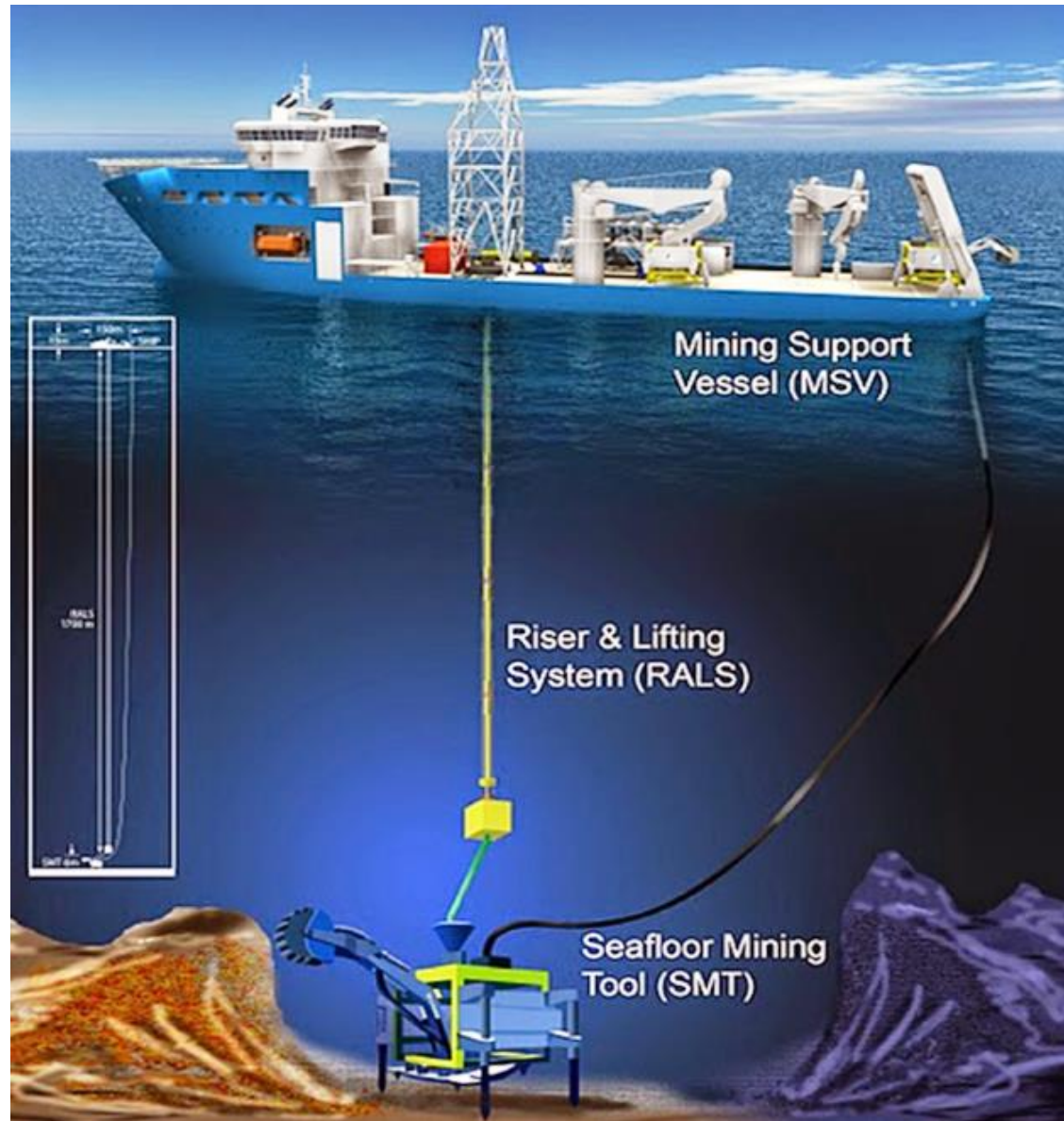


Submarine

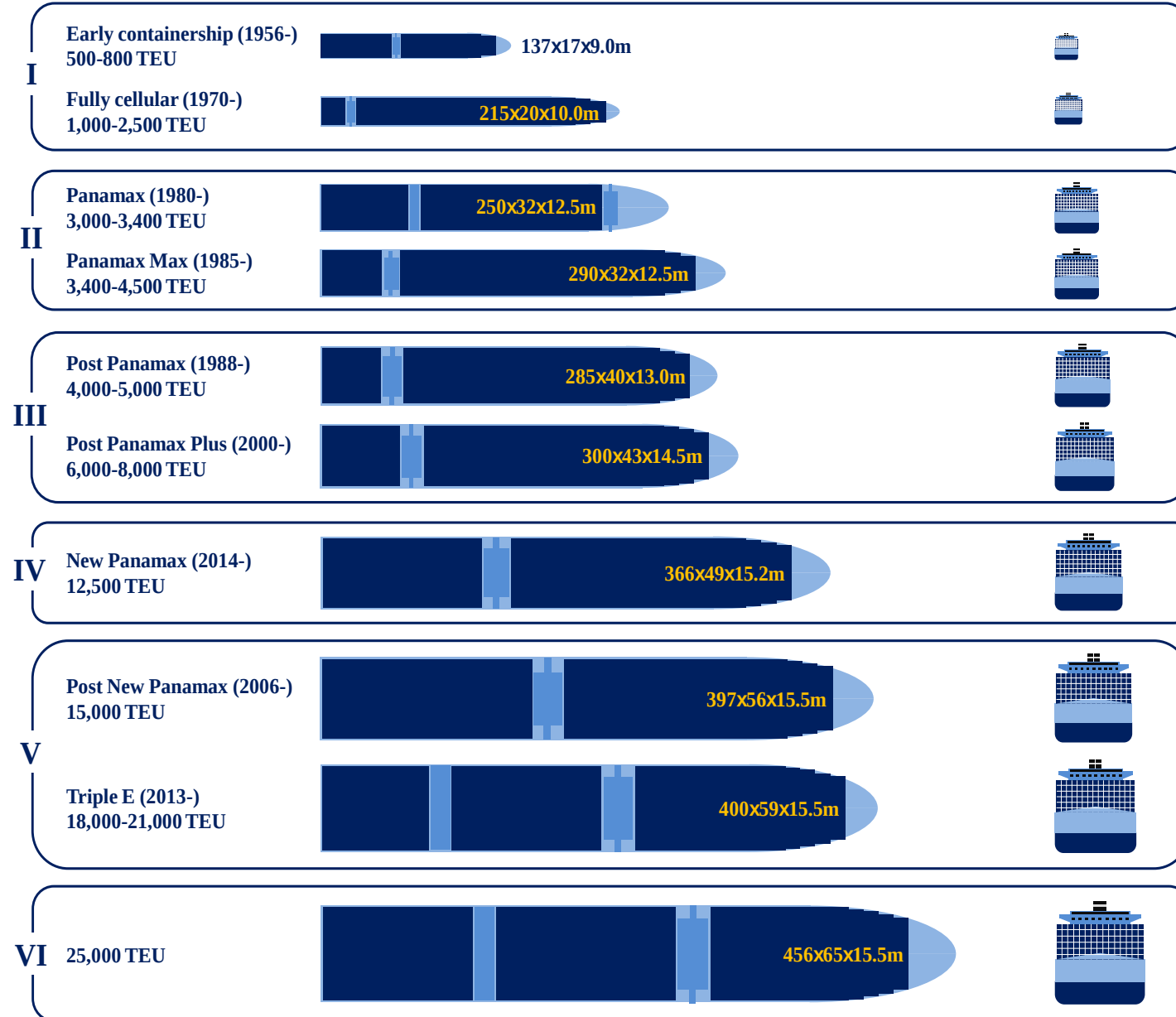
Types of Offshore Structures



Deep Sea Mining



Size of Containerships



2. Types of Extreme Conditions and Accidents in Ships and Offshore Structures

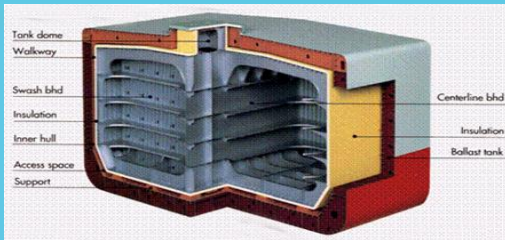
Advanced Structural Safety Studies

Cold Climate -
Winterization

Dropped Object



Collision with Iceberg



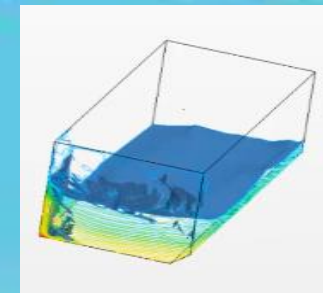
Cargo Containment
System



Subsea



Fire/Explosion



Sloshing

Wind



Wave



Current



Extreme Conditions and Accidents



- **Highly Nonlinear**
- **Non-Gaussian**
- **Multiple physical processes**
- **Multiple scales**
- **Multiple criteria**

[Ref] J.K. Paik, Making the case for adding variety to Goal-Based Standards, The Naval Architect, The Royal Institution of Naval Architects, London, UK, January 2015

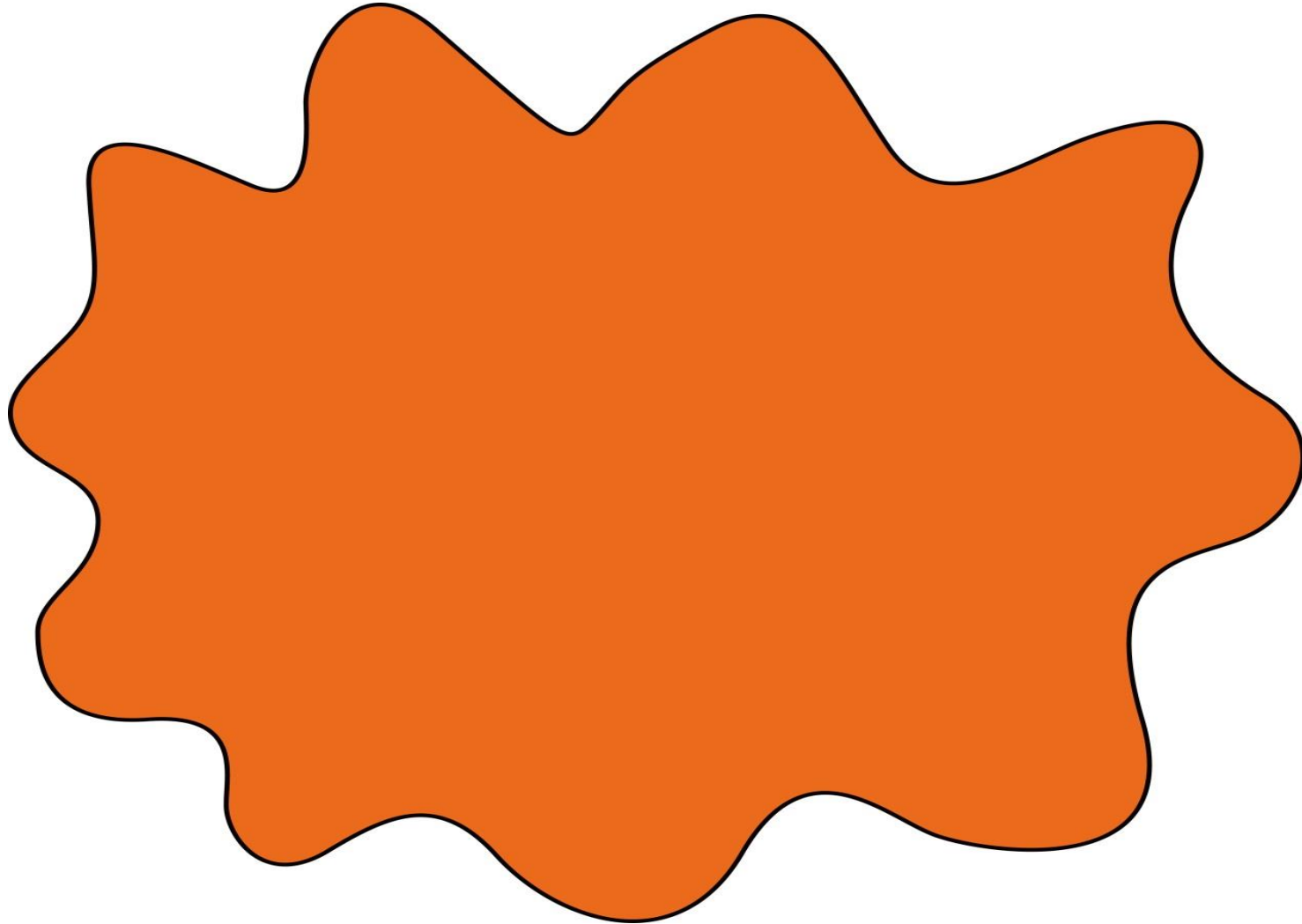
New Normal Associated with VUCA Environments

The New Normal is a previously unfamiliar, unusual, and abnormal situation that has now become familiar and usual, and looks like a daily state.

The catastrophes are the result of VUCA environments.

