ITER

Project Management

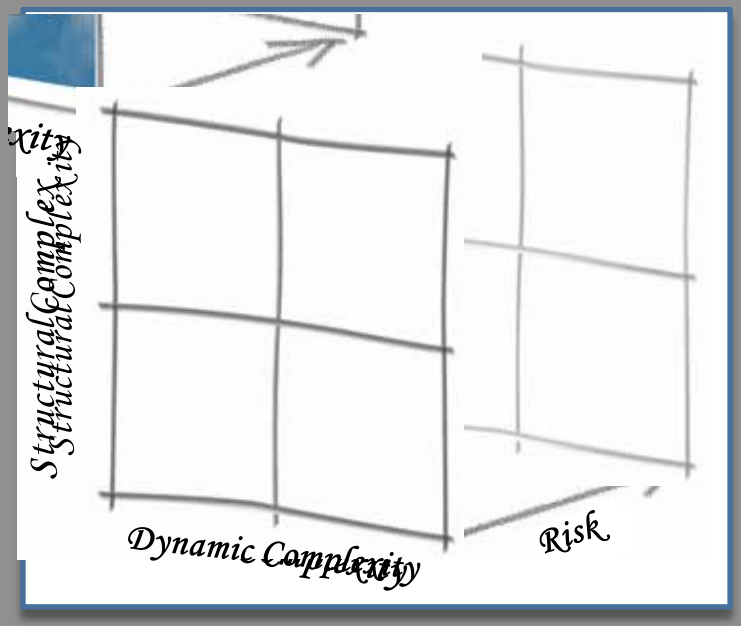
Hans H. ALTFELD, Head of ITER Project Control Office

Table of Contents

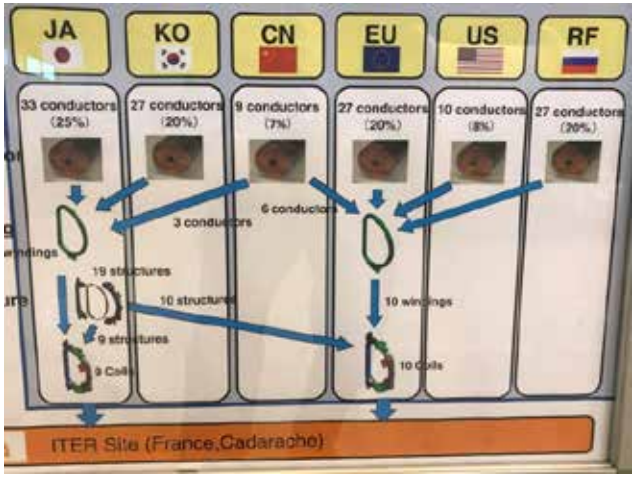
- ❑ **ITER Project Complexity**
- ❑ **PM: Where do we come from?**
- ❑ **Addressing Structural Complexity**
- ❑ **Addressing Dynamic Complexity**
- ❑ **Addressing Issues and Risks**
- ❑ **Addressing Complexity holistically**
- ❑ **Summary**

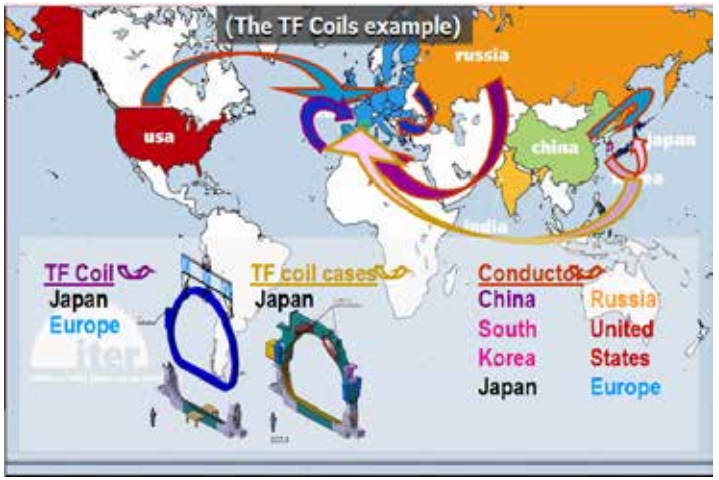
ITER
Project Complexity

- Structural Complexity
- Dynamic Complexity
- Risk



ITER
Structural Complexity





Global Supply Chain

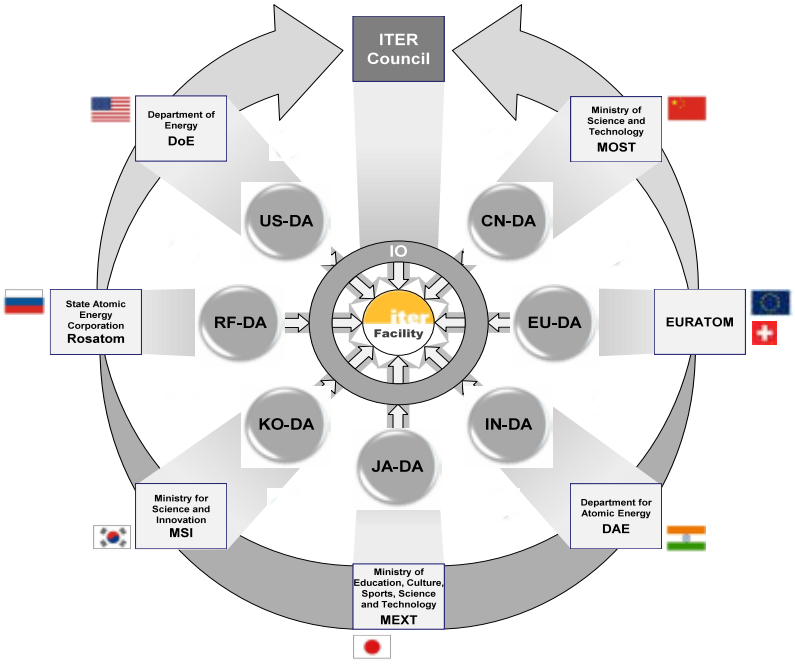
- Science vs industrial
- Non-nuclear vs nuclear

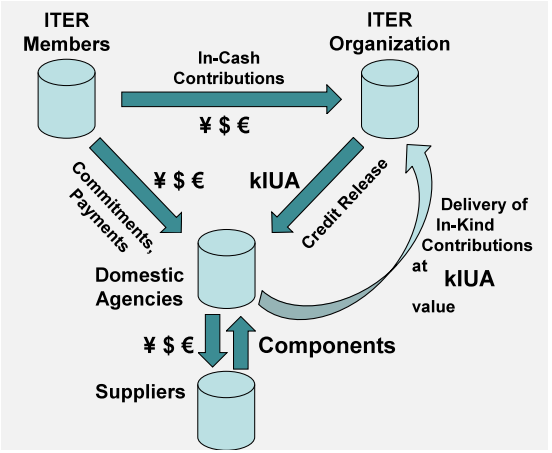
ITER
Structural Complexity

Governance Structure(s)

Global Supply Chain

- Science vs industrial
- Non-nuclear vs nuclear





ITER
Structural Complexity

- **ITER Agreement set up a structure where IO as the overall integrator does not have organizational control over the Domestic Agencies (component suppliers)**
  - **Domestic Agencies have their own reporting and financial/ budgetary structure**
  - **Drivers for IO (schedule progress, functional performance, overall cost optimization) and DAs (individual entity cost reduction) are not always aligned**

