US contribution to

ITER Design Integration and Assembly

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US ITER Forum
University of Maryland
May 8-9, 2003

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What is Design Integration?

- **Design integration includes:**
  - coordination of physical and functional interfaces,
  - global analyses, such as neutronics, disruption modeling
  - preparation and dissemination of specifications, design criteria, standards, etc.
  - Integration and dissemination of CAD models
  - and so on

- This coordination is necessary on all projects, but is ***critical on a multi-institution, multi-discipline, multi-national project like ITER*.**

How would the US participate in ITER Design Integration?

- **During the CDA and EDA phases of ITER, the US team had an active involvement in design integration activities**

- Design integration roles in which the **US should consider re-involvement** include:
  - Global analyses
  - Codes and Standards
  - Materials Database and *Technology Database*
  - translation and dissemination of CAD models within the US and between the ITER central team and US home team.

Global Analyses

- **Neutronics analysis** *(R. Santoro, ORNL, was lead)*
  - **ITER is a nuclear device**, analysis must be integrated
  - **Of special importance for port mounted equipment like diagnostics, heating systems**, **test blanket modules** (where nuclear heating is critical and shielding function cannot be compromised by contents of port)

- **Transient electromagnetic (disruption) analyses**
  - Essential to safe, reliable operation of all in-vessel components
  - Requires multi-discipline approach, including plasma modeling, electromagnetic modeling, structural modeling

Standards and Design Criteria

- **ASME code**
  - ASME Section III, Division 1 not really set up for fusion
  - Division 4 of Section III, specifically for fusion, is in the works
  - US would logically be involved

- **Design Criteria** (*Saurin Majumdar, ANL was lead*)
  - This provides the rules for acceptance of stress and fatigue conditions for all components
  - Many conditions are outside standard codes, especially first wall, blankets, and superconducting magnets.

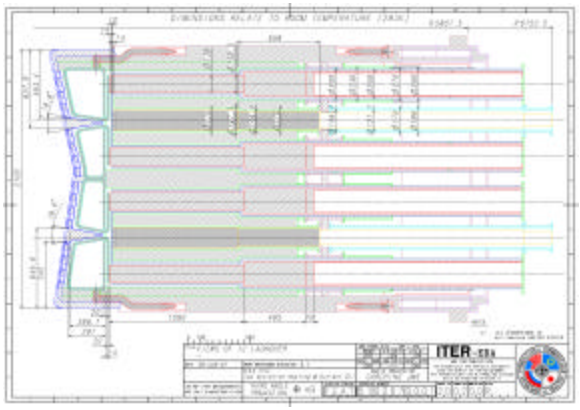
Materials and Technology Database

- **Materials database** *(John Davis, Boeing, was lead)*
  - Used as basis for all material properties during ITER design
  - Should be updated as new material data is acquired
  - Extremely useful for design team

- **Technology database**
  - New idea that would make new technology visible to ITER team and provide basis for qualification of new technology
  - Example is **friction stir welding**, a new technology that would allow “welding” of dispersion strengthened alloys like Glidcop, and possibly allow welding of highly irradiated materials (maybe fix leaks in components near plasma!)

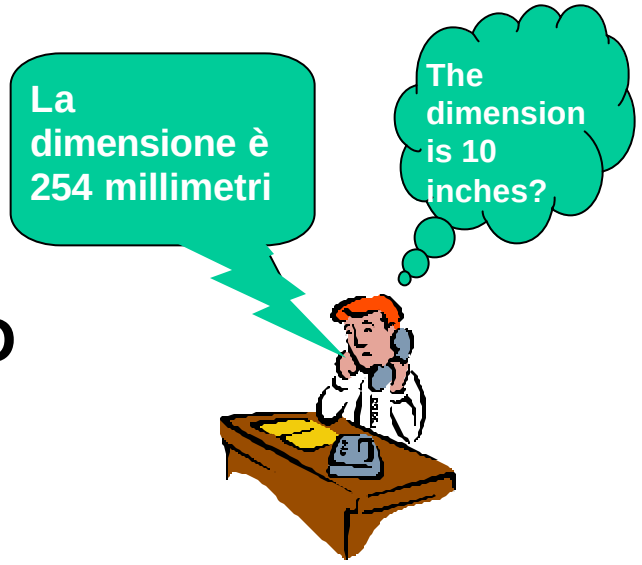
CAD database and interfaces

- **ITER has integrated CAD database**
  - All component designs must have appropriate CAD files included in database
  - All CAD data must be in CATIA format of appropriate version and file structure



- **Component designers must have access to ITER database for interface information**

- **May be most efficient to have single point contact with ITER CAD system for US team**



What about assembly?

- **During the CDA and EDA phases of ITER, the US team had an active involvement in assembly activities**
  - US developed assembly plan and specified large assembly tools during EDA (Stone and Webster)
  - US developed robotic welding equipment for vacuum vessel that could also be used for assembly (Boeing, ORNL)
- **Participation in assembly could offer involvement in task areas that may otherwise be precluded (e.g. vacuum vessel, blankets, first wall) and would provide valuable experience for future fusion devices (e.g. CTF, DEMO, etc)**
- **Assembly roles that the US should consider may include:**
  - Welding of the vacuum vessel sector to sector and port extension field joints
  - Initial blanket installation
  - In-vessel metrology

Automatic welding for assembly

- **Vessel assembly welding would be high-leverage area** for US team, since tools exist and have been tested on prototypical vacuum vessel sector-to-sector and port extension welds

Robot welding 40 mm VV wall, (both walls welded from plasma side)

Robot welding full scale port extension at JAERI

Summary

- **During the CDA and EDA phases of ITER, the US team had an active involvement in design integration and assembly activities, and should pursue a proportional role in these activities again.**

- **Design integration areas could include:**
  - Global analyses
  - Codes and Standards
  - Materials Database and *Technology Database*
  - Translation and dissemination of CAD models **(needed by all)**

- **Assembly activities (high leverage) could include:**
  - Vacuum vessel field joint welding
  - Blanket installation
  - In-vessel metrology