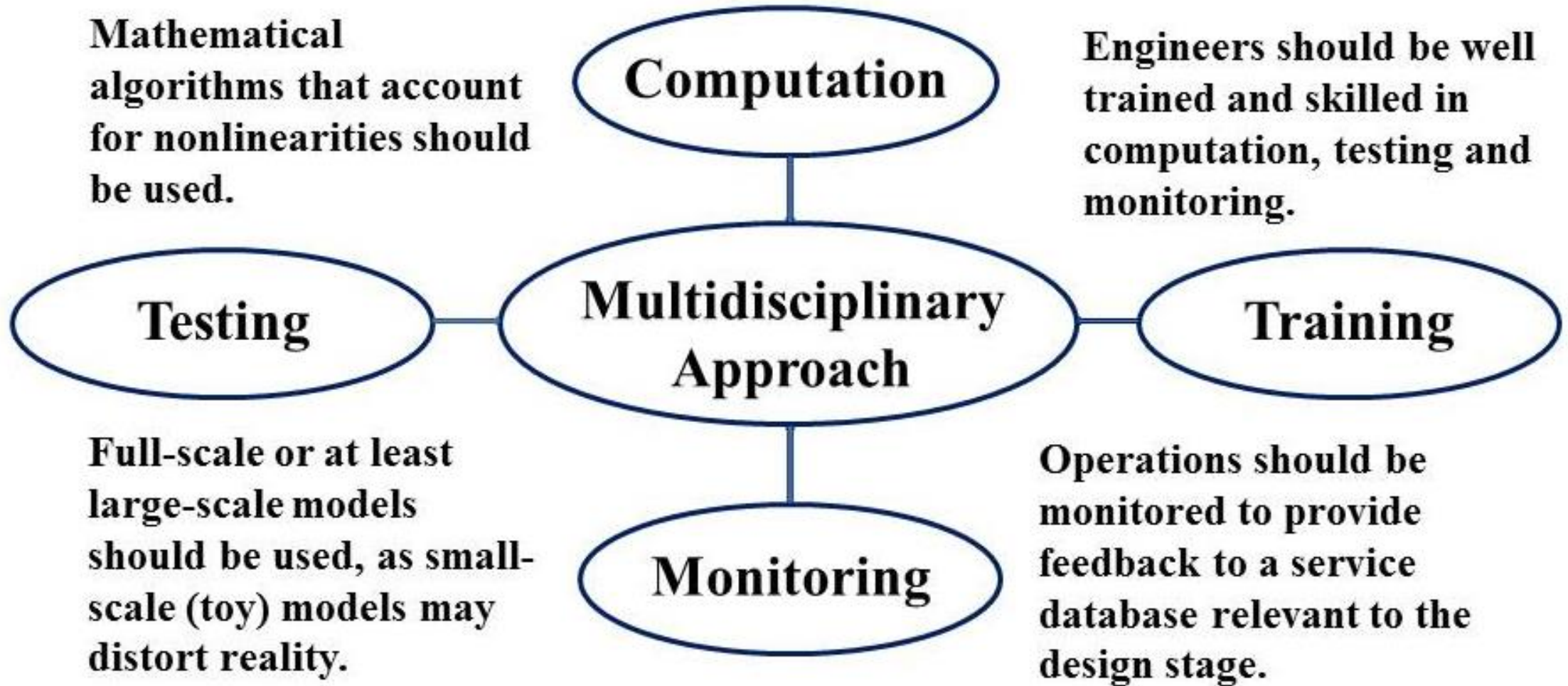
- Volatility (변동성)
- Uncertainty (불확실성)
- Complexity (복잡성)
- Ambiguity (애매모호성)

Engineering Modelling with Tolerable Uncertainties

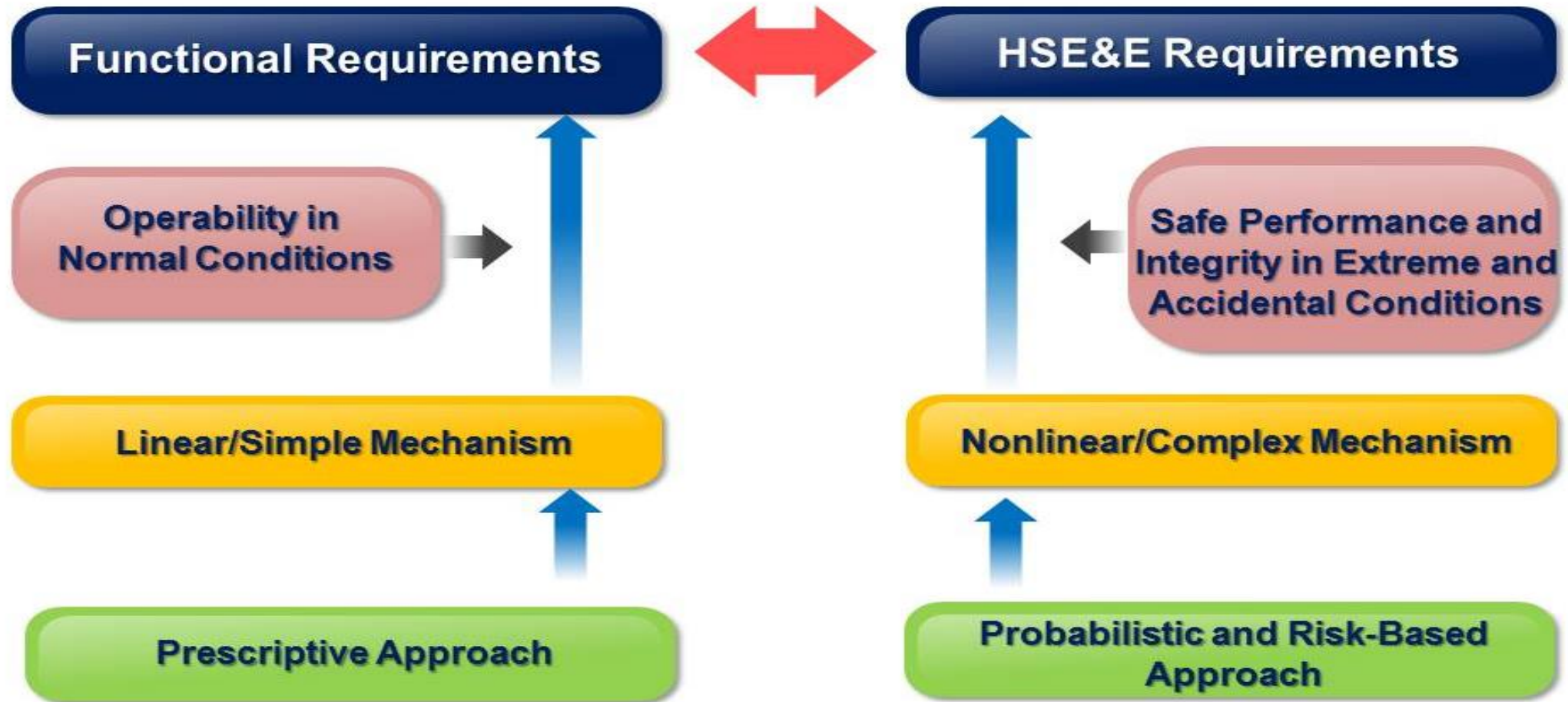


3. Multidisciplinary Approach

Multidisciplinary Approach



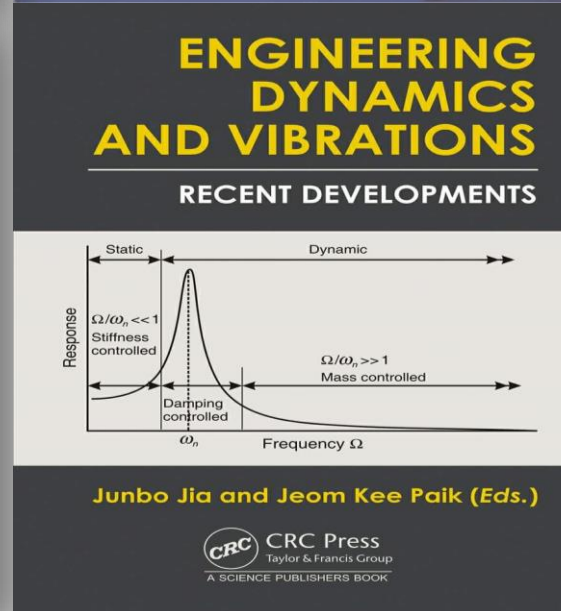
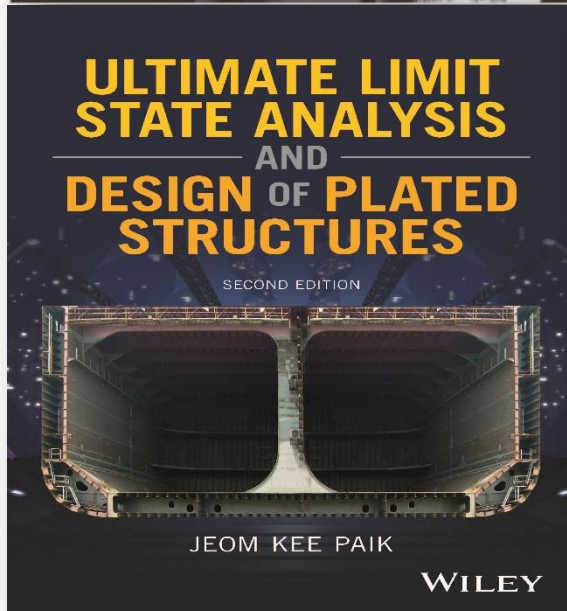
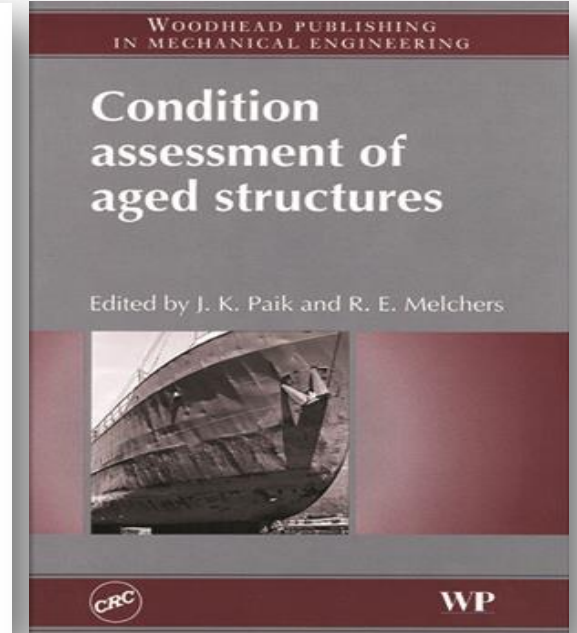
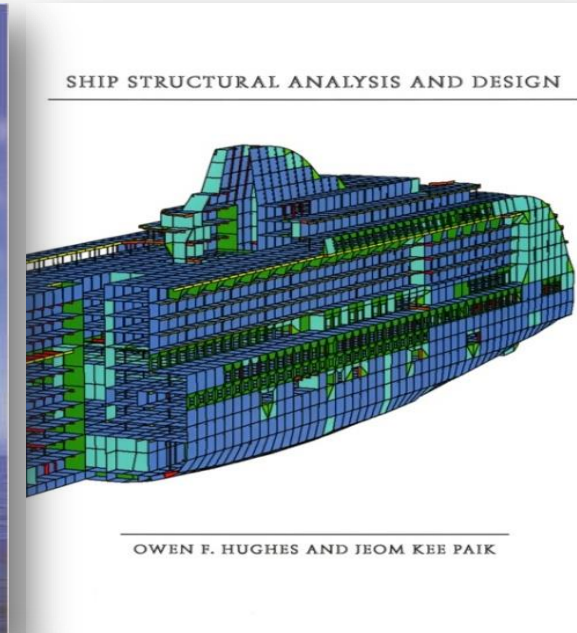
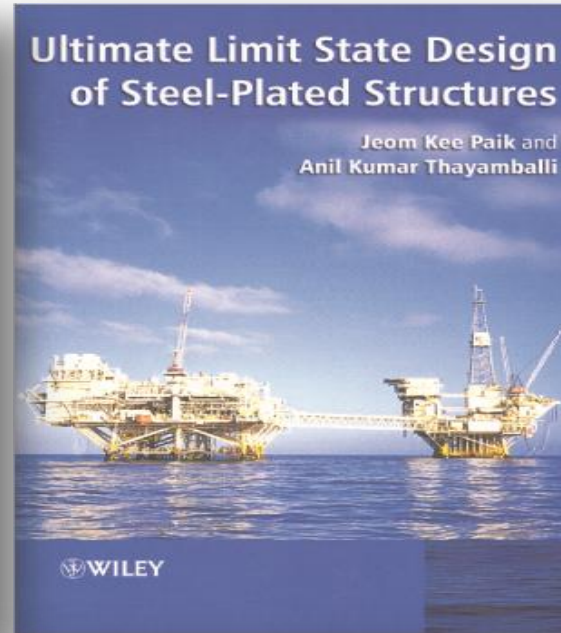
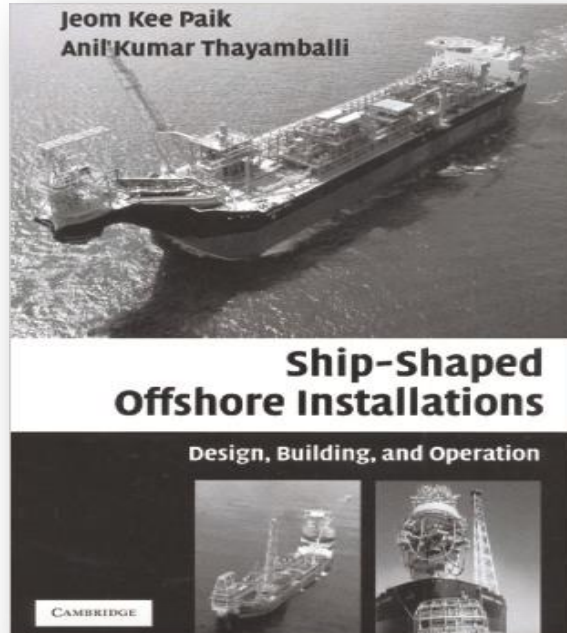
Safety Design and Engineering



HSE&E = Health, Safety, Environment & Ergonomics (Human Factors Engineering)