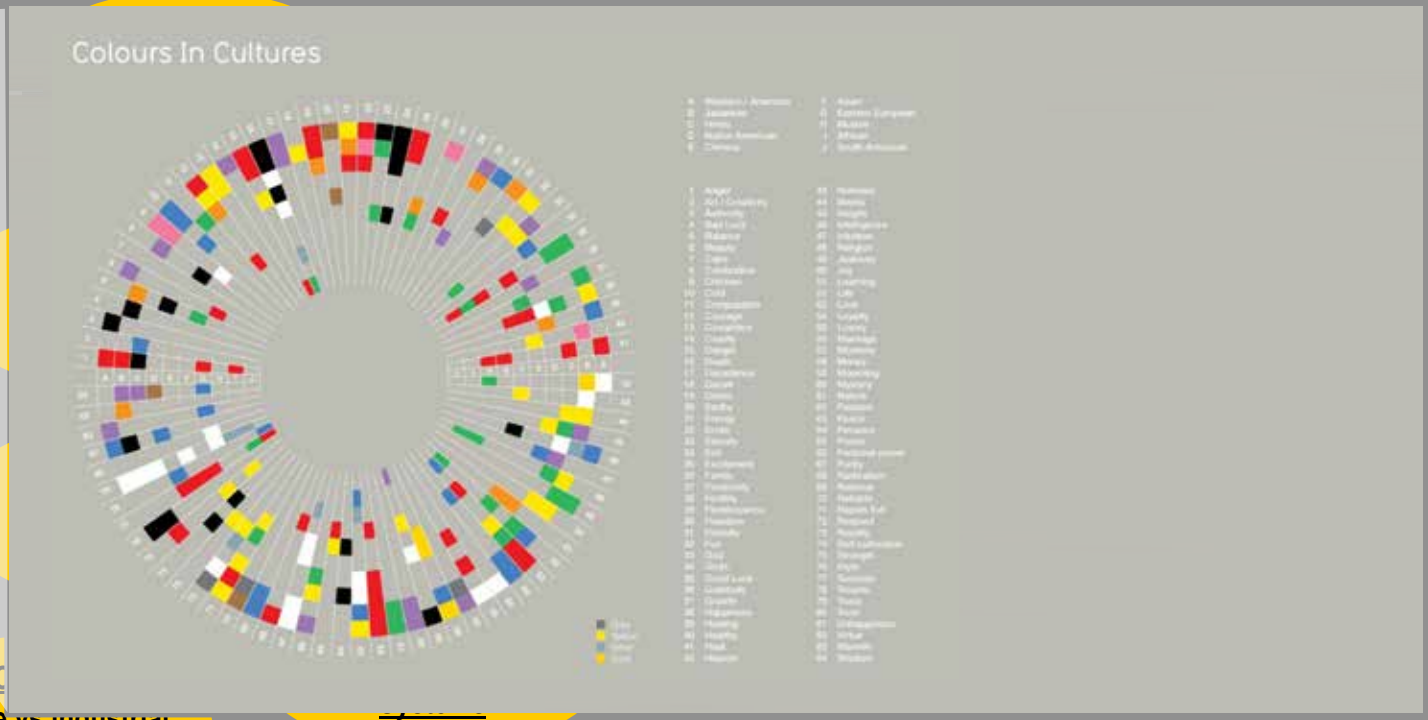
Governance Structure(s)

Global Supply Chain

- Science vs industrial
- Non-nuclear vs nuclear

ITER
Structural Complexity

Cultures:
A380: 1 Member
ISS: 5 Members
ITER: 7 Members



Governance Structure(s)

Global Supply Chain

- Science vs industrial
- Non-nuclear vs nuclear

ITER
Structural Complexity

Cultures:
A380: 1 Member
ISS: 5 Members
ITER: 7 Members

Drawings:
A380: 79,000
ITER: 250,000

Project FTEs:
A380: 6,000
ITER: 3,000

Cost of Development (ca.)
ISS: 100 €bn
ITER: 20 €bn

Governance Structure(s)