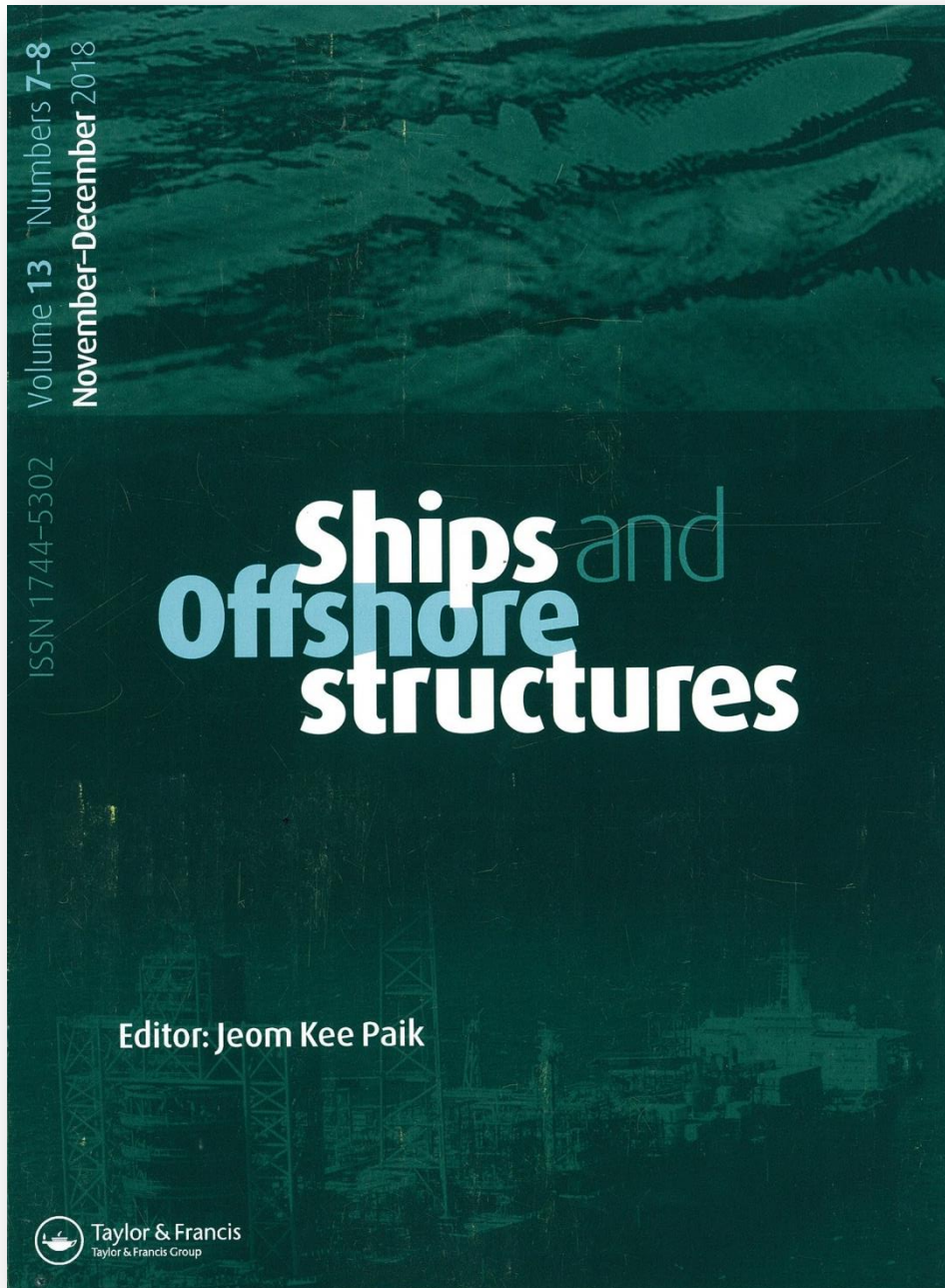
4. Advanced Computational Models

Book Publications



Under writing:

- **Advanced Structural Safety Studies** with Extreme Conditions and Accidents
- **Ship Structural Mechanics and Analysis**

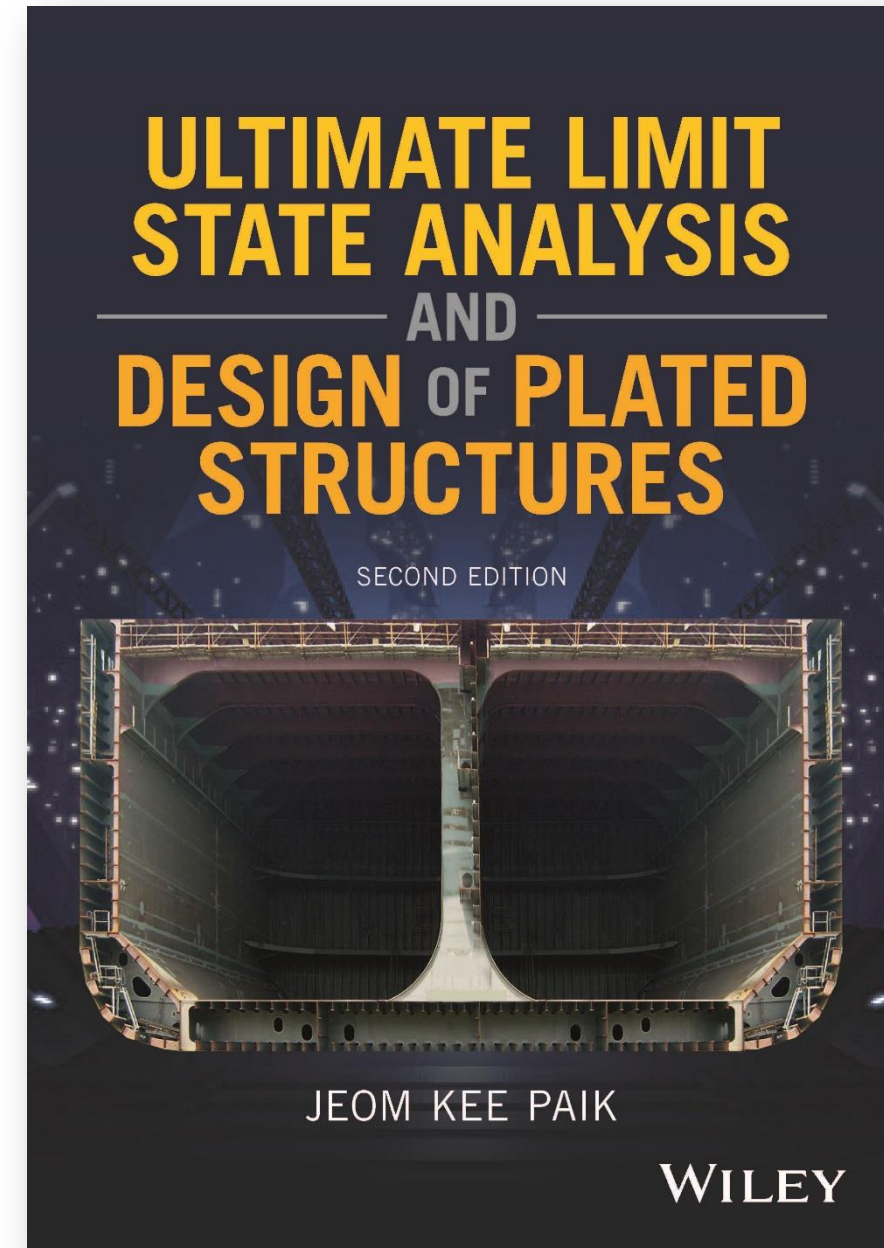


International Conference on Ships and Offshore Structures – www.icsos.info

- Hamburg, Germany, 2016
- Shenzhen, China, 2017
- Gothenburg, Sweden, 2018
- Florida, USA, 2019
- Glasgow, UK, 2020
- Osaka, Japan, 2021
- Trondheim, Norway, 2022

Structural Safety Study Methods

- The reliability based method, $\beta > \beta_T$
- The partial safety factor based method, $C_k/\gamma_C > \gamma_D D_k$
- The failure probability based method, $P_f < P_{fa}$
- The risk based method, $R < R_a$



Definition of Risk

$$R = F^a \times C^b$$

R = risk

F = frequency or likelihood of hazards

C = consequence or severity of hazards

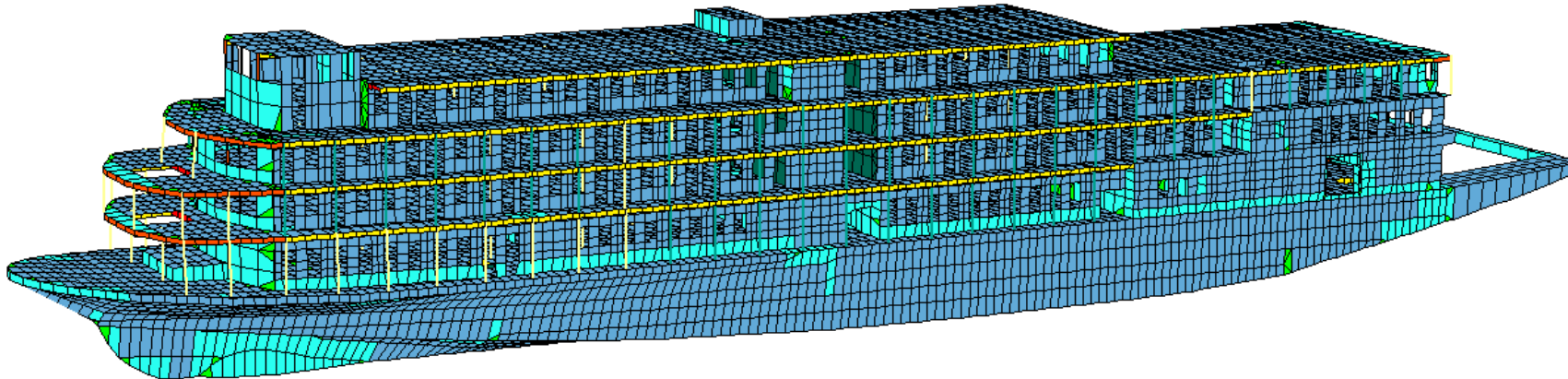
a, b = ascending constants that are usually taken as a = b = 1

This relationship applies to singular hazards; multiple hazards may be cross-coupled.

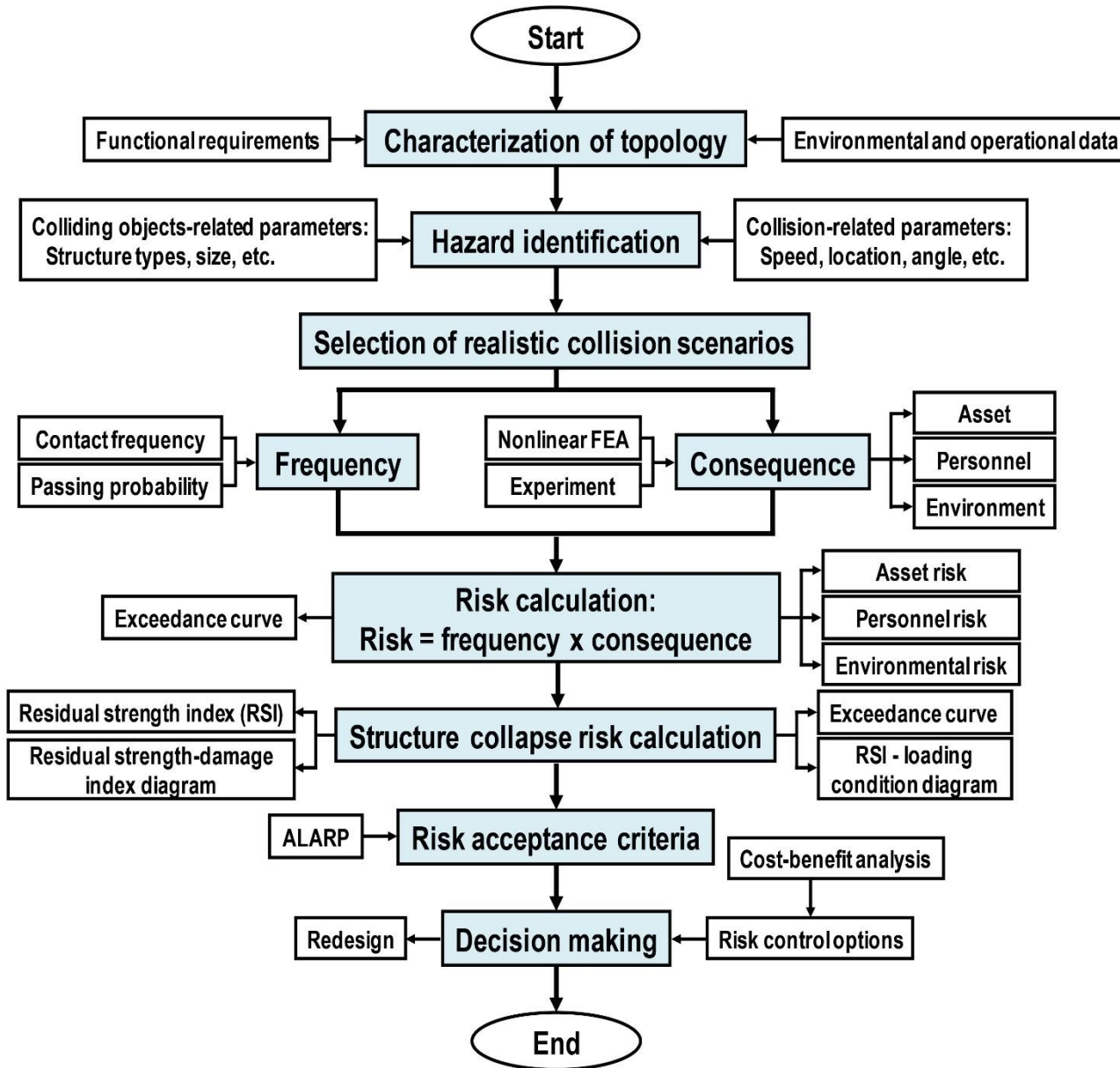
Computer Software for Ultimate Strength Analysis of Large Plated Structures (ALPS)

Modules Implemented into the MAESTRO Structural Design Code:

- **ALPS/ULSAP** – Ultimate strength analysis of stiffened panels
- **ALPS/HULL** – Ultimate strength analysis of hull structures
- **ALPS/GENERAL** – Ultimate strength analysis of general types of plated structures
- **ALPS/SPINE** – Elastic plastic large deflection analysis of plates and stiffened panels under complex loading conditions



Collision Risk Assessment and Management



LS-DYNA keyword deck by LS-PrePost

Time = 0

Contours of Effective Stress (v-m)

max IP. value

min=0, at elem# 4529

max=0, at elem# 4529

Fringe Levels

0.000e+00

0.000e+00

0.000e+00

0.000e+00

0.000e+00

0.000e+00

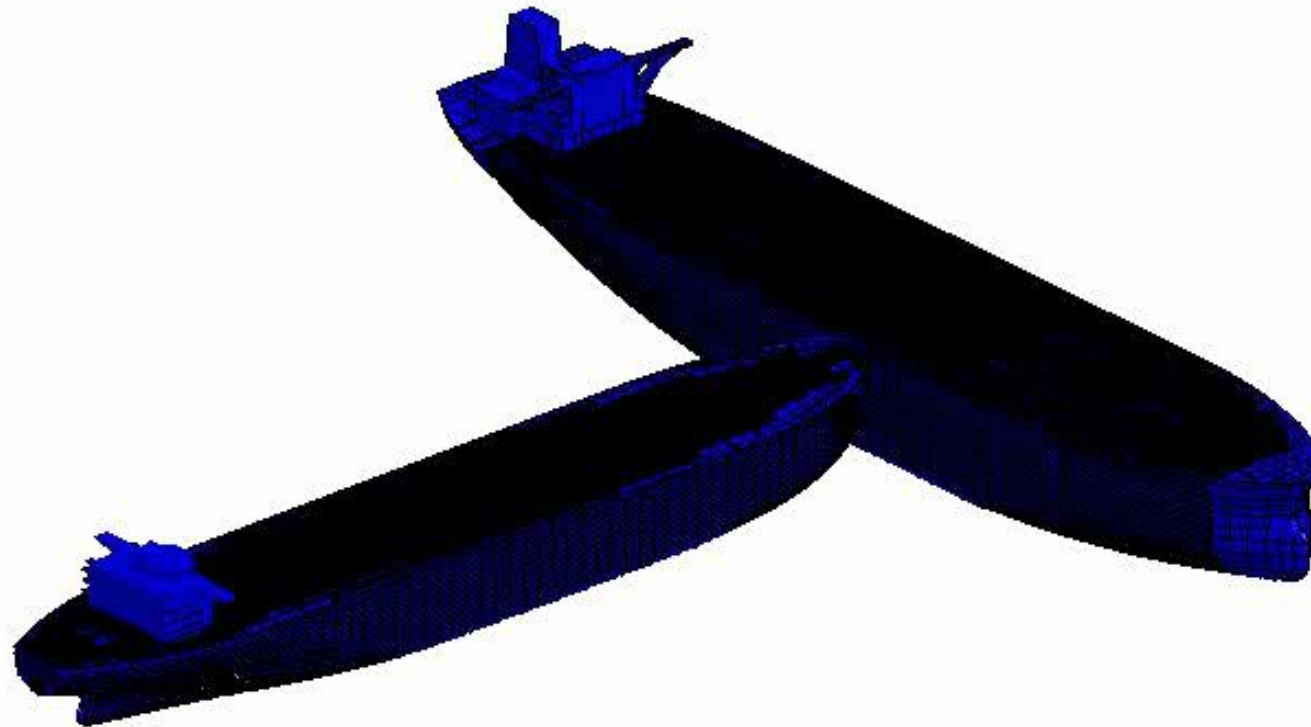
0.000e+00

0.000e+00

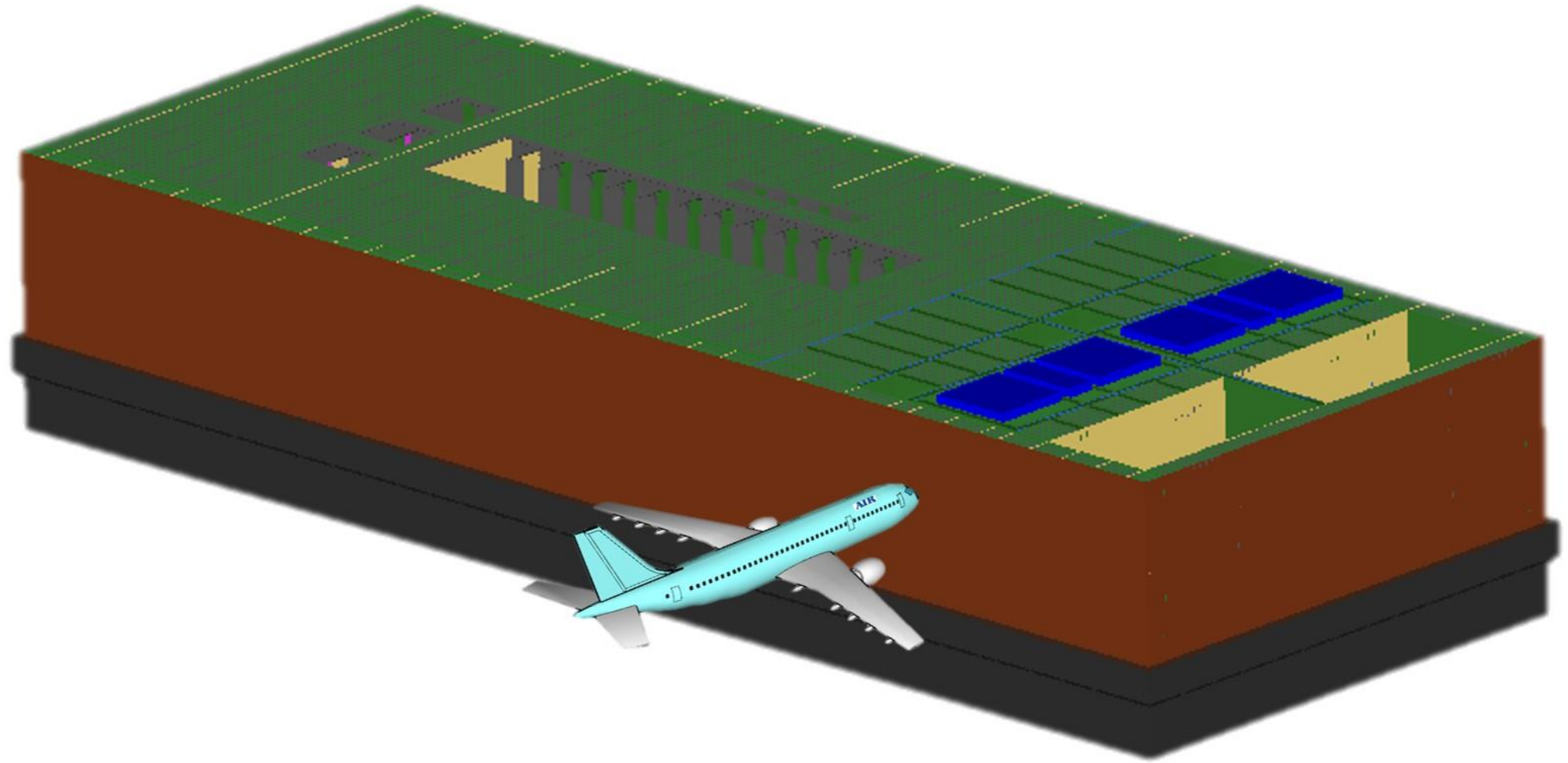
0.000e+00

0.000e+00

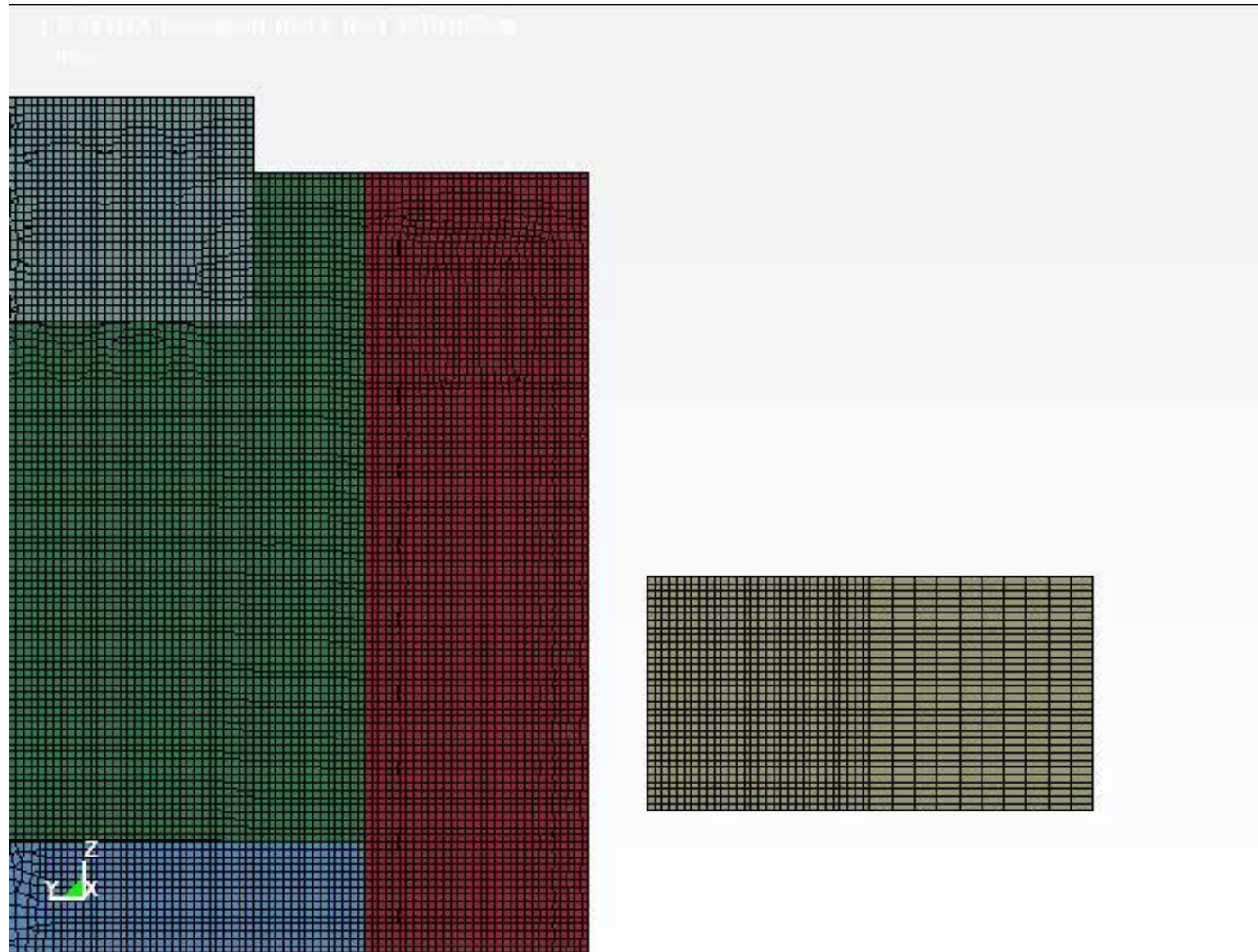