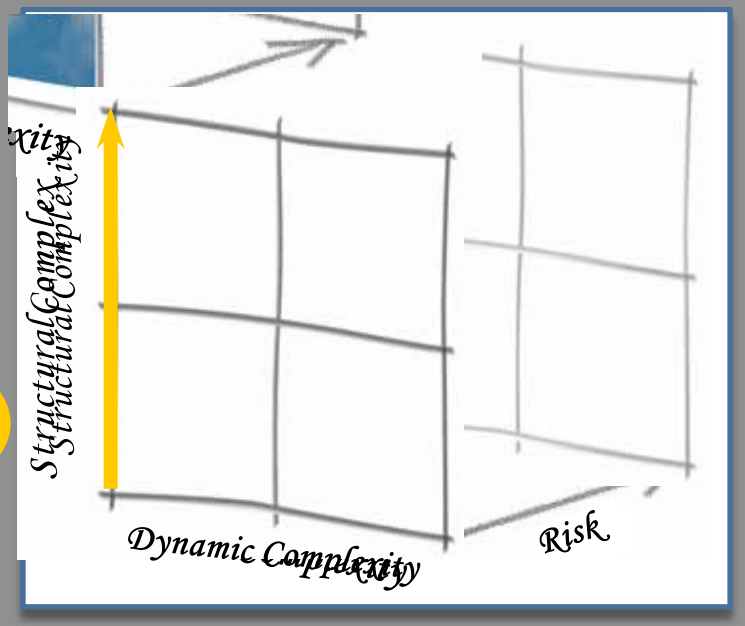
System of Systems

Parts:
747: $5 \cdot 10^6$
ITER: $10 \cdot 10^6$

Global Supply Chain

Interface Challenges and Systems

Cultures:
- Science vs industrial
- Non-nuclear vs nuclear



ITER
Dynamic Complexity

Technology Changes

Product Changes

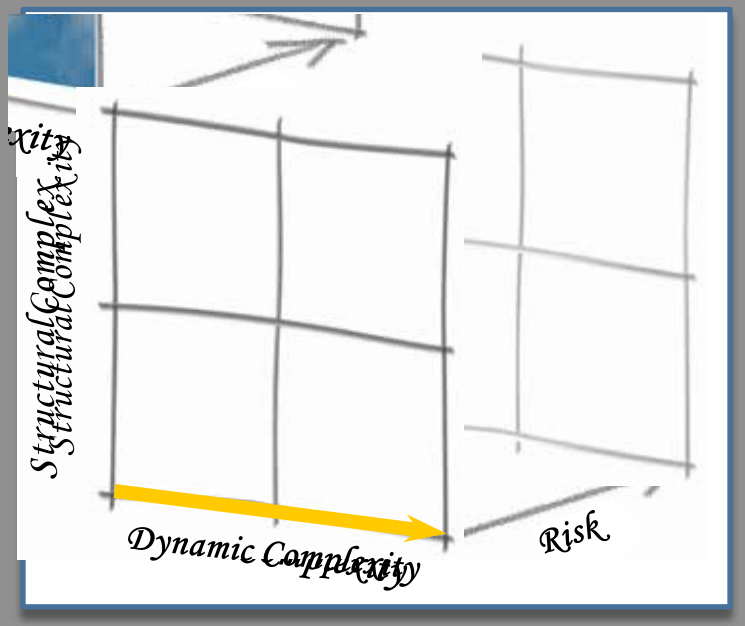
Financing Changes

Objectives Changes

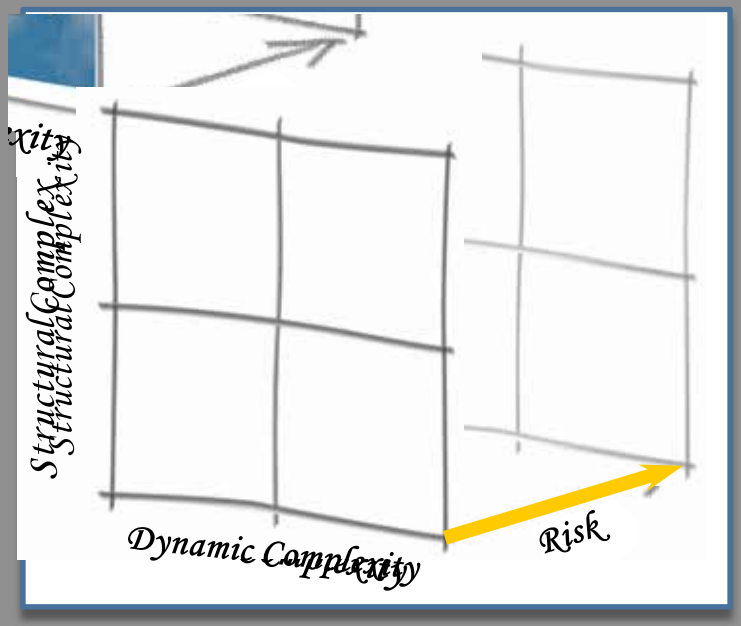
Process Changes

People Changes

Organization Changes



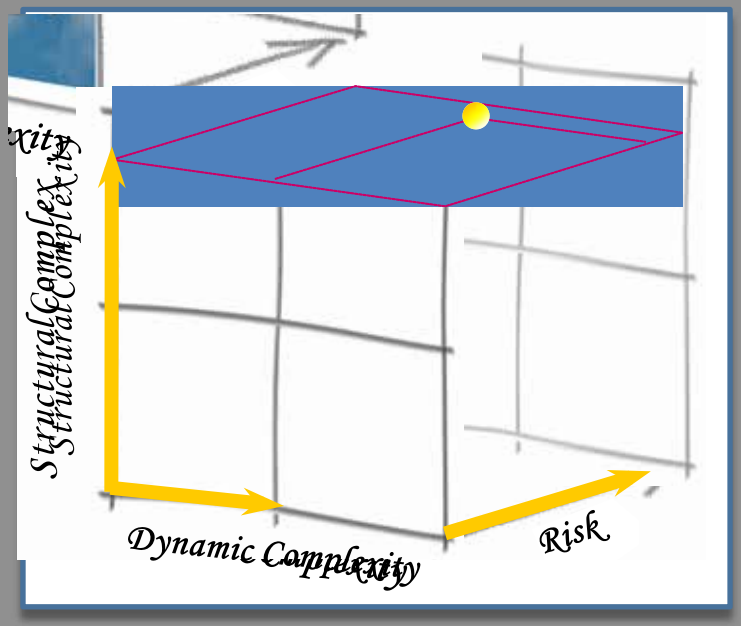
ITER
Risks (and Issues)



ITER
Project Complexity

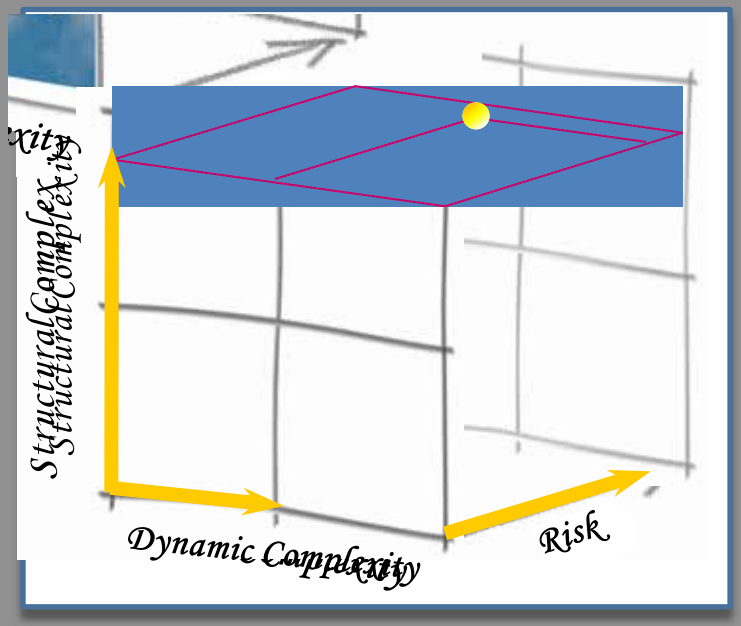
- High Structural Complexity
- Medium Dynamic Complexity
- More than medium Risk

➡ **Significant level of Complexity!**



ITER
Project Complexity

- High Structural Complexity
- Medium Dynamic Complexity
- More than medium Risk



➡ Significant level of Complexity!

➡ How to manage this Complexity?

- ITER Project Complexity
- **PM: Where do we come from?**
- Addressing Structural Complexity
- Addressing Dynamic Complexity
- Addressing Issues and Risks
- Addressing Complexity holistically
- Summary

<2013

Excerpt

- As a result of the complex governance setup, award of fabrication contracts in the past, when design was still evolving, was
  - made further complex by extremely complicated breakdown of components scope between multiple DAs and IO, resulting in complex interfaces and uncertain cost boundaries between DAs and IO
  - lacking decision speed as there was no central funding mechanism for compensating impact of design changes to be cascaded to the DAs

2013

Excerpt

ITER Management Assessment ("Madia Report")

- lack of a strong Project Management culture
- unrealistic schedule
- inadequate Systems Engineering and Design Integration
- a stove-piped organizational structure and inefficient management organization
- lack of a strong nuclear safety culture
- lack of effective IO-DA decision-making

2013

Excerpt

ITER Management Assessment ("Madia Report")

- lack of a strong Project Management culture
- unrealistic schedule
- inadequate Systems Engineering and Design Integration
- a stove-piped organizational structure and inefficient management organization
- lack of a strong nuclear safety culture
- lack of effective IO-DA decision-making

⇨ **Massive improvements required to project manage ITER**

2015

Excerpt

Action Plan presented by elect DG B. Bigot

- Integrate IO and DAs under the leadership of the DG, while respecting the ITER Agreement:
  - Provide DG with the global and ultimate technical responsibility, with DAs to participate in all key decision making processes
  - Introduce an Executive Project Board
  - Not only reinforce the Project Control Office and establish a Central Integration Office (CIO), but also strengthen their ties to their counterparts in the DAs
  - Create integrated IO/DA(s) project teams

2015

Excerpt

Action Plan presented by elect DG B. Bigot

- Provide DG with a central fund to finance technical changes initiated by the IO, so that technical decisions in the overall interest of the project can be taken much faster
- Implement powerful coordination tools for establishing a nuclear project culture
- Develop a project culture based on mutual trust, project loyalty and team spirit
- Implement a new organization at the IO in support of the above
- Hire senior managers with industrial background in managing complex projects

2015

Excerpt

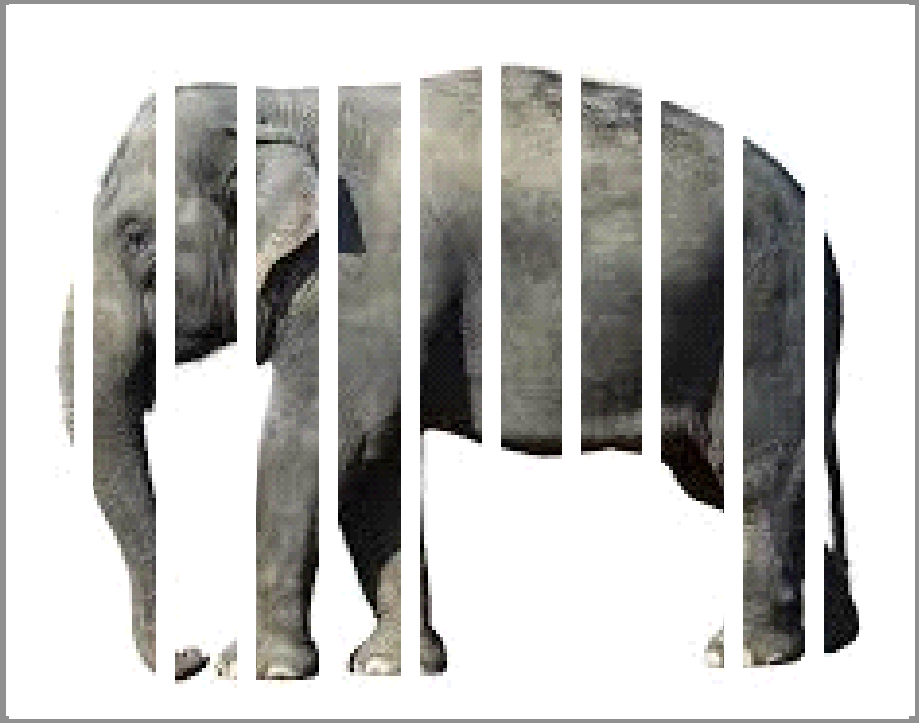
Action Plan presented by elect DG B. Bigot

- Provide DG with a central fund to finance technical changes initiated by the IO, so that technical decisions in the overall interest of the project can be taken much faster
- Implement powerful coordination tools for establishing a nuclear project culture
- Develop a project culture based on mutual trust, project loyalty and team spirit
- Implement a new organization at the IO in support of the above
- Hire senior managers with industrial background in managing complex projects