0.000e+00



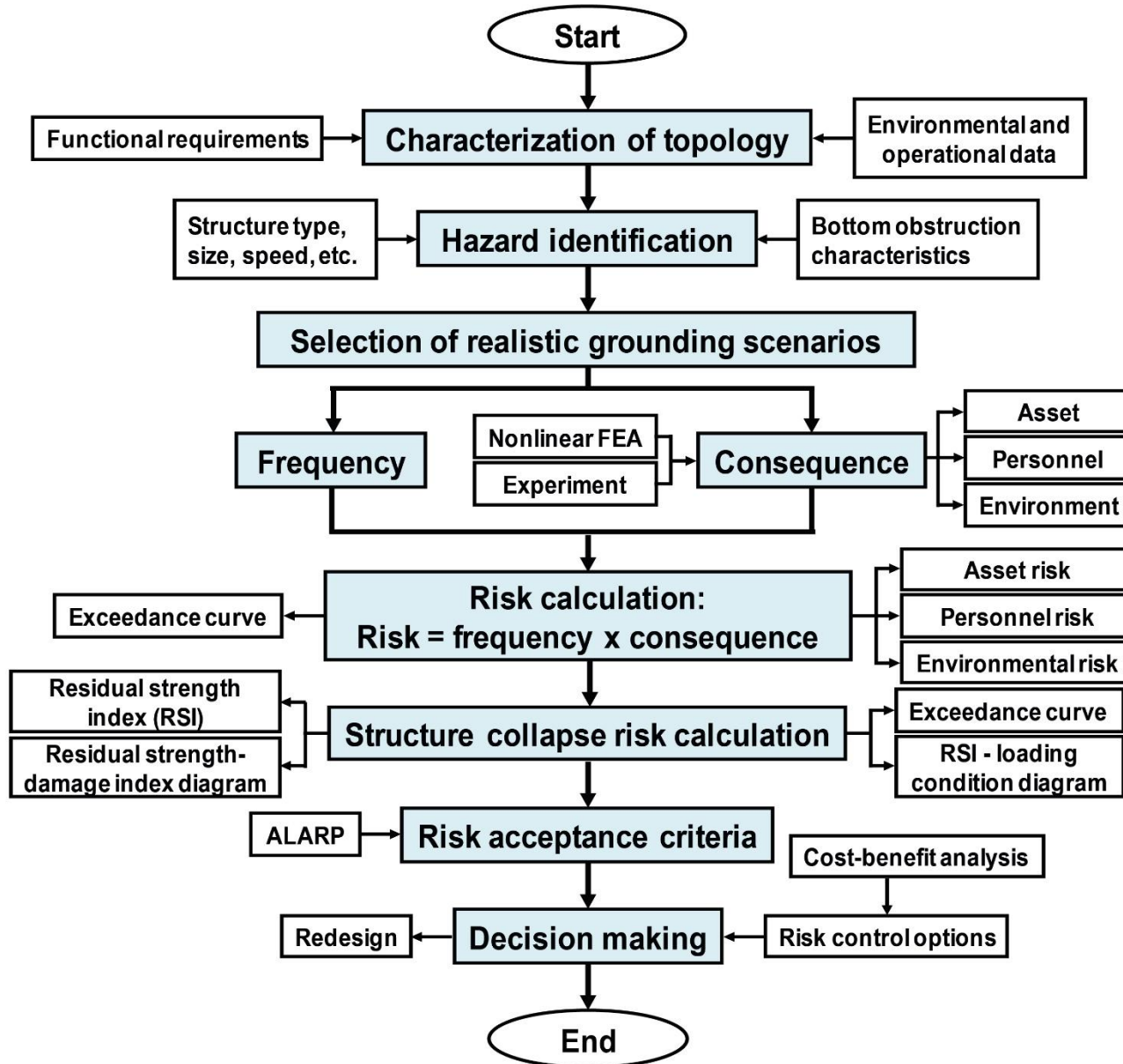
Aircraft Strike Impact Test

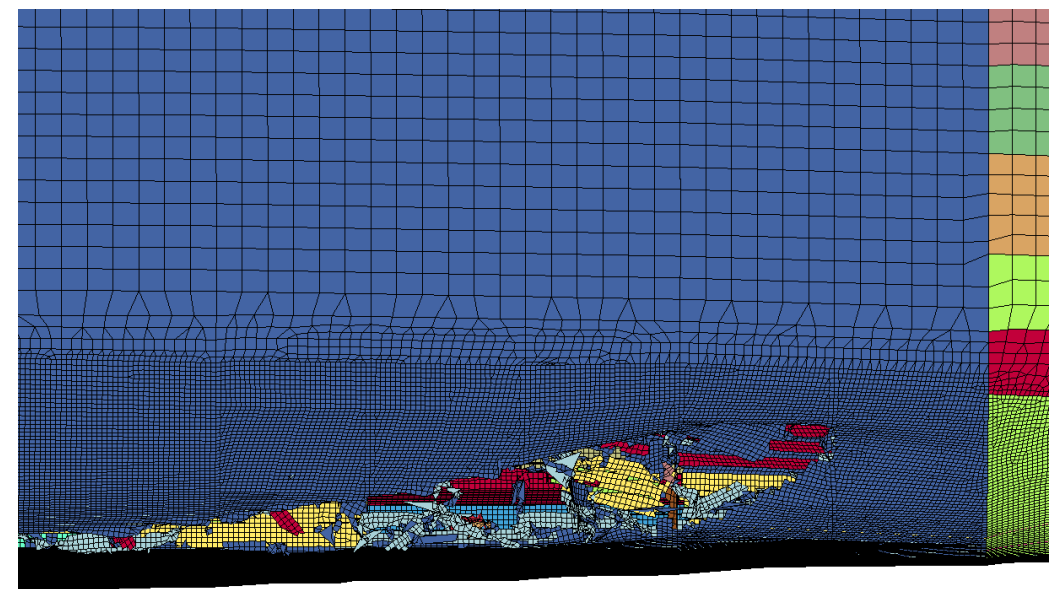
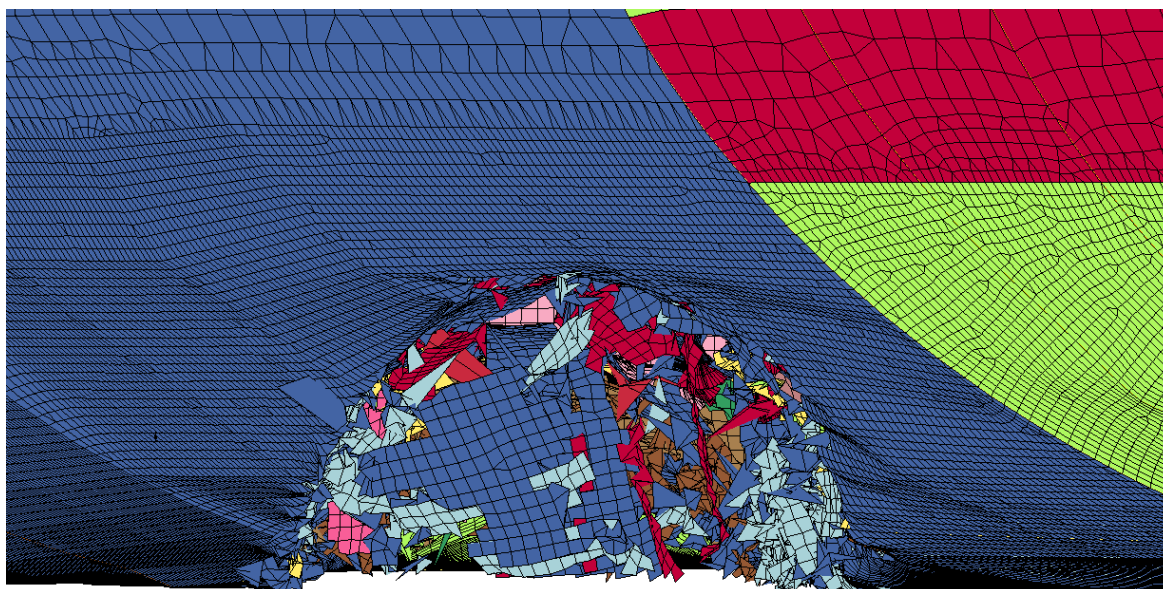
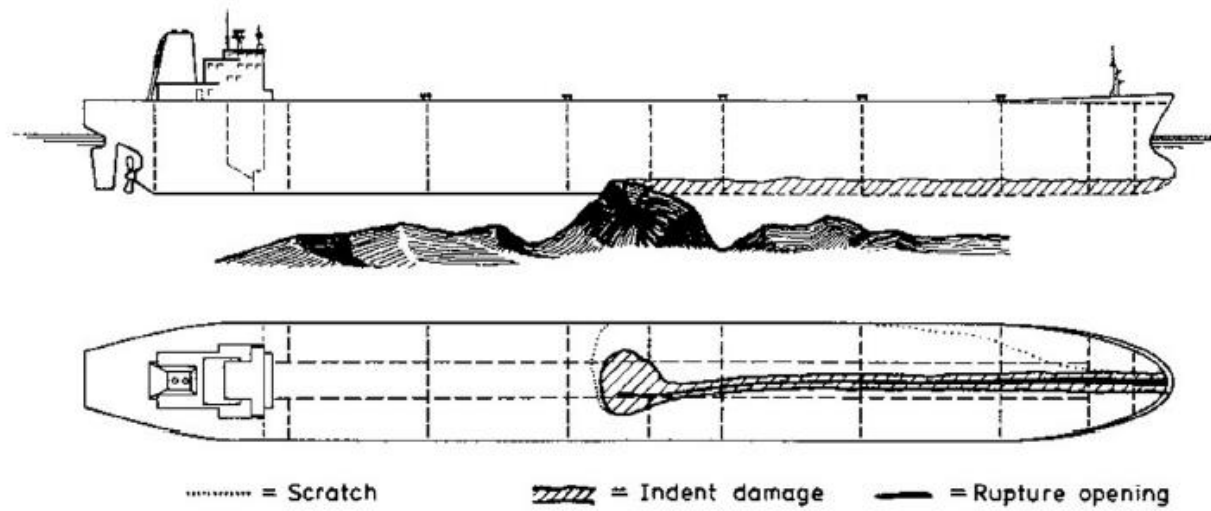


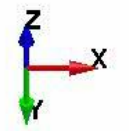
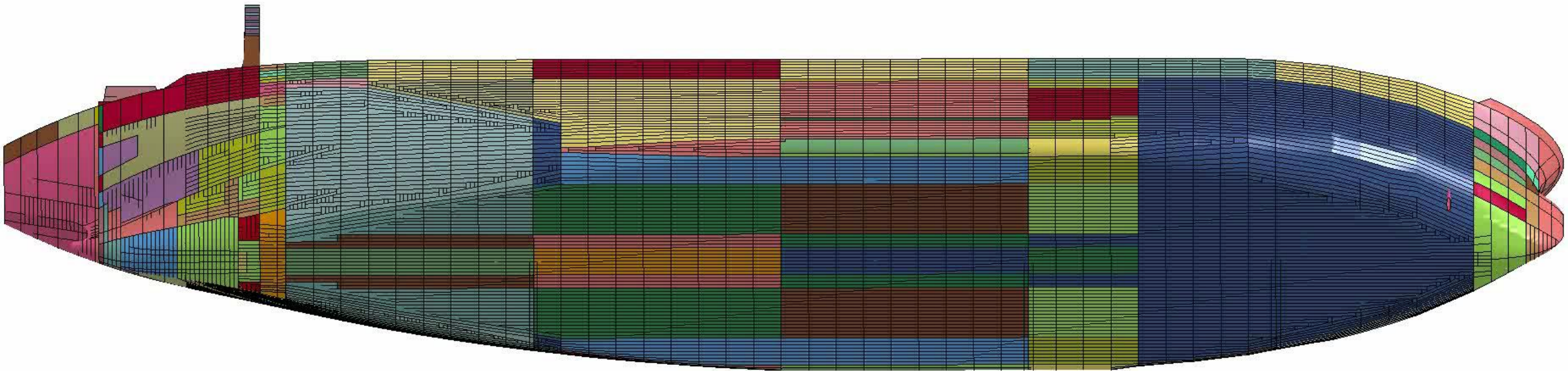
Aircraft Strike Impact Test



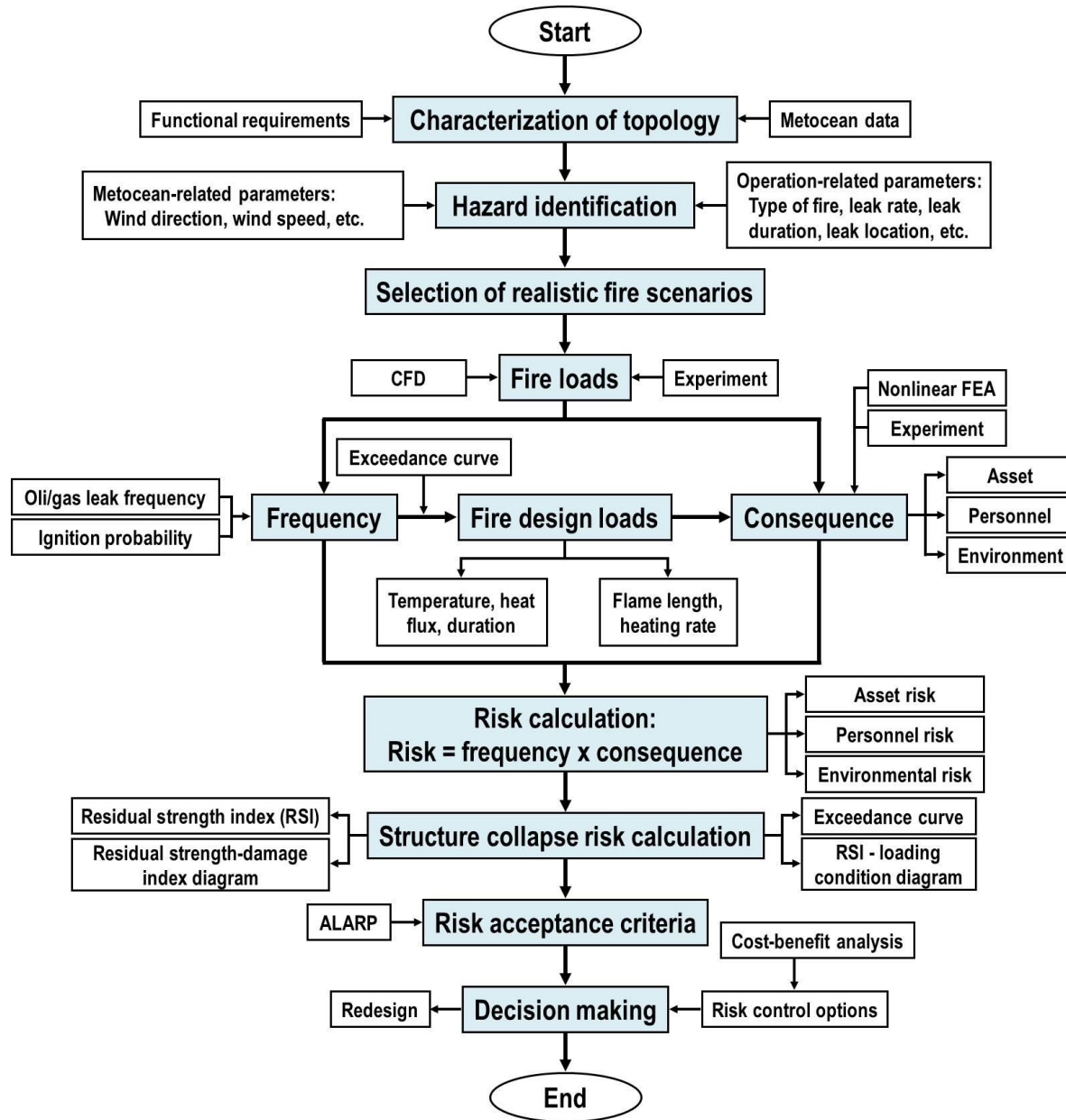
Grounding Risk Assessment and Management

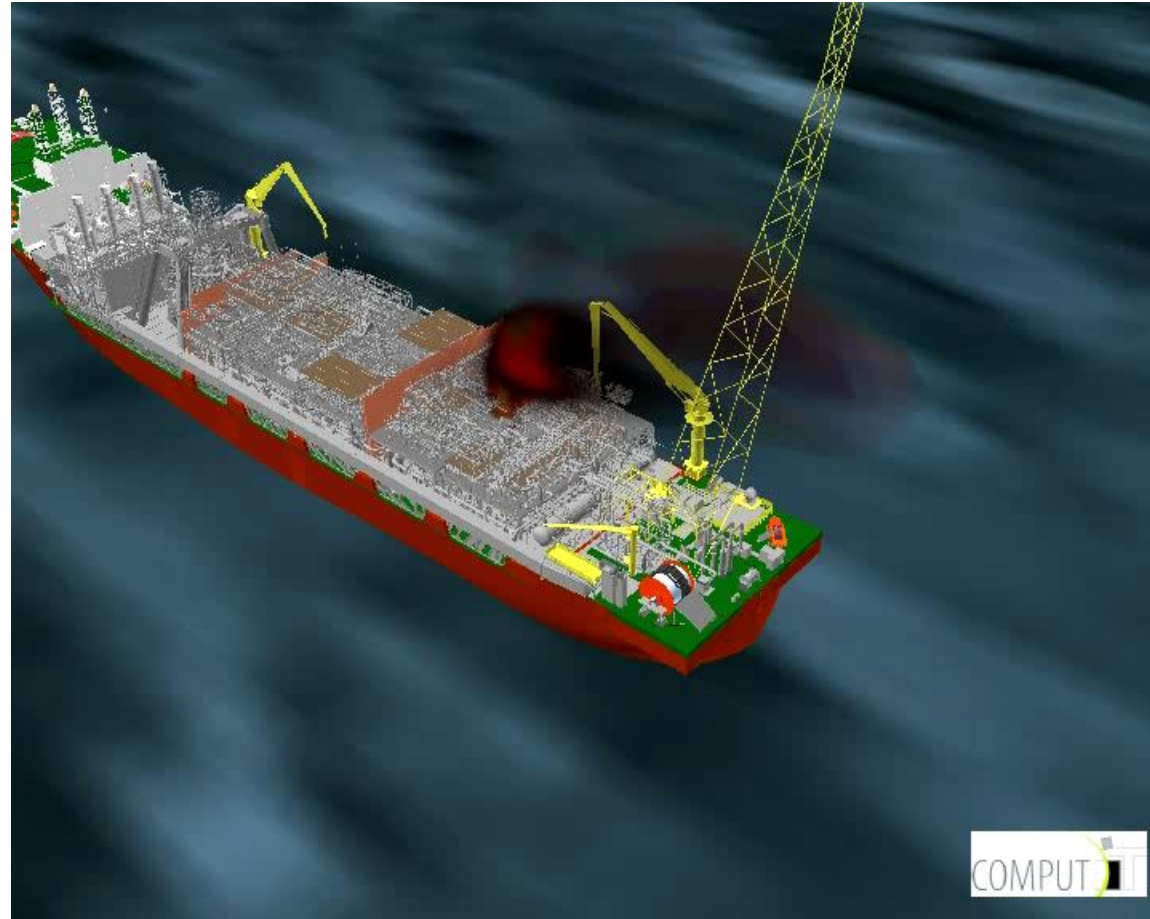




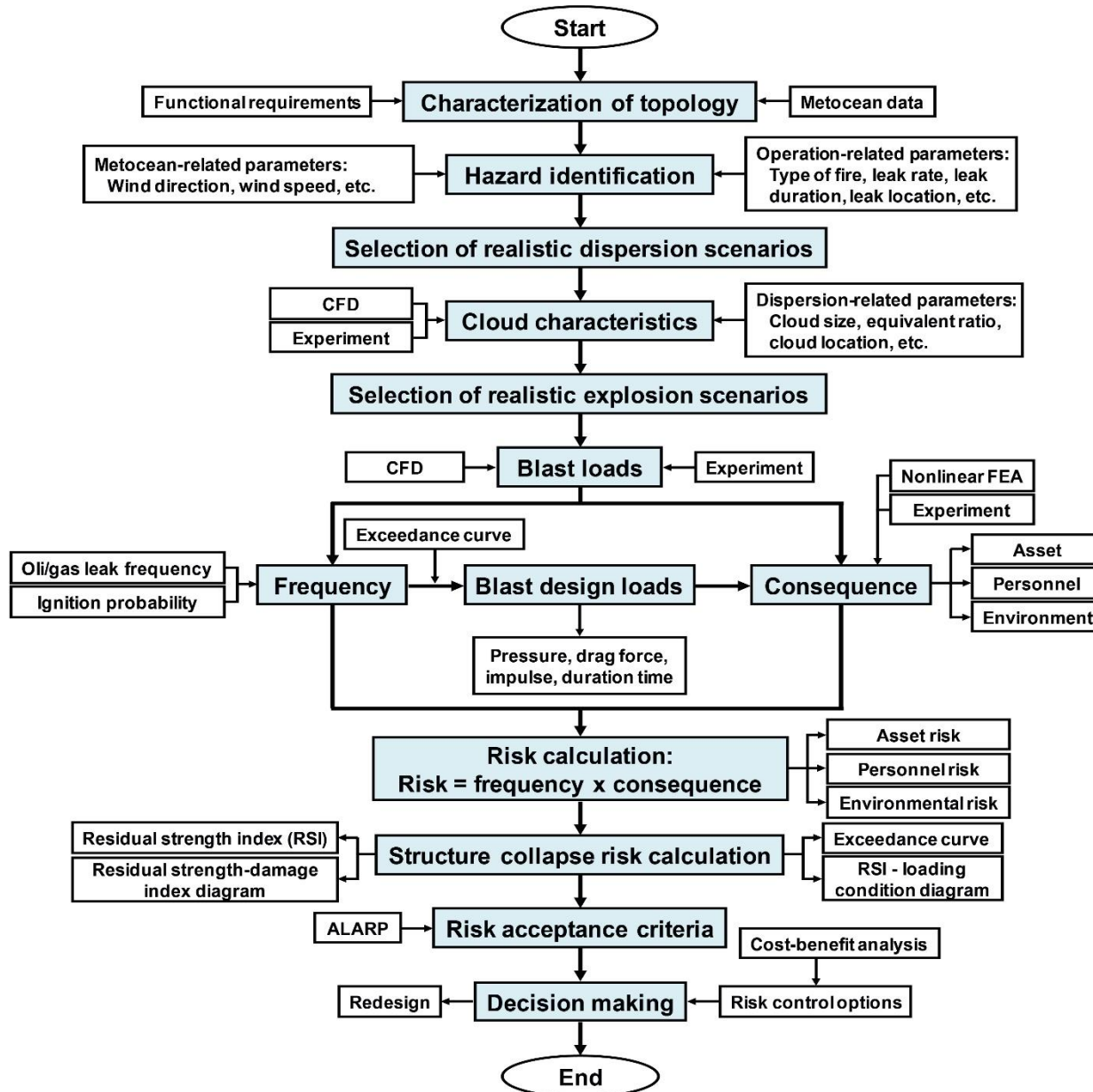


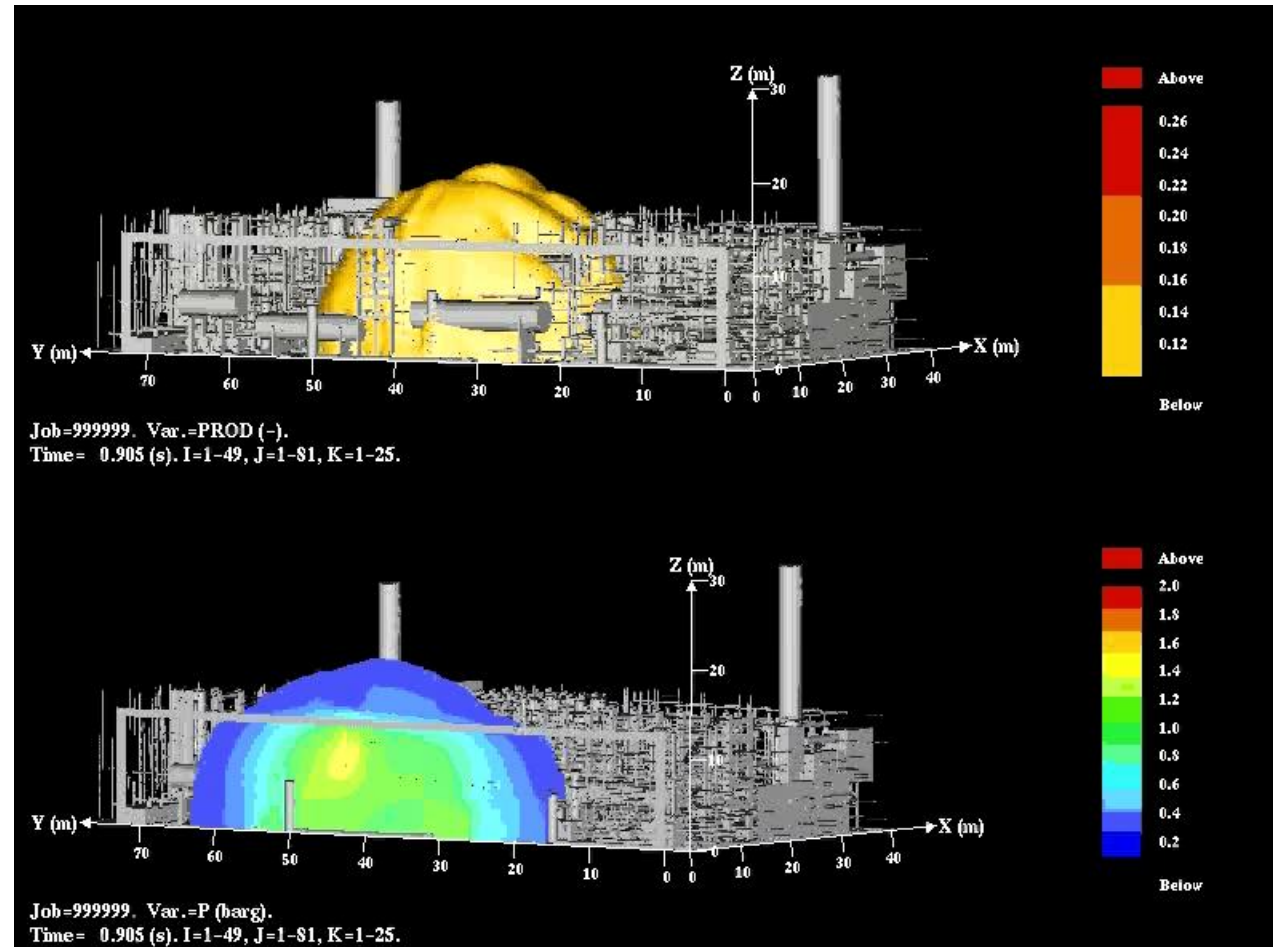
Fire Risk Assessment and Management





Explosion Risk Assessment and Management





LS-DYNA user input

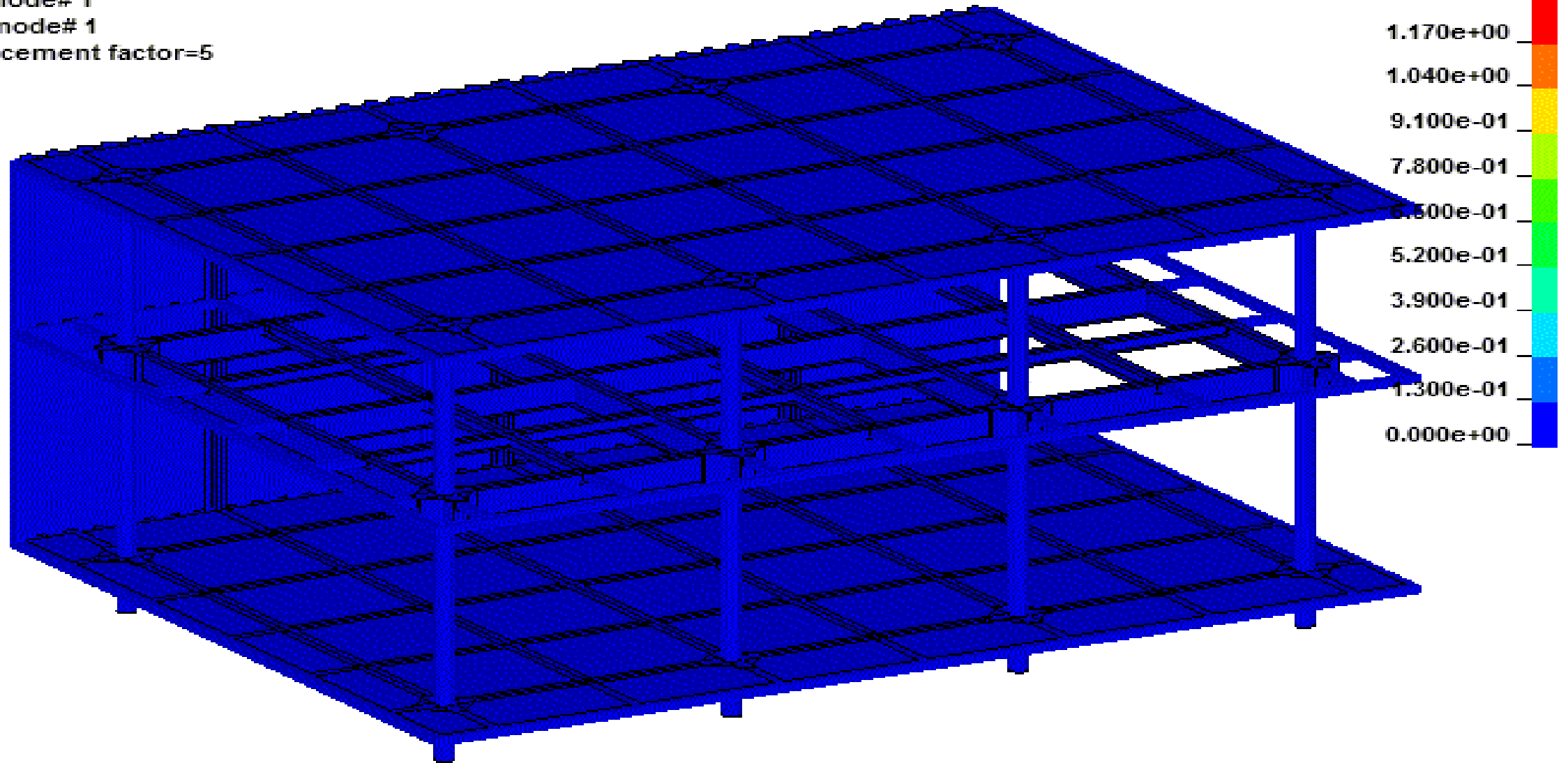
Time = 0

Contours of Resultant Displacement

min=0, at node# 1

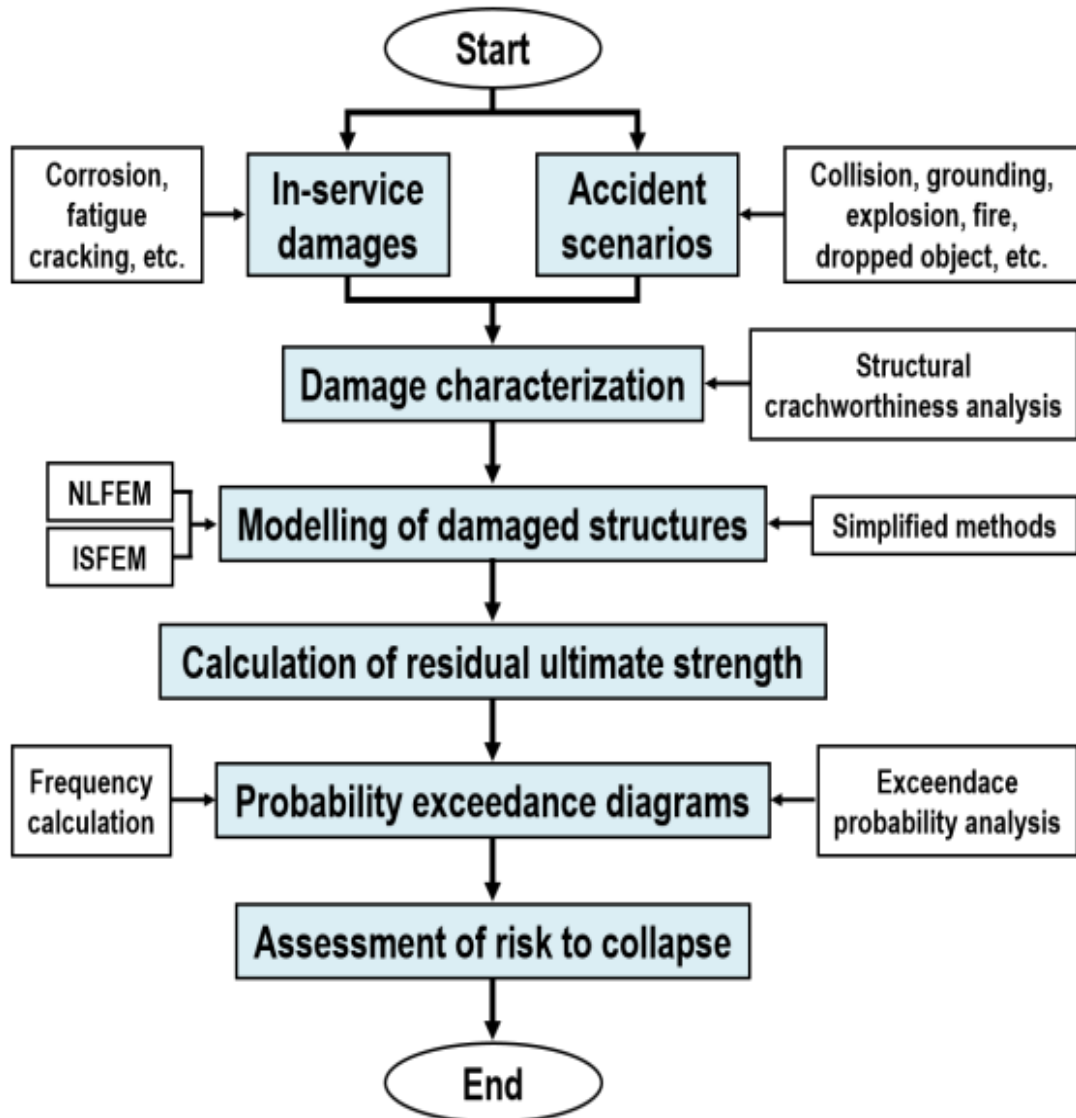
max=0, at node# 1

max displacement factor=5



Total displacement x 5(m) distribution with **actual explosion loads**

Hull Girder Collapse Risk Assessment and Management



Age-Induced Failure Risk Assessment and Management

HUMAN BODIES



Birth



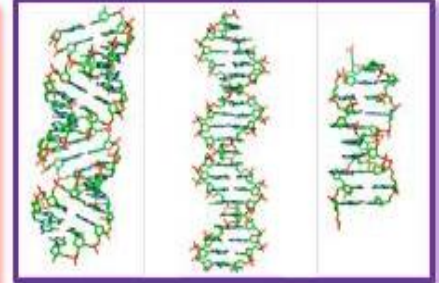
**Health monitoring
(Medical examination)**