➡ Action Plan fully supported by ITER Council and DAs

Table of Contents

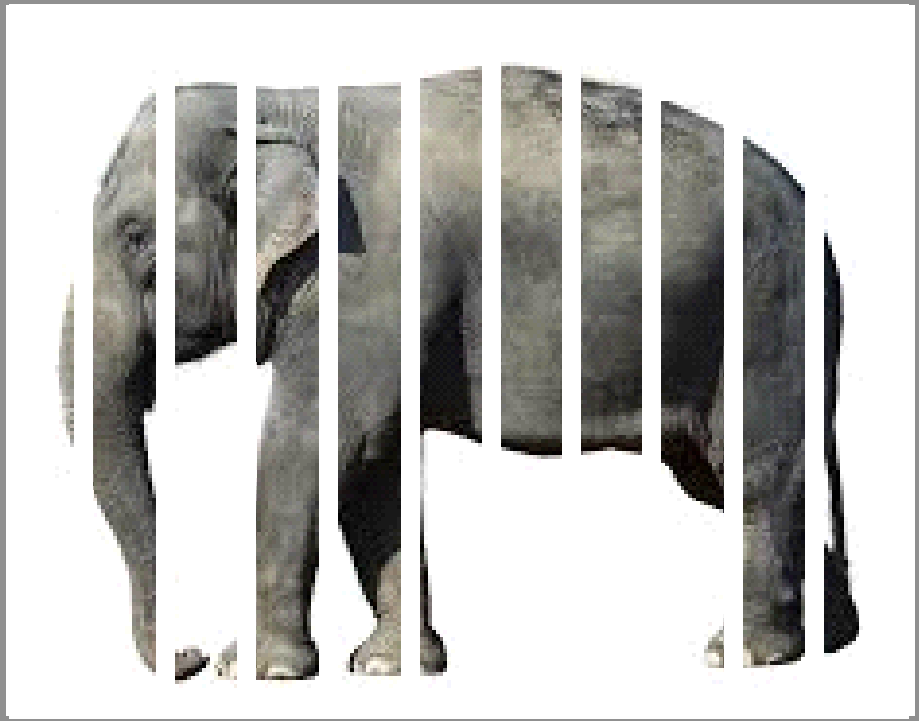
Today
Addressing Structural Complexity



Slicing the Elephant

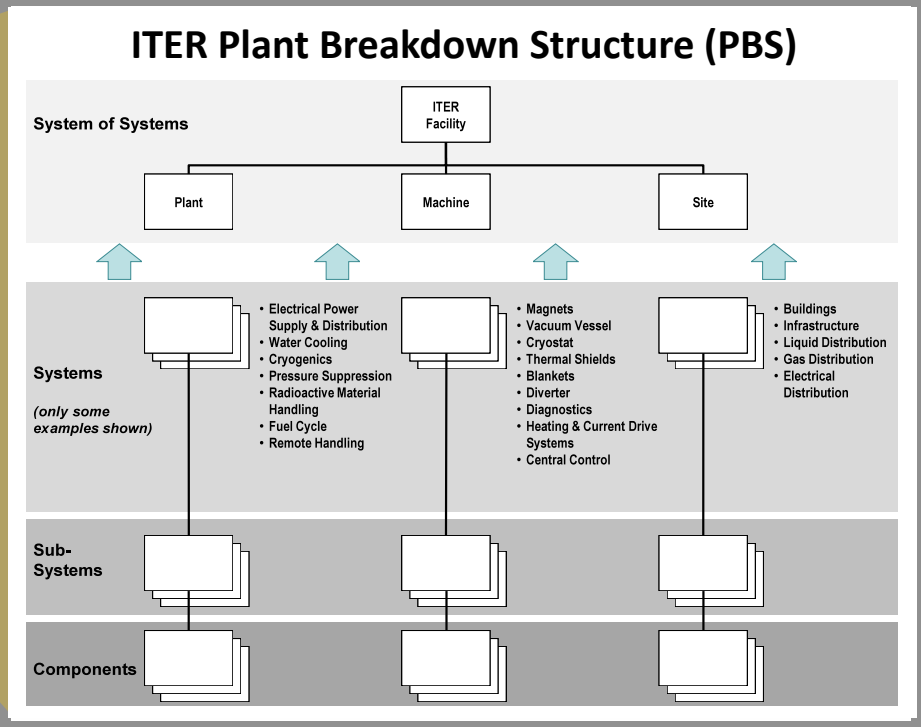
Today
Addressing Structural Complexity

- Break down of content along different dimensions, e.g.
  - System
  - Work
  - Requirements / V&V
  - Schedule
  - Site
  - Organization



Today
Addressing Structural Complexity

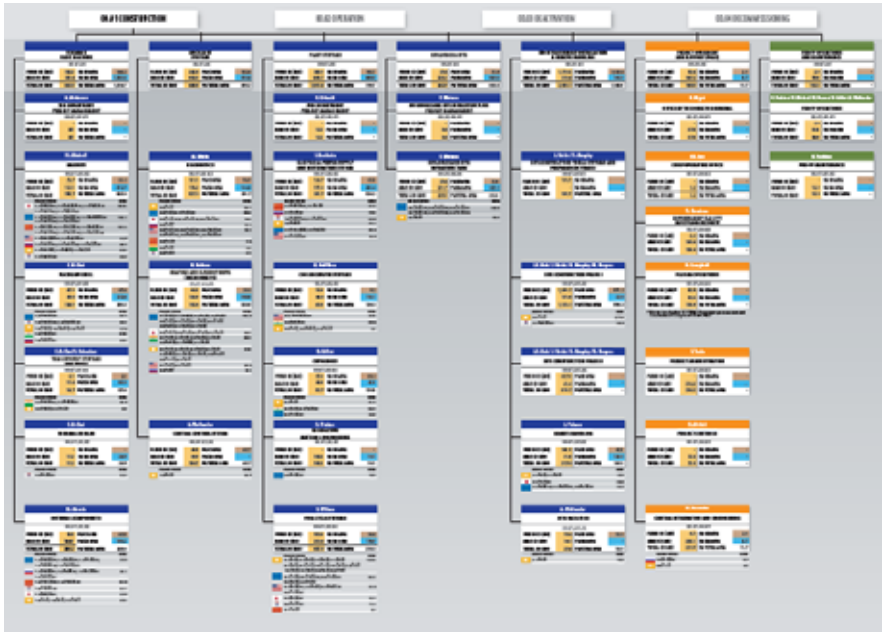
- Break down of content along different dimensions, e.g.
  - **System**



Today
Addressing Structural Complexity

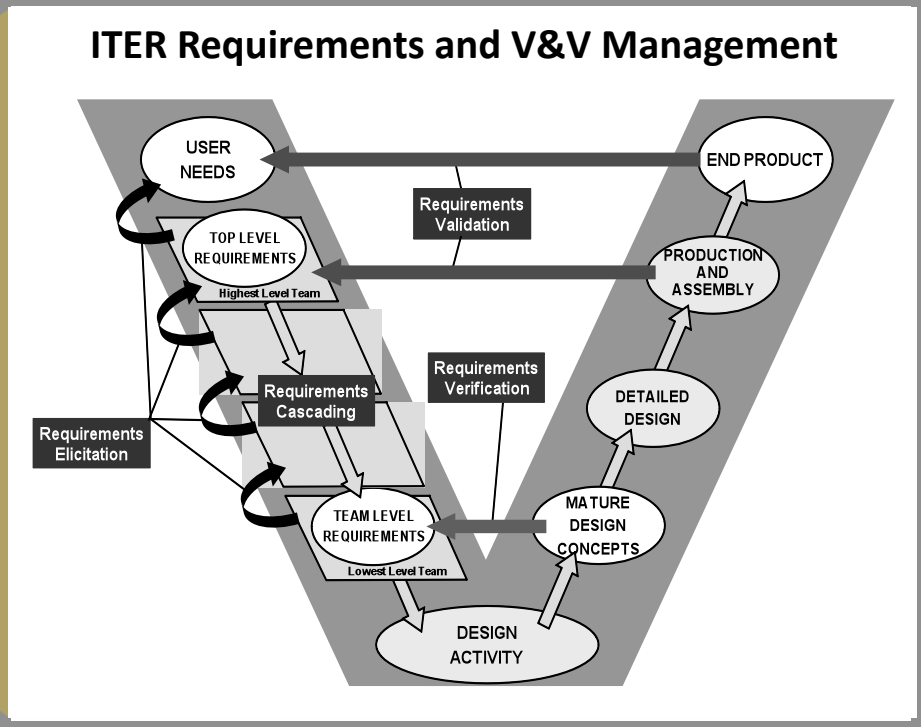
- Break down of content along different dimensions, e.g.
  - System
  - **Work**