**Condition
assessment**



**Medication or
operation**



**Prediction of
health condition**

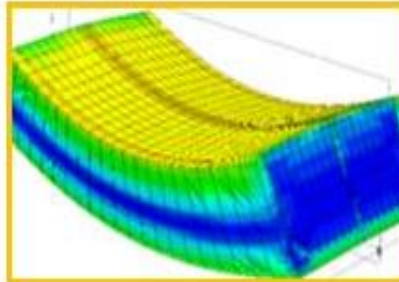
STRUCTURES



**Design and
fabrication**



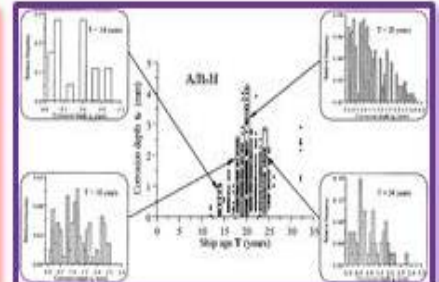
**Health monitoring
(Inspection)**



**Condition
assessment**



**Maintenance/ repair
or renewal**



**Prediction of
structure condition**

5. Large-Scale Physical Model Testing

KOSORI Hadong Campus



KOSORI Hadong Campus

Vertical Type Fire Wall Furnace Test



Horizontal Type Fire Wall Furnace Test



Indoor Fire System Test



Fire Bucking Collapse Test



Large Scale Structural Failure Test



Dropped Object Test



Blast Wall / Door / Window Test



Outdoor Fire / Explosion Test



High Speed Impact Test



Pulse Pressure Loading Rig

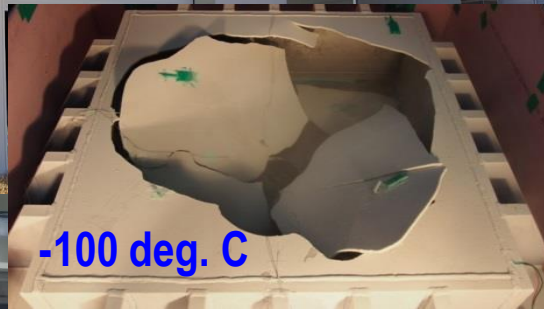
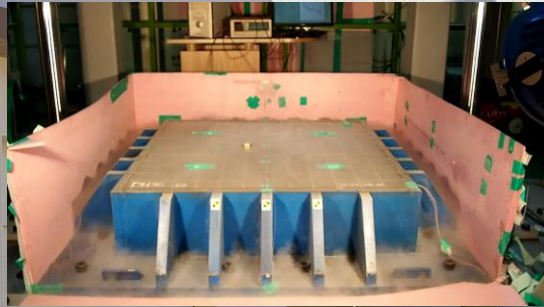
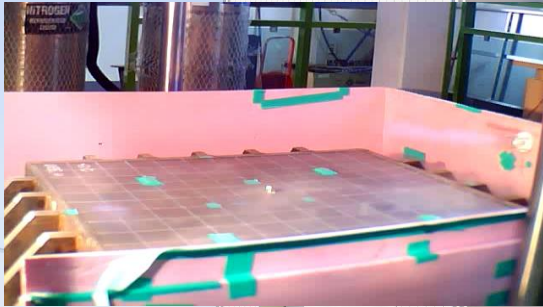


Subsea Hyperbaric Pressure Test



Dropped Object Test

3 x 3m, 30kN x 10m



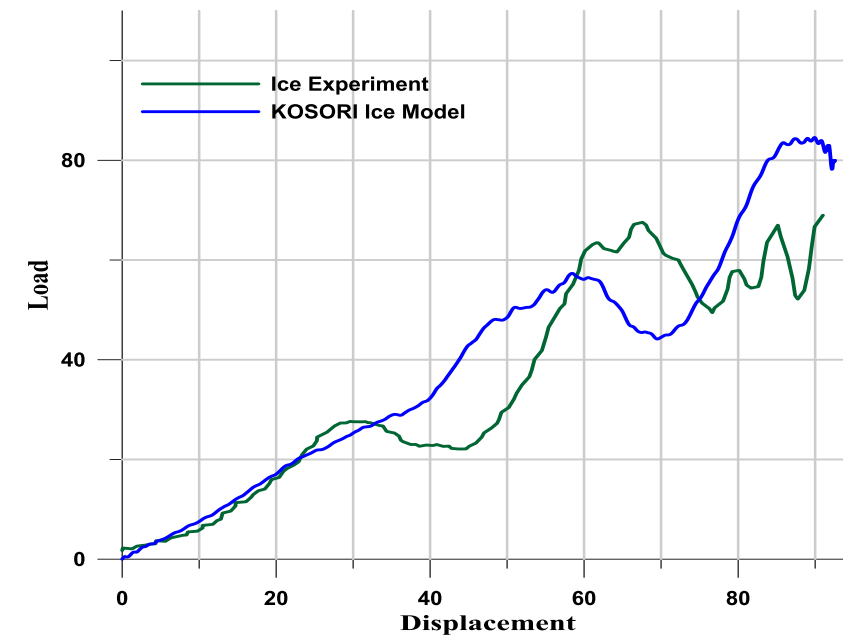
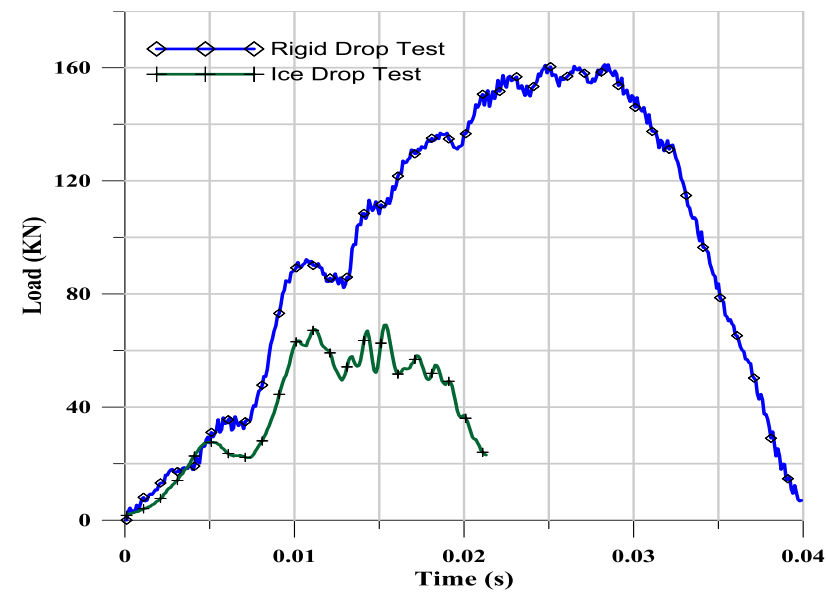
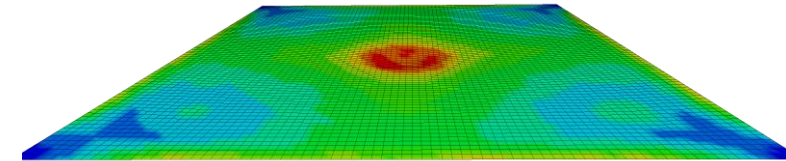
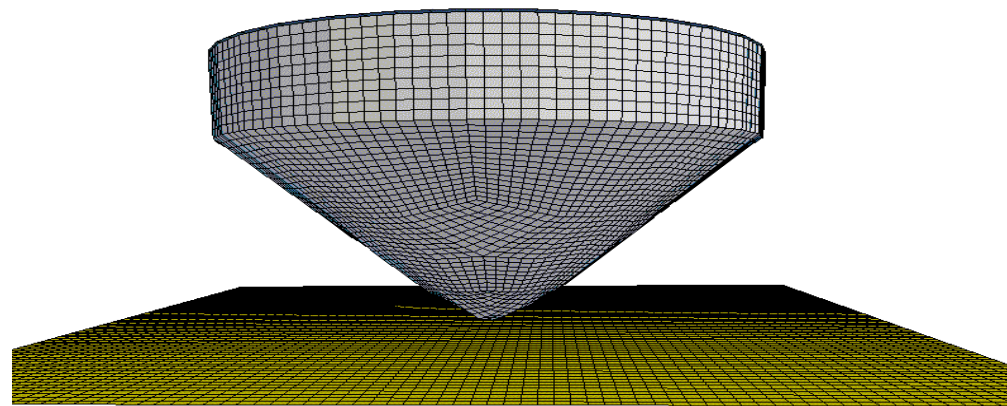
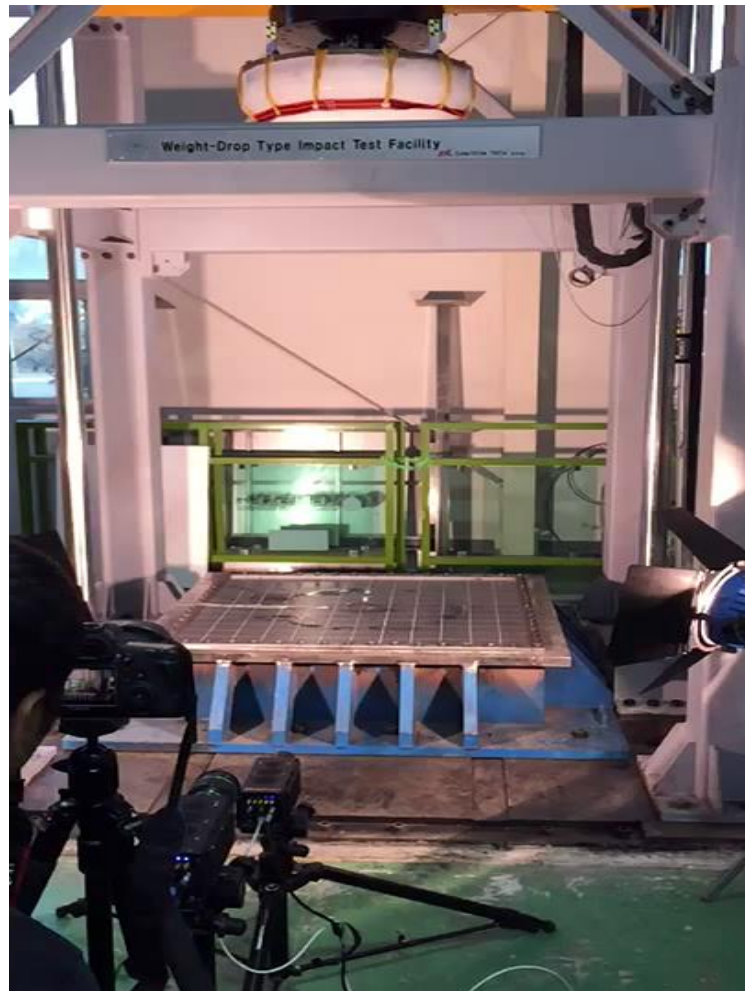
-60 deg. C

-100 deg. C

Temperature Control Chamber: -170 ~ 500 deg. C



Structure-Iceberg Collision



Fire Test Facilities (Furnace)



Horizontal Type Fire Wall

- Max. test specimen size: **6.5x4.5m**
- Max. temperature: 1,430degC
- Max. load: **3MN (300ton)**
- Fire curve: Standard and non-standard



Vertical Type Fire Wall

- Max. test specimen size: : **4.5x4.5m**
- Max. temperature: 1,430degC
- Max. load: 2MN (200ton)
- Fire curve: Standard and non-standard



Fire Collapse Test

- Max. test specimen size: **Φ4.5x5.0m**
- Max. temperature: 1,430degC
- Max. load: **10MN (1000ton)**
- Fire curve: Standard and non-standard

Large-Scale Fire/Explosion Test Site



20 m x 15 m x 10 m

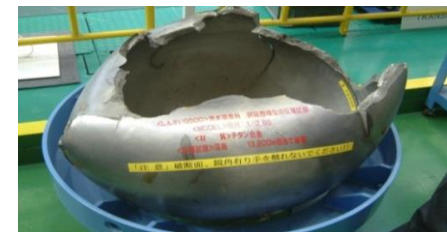
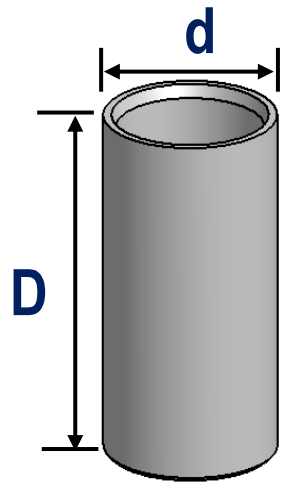
Subsea Hyperbaric Test Facilities

1.8 m x 4 m, 825 bar

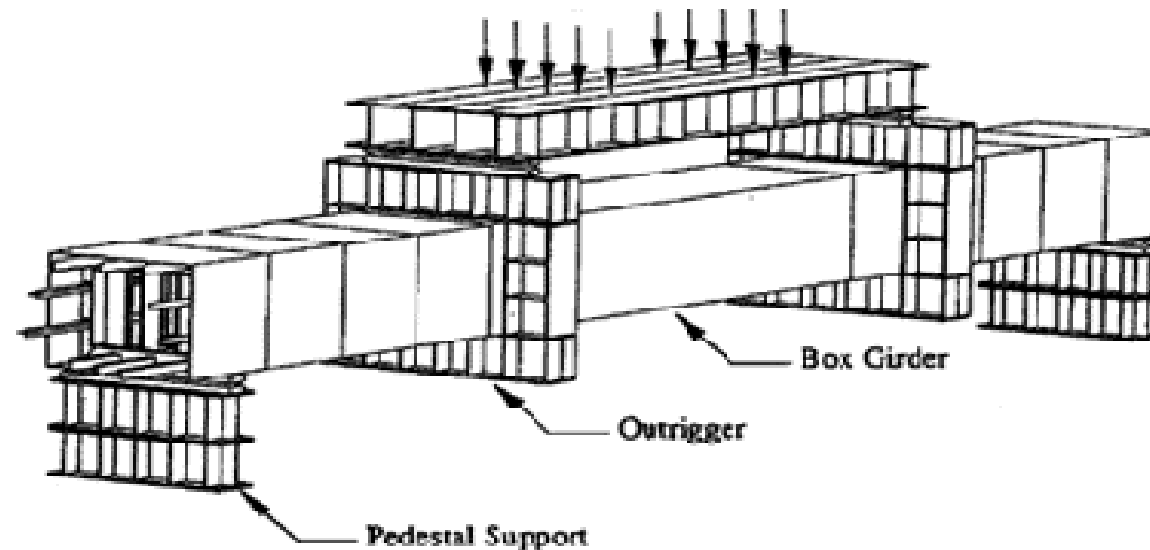


Subsea Hyperbaric Test Facilities

Specification	BALMORAL (UK)	NHC (UK)	SWRI (USA)	AKER (Norway)	JAMSTEC (Japan)	KOSORI (Korea)
d x D (m)	0.48 x 2.38	1.2 x 4.5	2.2 x 5.8	1.8 x 3.0	1.4 x 3.0	1.8 x 4.0
Maximum Pressure (bar)	700	445	275	550	700	825

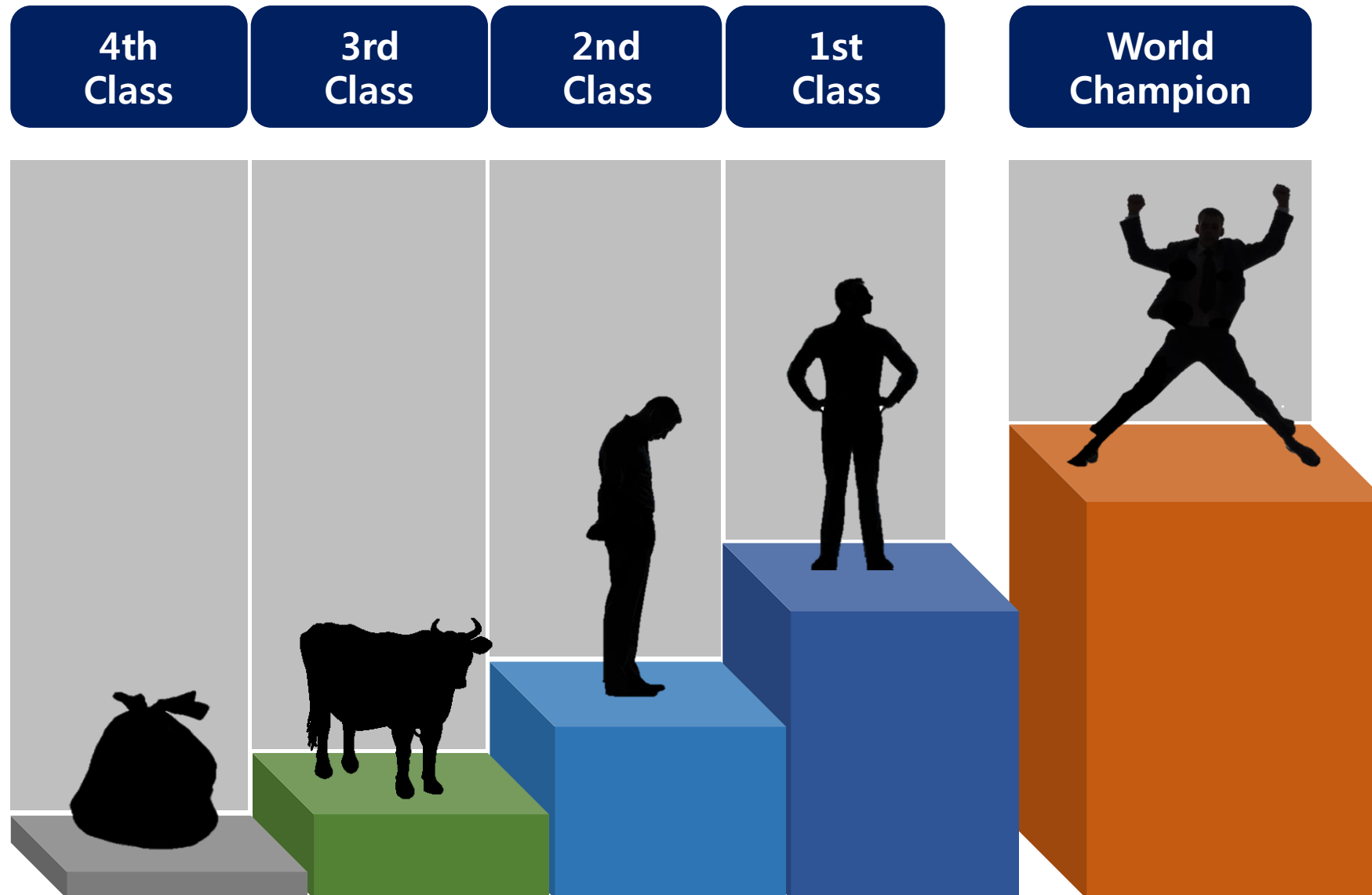


1/6 Scaled Hull Collapse Test of a 1,900 TEU Containership

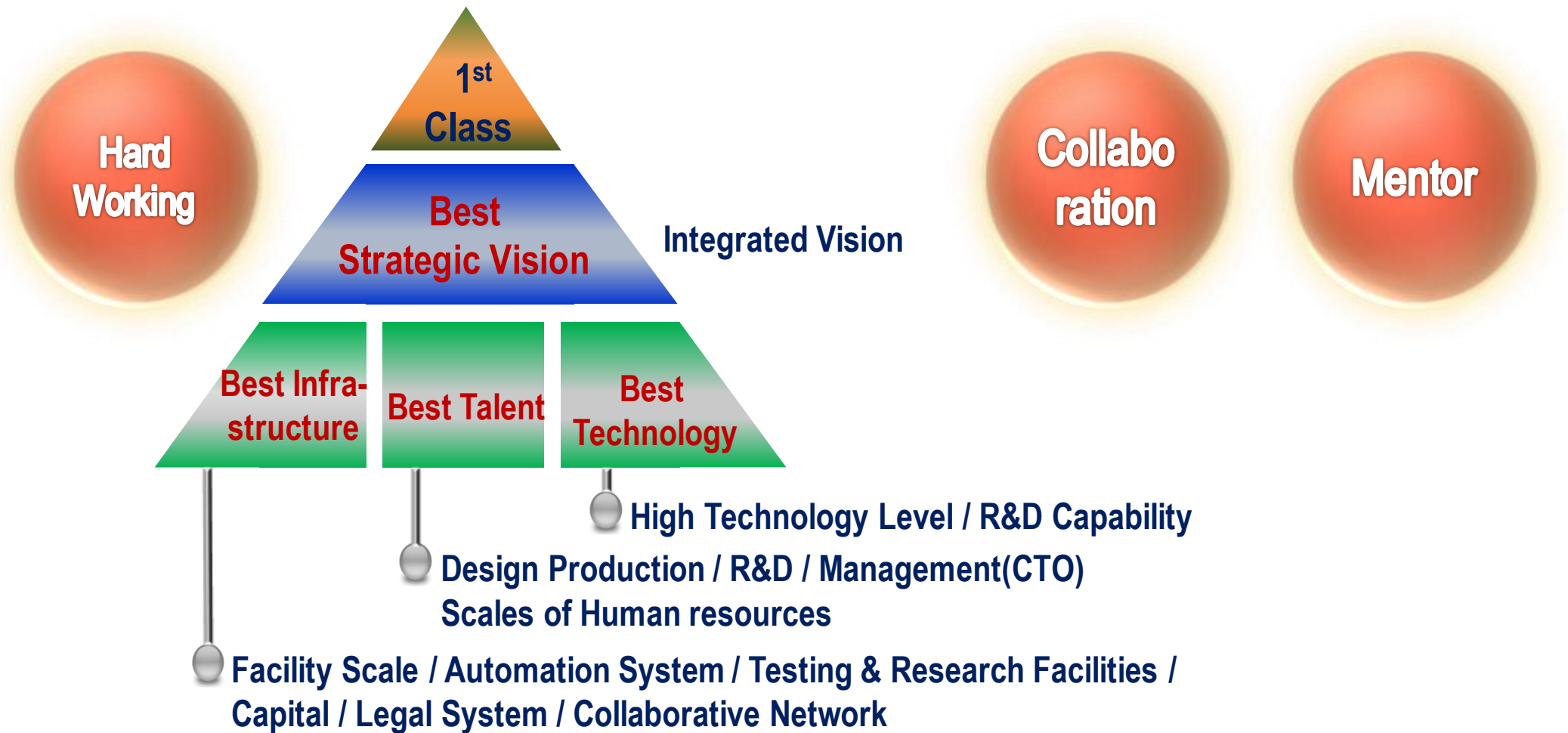


6. To Finish ...

Classification of Professional Competence



The Four Elements Theory to Achieve 1st Class



Vision is wisdom to look into the future and remain one step ahead in the arena of competition.

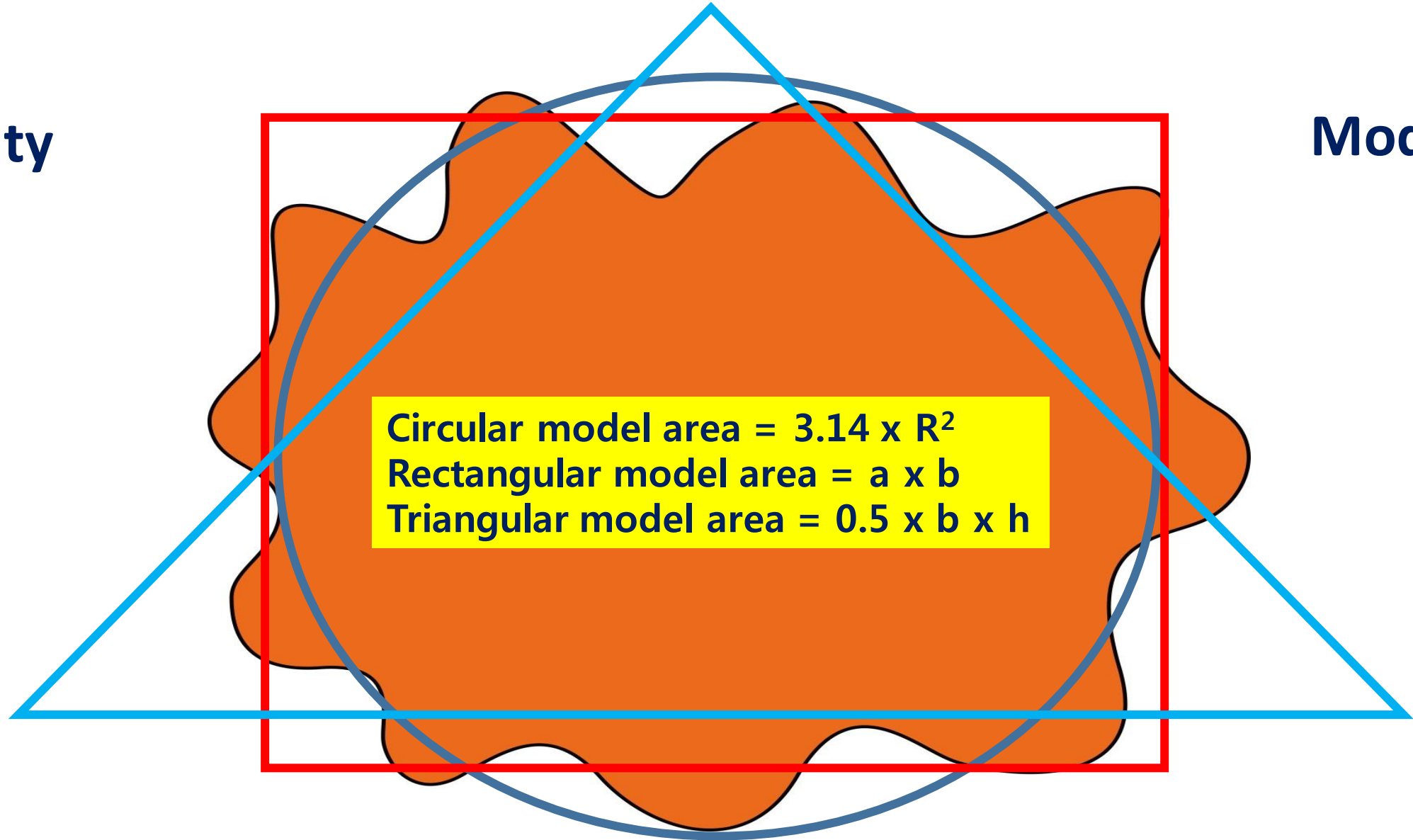
11 Tips That Will Bring You the Success

1. Be fluent in English
2. Aim at becoming a world champion in your field
3. Aim at contributing to our community, country and globe rather than yourself alone
4. **Four elements theory** – infrastructure, talent (human resource), skill(technology) and visionary strategies which are equally important
5. Be a catalyst
6. $E = mc^2$, where E = energy of success and c = endeavor
7. All problems must always have solutions, and don't give up
8. To be skilled, be familiar with
9. Collaboration is much smarter than doing in isolation
10. World is small, and don't fear it
11. World is roomy, and there must be a lot of things to do

Engineering Modelling with Tolerable Uncertainties

Reality

Models



Questions & Answers