ITER Work Breakdown Structure (WBS)



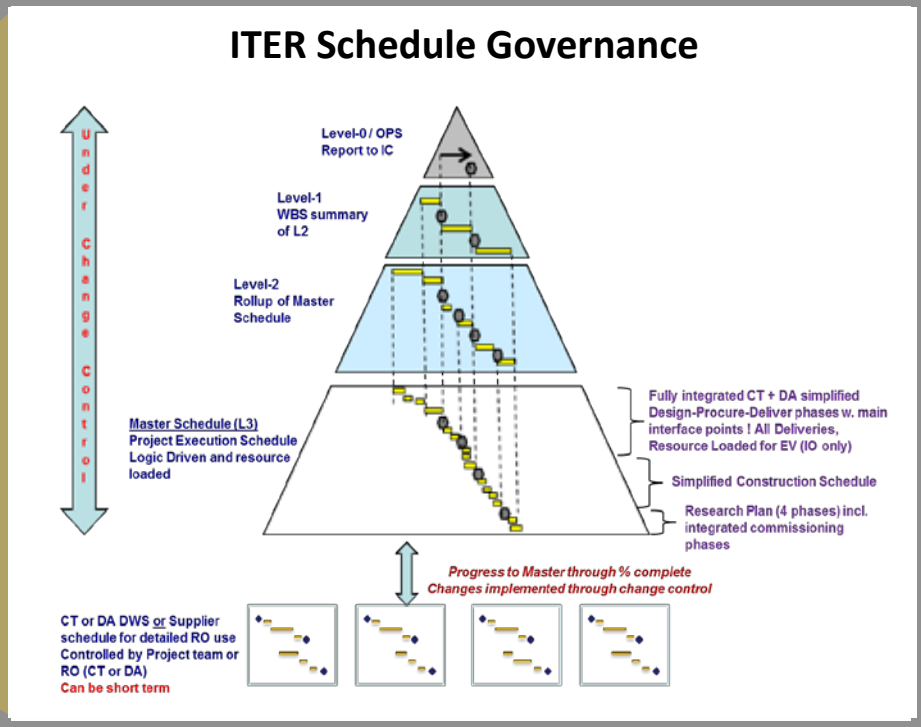
Today
Addressing Structural Complexity

- Break down of content along different dimensions, e.g.
  - System
  - Work
  - **Requirements**



Today
Addressing Structural Complexity

- Break down of content along different dimensions, e.g.
  - System
  - Work
  - Requirements
  - **Schedule**



Today
Addressing Structural Complexity

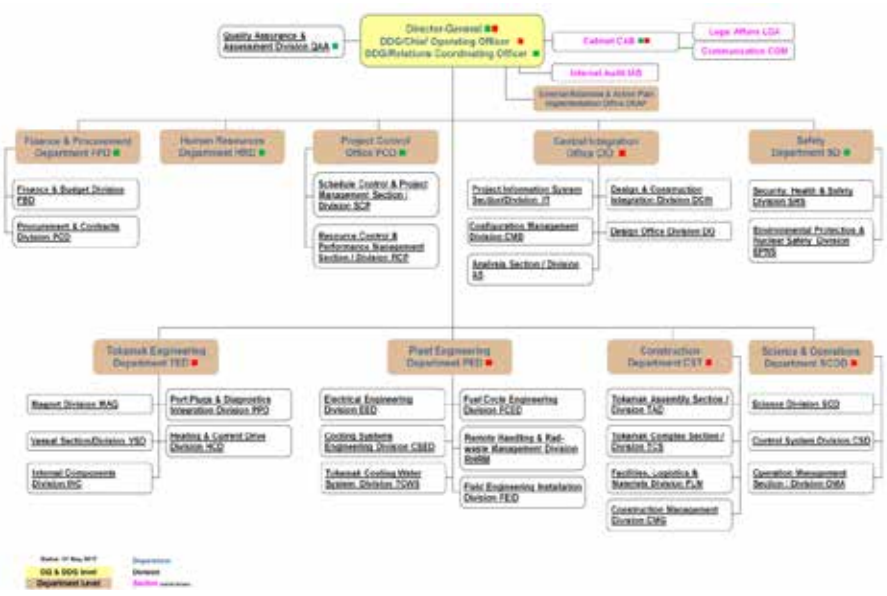
- Break down of content along different dimensions, e.g.
  - System
  - Work
  - Requirements
  - Schedule
  - **Site**

ITER Geographic Breakdown Structure (GBS)

Today
Addressing Structural Complexity

- Break down of content along different dimensions, e.g.
  - System
  - Work
  - Requirements
  - Schedule
  - Site
  - **Organization**

ITER Organization Breakdown Structure (OBS)



Today
Addressing Structural Complexity

- ‘Slicing the Elephant’ requires tight management and control of I^3
  - Interfaces managed through Interface Sheets
  - Interdependencies managed through schedule governance and customer-supplier relationship monitoring tools
  - Interchangeabilities managed through Configuration Management

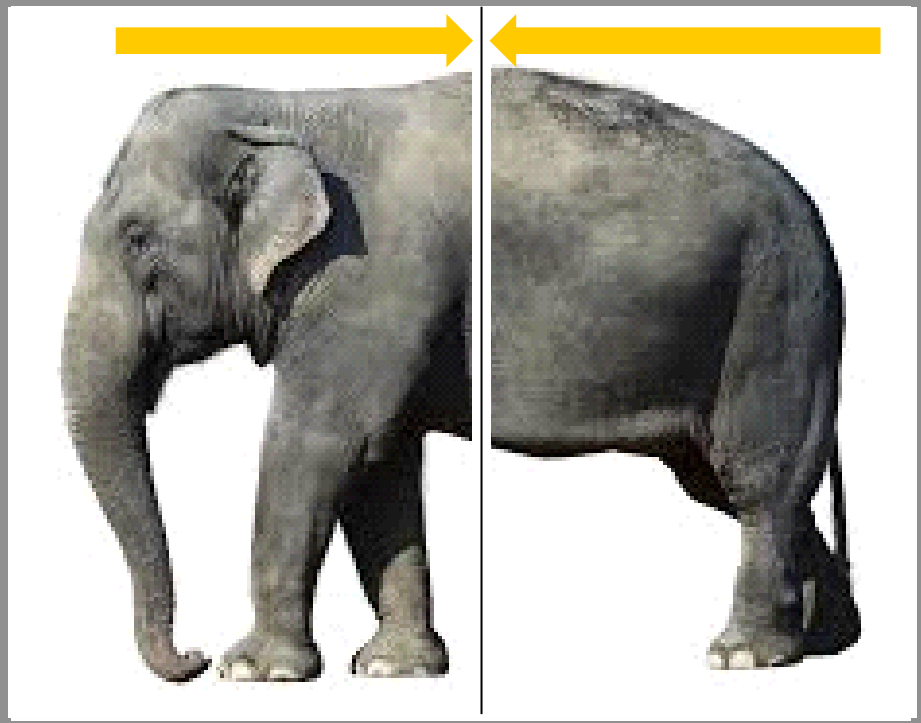


Table of Contents

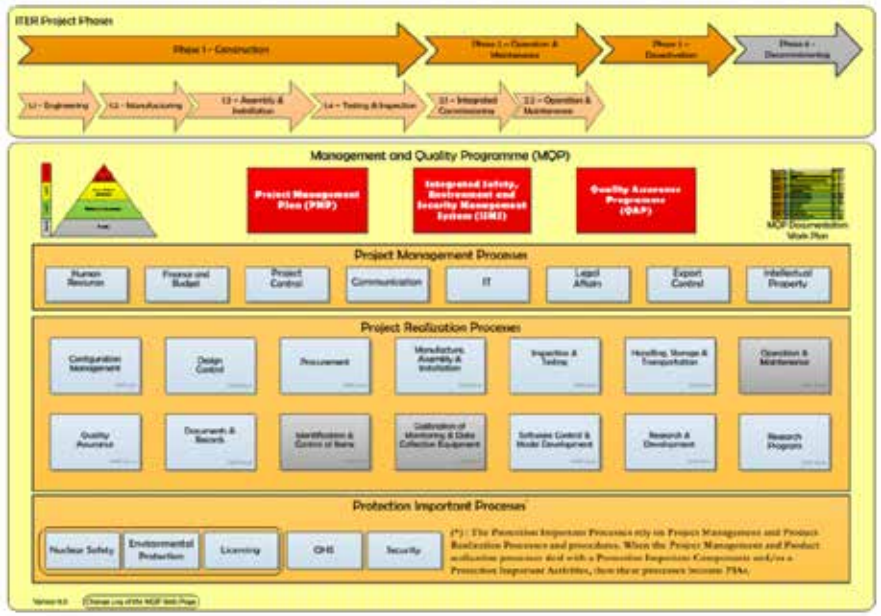
Today
Addressing Dynamic Complexity

- Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner

Today
Addressing Dynamic Complexity

- Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner.
  - **Processes**

ITER Management & Quality Program (MQP)



Today
Addressing Dynamic Complexity

- Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner.
  - **Processes**

ITER Management & Quality Program (MQP)

Today
Addressing Dynamic Complexity

- Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner.
  - **Processes**

⇨ 'Business Operating System' now well defined

Today
Addressing Dynamic Complexity

- Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner.
  - Processes
  - **Change Control**

Baselines

- Technical Baseline
- Updated Cost and Schedule Baseline approved 'ad referendum' in November 2016
  - after review by an ITER Council Working Group on the Independent Review of the Updated Long Term Schedule and Human Resources (ICRG)
  - based on best technically achievable and risk-reducing '4-Stage Approach' from FP (Dec '25) to DT operations (Dec '35)
  - on purpose without initial schedule or cost contingency

Today
Addressing Dynamic Complexity

- Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner.
  - Processes
  - **Change Control**

Baselines

- Technical Baseline
- Updated Cost and Schedule Baseline approved 'ad referendum' in November 2016
  - after review by an ITER Council Working Group on the Independent Review of the Updated Long Term Schedule and Human Resources (ICRG)
  - based on best technically achievable and risk-reducing '4-Stage Approach' from FP (Dec '25) to DT operations (Dec '35)

⇨ Baselines serve as references against which change is controlled

Today
Addressing Dynamic Complexity

- Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner.
  - Processes
  - **Change Control**

Decision Making Hierarchy

Control Level	Decision Authority	Topics for Decision Topics (Examples)	@ Level	To be Consulted
0	IC ASN	• Project Baseline Document(s)	0	STAC MAC
		• IROs to Project Baseline(s)	0	
		• Baseline Change Requests	0	
		• IO-OBS	1-n	
		• Generally: Items which are depicted in the Article 6 of the ITER Agreement		
I	IO-DG	• Project Baseline Document(s)	1	EPB
		• IROs to Project Baseline(s)	1	
		• Baseline Change Requests	1	
		• Reserve Fund allocation		
II	IO-DDG	• Project Baseline Document(s)	2	CCB-II
		• IROs to Project Baseline(s)	2	
		• Baseline Change Requests	2	
III	Various*	• Project Baseline Document(s)	3	CCB-III
		• IROs to Project Baseline(s)	3	
		• Baseline Change Requests	3	
		• PBS	1-n	
		• WBS	0-n	
		• Changes which do not impact the Project Baseline		Potentially affected Stakeholders
IV	Various*	• Ÿwithin the authority of a single organization, or organizational unit, with no impact on another organization, unit or system		Potentially affected Stakeholders

Today
Addressing Dynamic Complexity

- Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner.
  - Processes
  - **Change Control**

Decision Making Hierarchy

Control Level	Decision Authority	Topics for Decision Topics (Examples)	@ Level	To be Consulted
0	IC ASN	• Project Baseline Document(s)	0	STAC MAC
		• IROs to Project Baseline(s)	0	
		• Baseline Change Requests	0	
		• IO-OBS	1-n	
		• Generally: Items which are depicted in the Article 6 of the ITER Agreement		
I	IO-DG	• Project Baseline Document(s)	1	EPB
		• IROs to Project Baseline(s)	1	
		• Baseline Change Requests	1	
		• Reserve Fund allocation		
II	IO-DDG	• Project Baseline Document(s)	2	CCB-II
		• IROs to Project Baseline(s)	2	
		• Baseline Change Requests	2	
III	Various*	• Project Baseline Document(s)	3	CCB-III
		• IROs to Project Baseline(s)	3	
		• Baseline Change Requests	3	
		• PBS	1-n	
		• WBS	0-n	
		• Changes which do not impact the Project Baseline		Potentially affected Stakeholders

➡ **Hundreds of Change Requests have been processed and implemented**

Today
Addressing Dynamic Complexity

- Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner.
  - Processes
  - **Change Control**

Reserve Fund

- covers cost of IO-directed design/ scope changes post-March 2015
- 1.05 Billion EUR in the Updated Baseline
- at the discretion of the DG, subject to EPB consultation
- ~ 29% used so far/ in pipeline

Today
Addressing Dynamic Complexity

- Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner.
  - Processes
  - **Change Control**

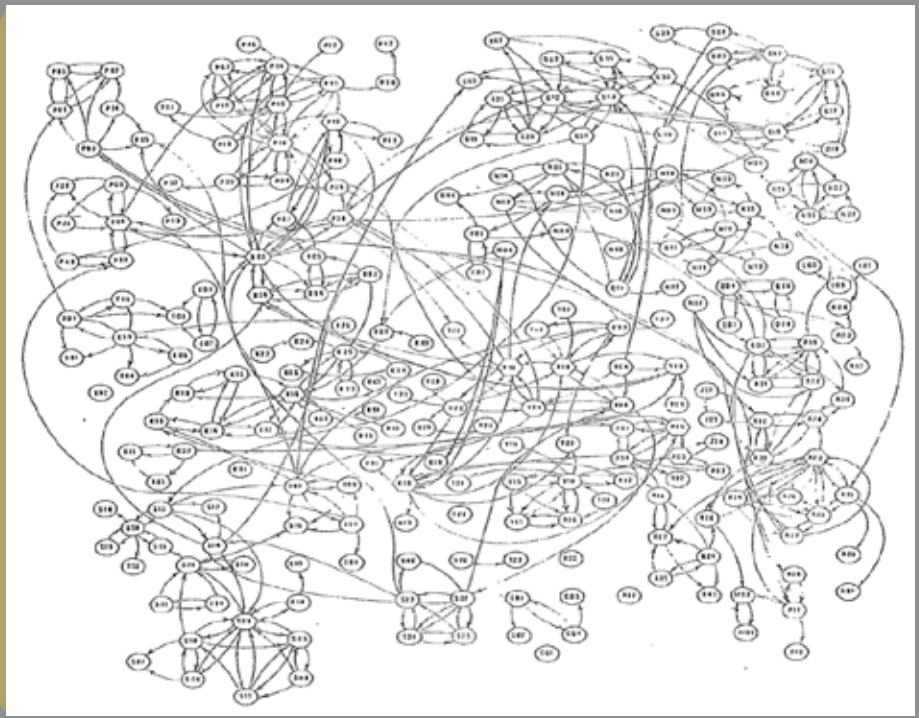
Reserve Fund

- covers cost of IO-directed design/ scope changes post-March 2015
- 1.05 Billion EUR in the Updated Baseline
- at the discretion of the DG, subject to EPB consultation
- ~ 29% used so far/ in pipeline

⇨ **Speed of decision-making has been substantially increased**

Today
Addressing Dynamic Complexity

- Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner.
  - Processes
  - Change Control
  - **Effective Communication**

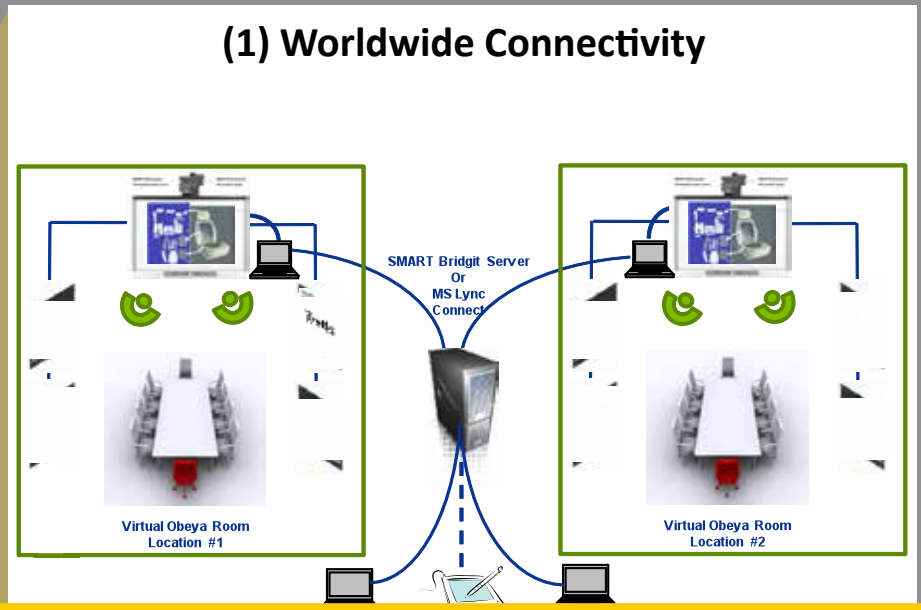


Today
Addressing Dynamic Complexity

- Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner.
  - Processes
  - Change Control
  - **Effective Communication**

Today
Addressing Dynamic Complexity

- Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner.
  - Processes
  - Change Control
  - **Effective Communication**

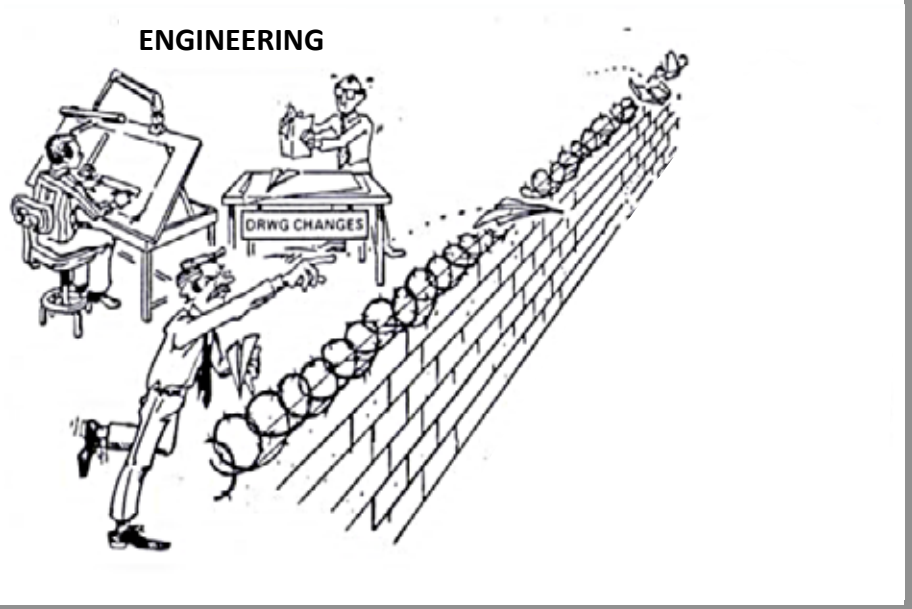


➡ **Videoconferencing intensively used as 2nd best way of communication**

Today
Addressing Dynamic Complexity

- Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner.
  - Processes
  - Change Control
  - **Effective Communication**

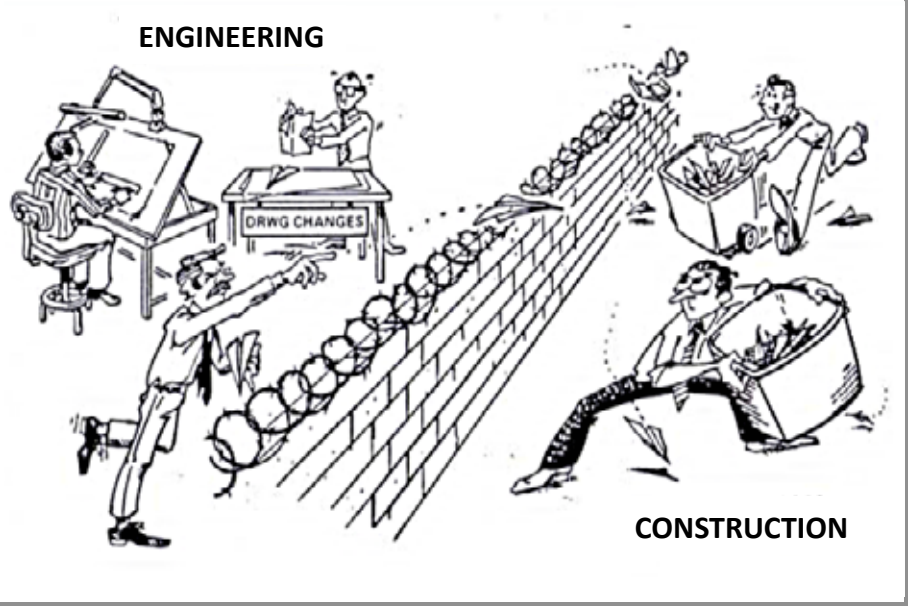
(2) Integrated Project Teams



Today
Addressing Dynamic Complexity

- Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner.
  - Processes
  - Change Control
  - **Effective Communication**

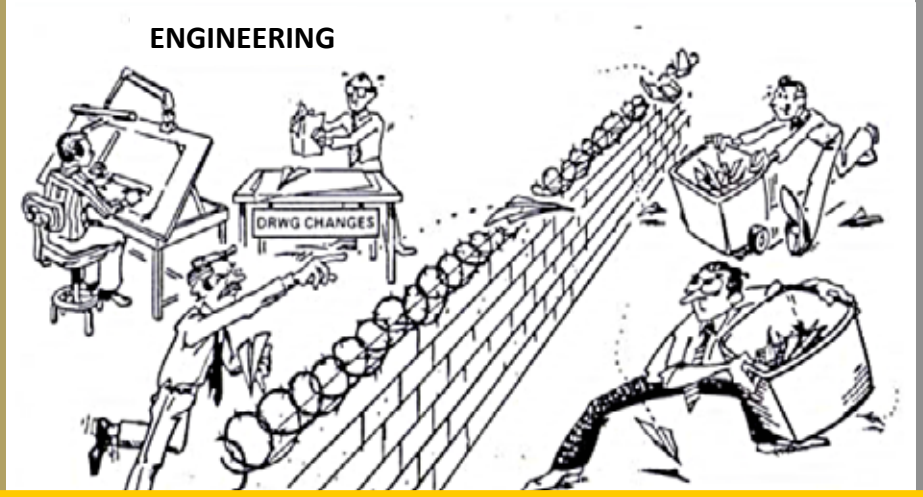
(2) Integrated Project Teams



Today
Addressing Dynamic Complexity

- Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner.
  - Processes
  - Change Control
  - **Effective Communication**

(2) Integrated Project Teams



➡ **PTs introduced for a variety of deliverables (VV, BIPS, Cryo, TBM)**

Today
Addressing Dynamic Complexity

- Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner.
  - Processes
  - Change Control
  - Effective Communication
  - **Competences of People**

(1) Experience-based People Selection

Today
Addressing Dynamic Complexity

- Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner.
  - Processes
  - Change Control
  - Effective Communication
  - **Competences of People**

(2) ITER Academy

Today
Addressing Dynamic Complexity

- Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner.
  - Processes
  - Change Control
  - Effective Communication
  - **Competences of People**

(3) Annual Performance Assessment

Today
Addressing Dynamic Complexity

- Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner.
  - Processes
  - Change Control
  - Effective Communication
  - Competences of People

Frequency of Change

Today
Addressing Dynamic Complexity

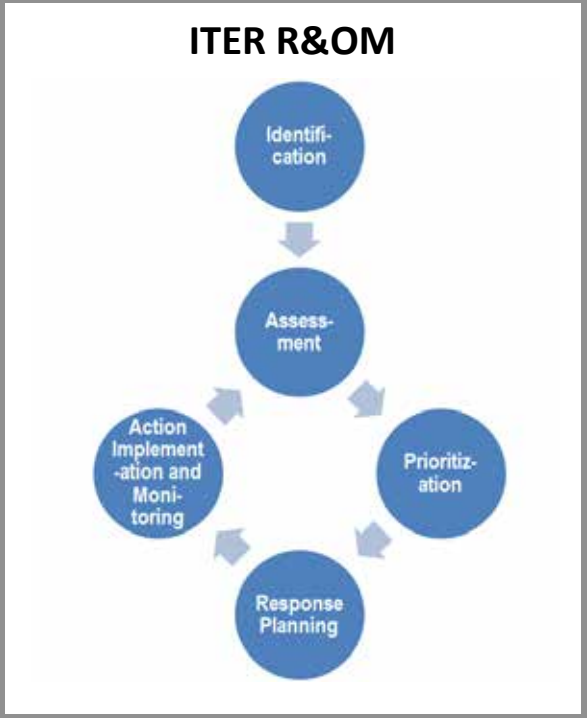
- Addressing Dynamic Complexity is all about responding to change in a controlled, yet agile manner.
  - Processes
  - Change Control
  - Effective Communication
  - Competences of People

➡ Effective Communication and People Competences vital for ITER

- ITER Project Complexity
- PM: Where do we come from?
- Addressing Structural Complexity
- Addressing Dynamic Complexity
- **Addressing Issues and Risks**
- Addressing Complexity holistically
- Summary

Today
Addressing Issues and Risks

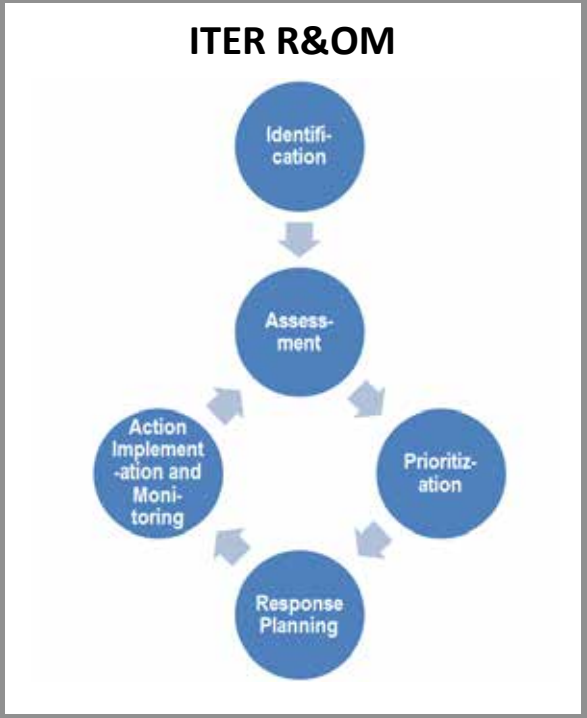
- ITER Project Baseline comes without any initial contingencies for cost and schedule
- The Project has to identify and generate opportunities to manage issues and risks



Today
Addressing Issues and Risks

- ITER Project Baseline comes without any initial contingencies for cost and schedule
- The Project has to identify and generate opportunities to manage issues and risks

→ **Holistic IRO Management**



Today
Addressing Issues and Risks

- ITER Project Baseline comes without any initial contingencies for cost and schedule
- The Project has to identify and generate opportunities to manage issues and risks

→ Holistic IRO Management

→ Professional, but classical approach

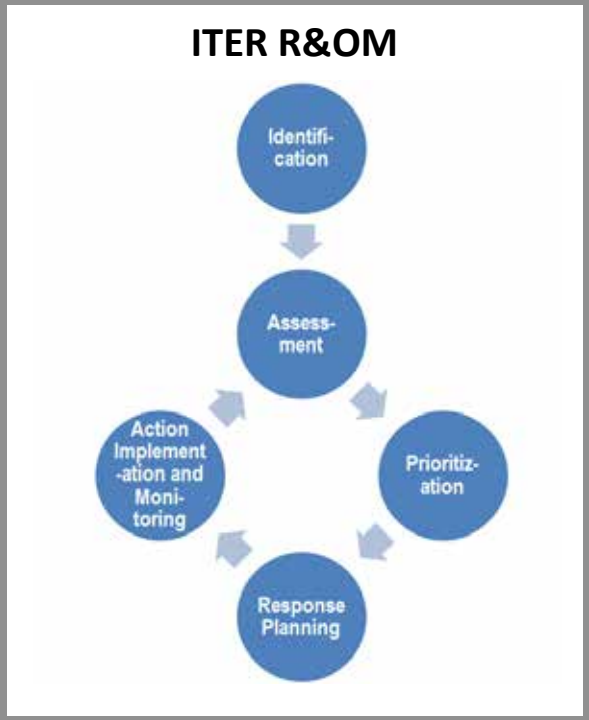


Table of Contents

Today
Systems Engineering and Design Integration

- CIO established to systematically implement
  - Systems Engineering (Design Control)
  - Configuration Management
  - Design Integration

  across the Project.
- Transversal functions, such as nuclear integration and functional analysis, have been clearly defined and systematically controlled since 2017
- Methods, processes, tools now are industry state-of-the-art

⇨ Implementation Plans defined and being executed

Today
Product Lifecycle Management (PLM) System

- Approval for introduction of PLM system in 2015
- Tool customization during 2016-2017
- Deployment of system kicked-off in 2017
- Initially used in support of Configuration Management

➡ **Backbone for managing technical data during ITER lifetime set up**

Today
Project Status Reporting

- Overall Project status periodically reported to EPB and IC, thereby providing the basis for recoveries and risk mitigations
- Typical status report includes:
  - Overall status of Project progress, including % complete
  - Status of High Level Project Milestones
  - Major risks and challenges
  - Earned Value Management indicators – SPI and CPI
  - KPIs for transversal process performance

⇨ A robust mechanism for monitoring and reporting is in place

Today
External Audits

- Since the Madia Report, ITER's capabilities to manage the Project professionally have been audited at a variety of occasions, with more audits yet to come:
  - Bi-annual Management Assessments (2015, 2017)
  - ICRG – 2016
  - Risk Management – April 2017
  - Interface Freeze – September 2017
  - Configuration Management – August 2018
- Strong US representation in external audits/ validations

➡ External Audits provided much support towards better PM/SE

Table of Contents

Summary
General

- Thanks to substantial improvements implemented since 2015, the ITER Project is under control – from a technical, cost and schedule perspective
- Deviations from baselines are constantly monitored and – where necessary – recovery or mitigation measures are implemented
- Project status is reported regularly in a transparent manner to EPB and IC
- Further evolutions in managing ITER are being implemented

Summary
General

- Thanks to substantial improvements implemented since 2015, the ITER Project is under control – from a technical, cost and schedule perspective
- Deviations from baselines are constantly monitored and – where necessary – recovery or mitigation measures are implemented
- Project status is reported regularly in a transparent manner to EPB and IC
- Further evolutions in managing ITER are being implemented

⇒ **Significant progress made, confirmed by external audits**

Summary
General

- Thanks to substantial improvements implemented since 2015, the ITER Project is under control – from a technical, cost and schedule perspective
- Deviations from baselines are constantly monitored and – where necessary – recovery or mitigation measures are implemented
- Project status is reported regularly in a transparent manner to EPB and IC
- Further evolutions in managing ITER are being implemented

⇨ Significant progress made, confirmed by external audits

⇨ But more work needed to reach full adequacy of capabilities

Summary
Nuclear Safety

- Enormous progress achieved by IO, together with the DAs, in persuading ASN (the local Nuclear Safety Regulator in France) to follow a flexible approach for regulating nuclear fusion versus fission without compromising safety requirements
- Demonstrating to ASN robustness of
  - propagation of safety requirements across distributed supply chain
  - compliance with requirements across supply chain
- Ongoing work with ASN to demonstrate safety of FOAK systems like detritiation systems

Summary
Nuclear Safety

- Enormous progress achieved by IO, together with the DAs, in persuading ASN (the local Nuclear Safety Regulator in France) to follow a flexible approach for regulating nuclear fusion versus fission without compromising safety requirements
- Demonstrating to ASN robustness of
  - propagation of safety requirements across distributed supply chain
  - compliance with requirements across supply chain
- Ongoing work with ASN to demonstrate safety of FOAK systems like detritiation systems

⇨ **ITER sets the scene for regulations in nuclear fusion**

Thank You!

www.iter.org