Summary

- Mission Systems design issues
- Collaborative engineering concepts
- Research activities
- Technologies
- An application case
Mission Systems Design

Mission Systems complexity is growing for several reasons:

- number of tools for all aspects involved
- articulated organizations
- very high level of integration of many disciplines
- time and planning constraints
- costs limitations
- complex products processes

This situation is therefore multidimensional and has to be carefully assessed to identify possible solutions
The situation presented requires the adoption of a sophisticated design environment and associated tools. Mission systems have complex lifecycle process supported by dedicated tools for each phase:

- requirement capture & traceability
- system design
- HW design & simulation
- SW design & simulation
- interfaces definition
- SW & system test definition, stimulation & acquisition
- configuration management
Moreover, complex systems are driven not only by product technical constraints but also by process quality aspects. This implies the adoption of tools to support other relevant aspects of the complete lifecycle from conception to full certification and in-service life such as:

- configuration management
- safety, reliability, maintainability and testability analysis
- procurement (e.g. supply chain management)
- logistic support analysis and deployment
- project management (e.g. planning and cost control)
- risk management

The adoption of enhanced toolsets has shown in several projects significant cost savings and reductions in the development timescale. One critical issue remains in the possibility to easily integrate the different products into a coherent process.
Mission Systems Design

Partners

DATA BASE

PRODUCT DATA MANAGER

CAD
CAM
other CAx

DATA BASE
DATA BASE
DATA BASE

Digital Mock Up Visualization

USERS

Web access

Human simulation

Space Allocation Mock-Up

Visual system

DMS

PDM

Web access
High level of integration is a key for product optimization and performance enhancement (e.g. sensors fusion) and implies very tight interconnections between different disciplines with respect to the final result.

This makes the traditional “sequential” design approach impracticable for the following reasons:

- decision taken at a single discipline level have great impacts on the other disciplines
- many interactions are needed to stabilize the project with acceptable results
- considerable rework during the initial phases
- late recovery actions may not be possible
- unacceptable time, cost and quality implications
Technical complexity is associated to organizational complexity in particular if tight and articulated international collaborations are in place and industries are continuously working within consortiums. The need to consider several different disciplines at each time has led to the constitution of “Integrated Project Teams” (IPT’s) which are essentially formed by group of experts working together.

This typical organization presents the following shortfalls:

- number of people involved
- different technical background and specific objectives
- different cultures and experiences
- different personal or company objectives
- different language
- different locations
To adequately approach the situation a different design methodology is necessary which makes use of:

- integrated multi-disciplinary tools
- automatic optimization tools
- standard interface protocols among different disciplines
- analysis tools
- a collaborative/concurrent engineering attitude

This will allow:

- a coherent and parallel product definition in all aspects
- access to the project evolution since initial phases to all involved disciplines

All the above is currently being pursued by the activities related to:

COLLABORATIVE ENVIRONMENTS & PLATFORMS
The situation described has become today applicable to all business and private activities, not only engineering. Therefore a number of commercial solution are already available since late ’90 and provide computer-based collaborative work solutions to meet the basic needs of institutions as:

- corporations, small and medium businesses
- local governments
- NGO’s and associations
- universities

These web-based collaborative workspace management platforms represent the “generic collaborative work tools” which are likely to become, in the future, as common as e-mails or office applications.
A number of different services are provided like:

**Synchronous functions**
- application sharing, virtual meetings and presence indicators
- voice and video recording, instant messaging and whiteboard
- online polls

**Asynchronous functions**
- online document creation, modification and deletion
- file version management
- company portal integration
- specific content distribution
- search engine

**Security**
- management of access rights, backup and recovery
Main uses for these commercial platforms are:

- **project workspaces**: to share and manage team project-related information in a single location for projects like IT, HR, R&D, events (exhibits, congress, etc.) and NGO teams.
- **publication workspaces**: to publish information on the web via conversion and visualization of documents generated with many different applications; possible uses are for virtual exhibits, HR and corporate information.
- **temporary workspaces**: to share large files for a short time.
- **knowledge workspaces**: to create knowledge management bases for organizations, coupled with other specialized tools.
- **training workspaces**: to support education related activities such as discussion forums, quiz, test results and courseware creation/distribution for schools, colleges, training centres, etc.
A complete exploitation of a collaborative engineering platform requires further steps from the basic commercial solutions and the effort is mainly related to tailoring the system to the specific applications. To achieve this, particular attention must be given to the peculiar characteristics of the project to be supported to obtain:

- multi-physical engineering platforms extended to embrace all disciplines
- adequate interfaces between disciplines
- capability to perform the required system analysis sharable among all participants to the project
- direct production of documentation
- use in all phases of the project (training, support, logistics, maintenance, commissioning, assembly, integration, test)
- knowledge management
The actuation of a collaborative environment implies also careful attention to the human factors and several social and psychological aspects have to be considered, such as:

- individual and team responsibility
- motivation and de-motivation
- pressure and stress (workload)
- cultural issues
- team-working attitude
- management, leadership and supervision
- training and education (e.g. for engineers with a multi-disciplinary culture)
Collaborative engineering concepts

Existing collaborative engineering solutions are like this.
Several research projects have addressed the issue of cooperative environments; some key ones are summarized here below.

**ARICON**

This project has examined the virtual Enterprises (VE) which are defined as: “... a temporary alliance of enterprises that come together to share skills or core competences and resources in order to better respond to business opportunities, and whose cooperation is supported by computer networks”

The objective is to define a methodology to assess, design and constitute successful cooperation in virtual industry and research enterprises for new product development.
ARICON (cont’d)

An ideal VE shall have the following attributes:

- temporary collaboration of several partners
- flexible coordination in dynamic networks
- contributing partners bringing complementary core competences
- coordination of partners enabled by ICT
- appears as one single enterprise
- participants shall have mutual trust
- members shall have equal positions and rights
- partners perform specific roles and tasks

and the following objectives:

- reduction of effort, cost and Time-to-Market
- increased know-how and flexibility
- increased and optimised utilization of capacity
- risk sharing
- increased quality
ARICON (cont’d)

The methodology is based on 2 methods of cooperation:

- **VALUE CHAIN** - characterised by a large enterprise willing to involve in their process their suppliers
- **PEER TO PEER** - formed by a group of SME’s belonging to a specific sector and/or having converging objectives

and on 6 investigation areas:

- organisations and process models
- business models and strategies
- legal issues
- information and communication technologies
- innovation and technology
- human issues
VIVACE

The Virtual Improvement through a Virtual Aeronautical Enterprise (VIVACE) is a research project under development in the context of the 6th Framework Programme of the European Community.

The project will develop advanced capabilities for a large collaboration hub for heterogeneous enterprises. VIVACE has the objective to strongly reduce the development cost of new aircraft and engines with the delivery of a Virtual Product Design and Validation Platform based on a distributed concurrent engineering methodology.

Activities are based on the results of the previous project ENHANCE, funded by the European Commission which helped to build a basic distributed concurrent engineering design environment in terms of standardized processes and tools.
The main expected result is an Aeronautical Collaborative Design and Simulation Environment based on a consolidated set of reference methods, processes and tools. This will be achieved progressing these 6 key themes:

- knowledge enabled engineering,
- multidisciplinary design and optimization
- design to decision objectives
- engineering data management
- distributed information systems
- collaboration hub for heterogeneous enterprises
INTUITION

The Network of Excellence on Virtual Reality and Virtual Environments applications for future workspaces (INTUITION) is developed in the context of the 6th Framework Programme of the European Community in the area of Information Society Technology.

The network objectives are:

- support the development of Virtual Reality (VR) and Virtual Environments (VE) technologies, their integration in different business processes, including aeronautical applications
- develop modularity concepts for VR and VE applications
- support the development and use of wireless technologies for e-work, e-training and other general interest services
One of the key facilitating technology for collaborative environments has been the introduction of Grid computing.

Grid computing can be defined as: “distributed computing across virtualized resources”. The goal is to create the illusion of a simple, large and powerful virtual computer out of connected and heterogeneous systems sharing various combinations of resources.

Grid computing makes computing pervasive and individual users can gain access to computing resources (processors, storage, data, applications, etc.) as needed with little or no knowledge of where those resources are located or what the underlying technologies, hardware, operating system are.

This virtualization is only achievable through the use of open standards to ensure that applications can transparently take advantage of whatever appropriate resources can be made available.
Technologies
Grid computing can be defined as a variety of levels of virtualization. The process starts from partitioning a machine into virtual machines and progressing into virtualizing similar or homogeneous resources, not only to servers and CPUs, but to storage, networks and applications. The following steps are to virtualize unlike resources to virtualize the entire enterprise, not just in a data center or a department, but across a distributed organization, and then, finally, virtualizing outside the enterprise (e.g. across internet), to access resources from a set of OEMs and their suppliers or you might integrate information across a network of collaborators.

Grid computing involves an evolving set of open standards for web services and interfaces that make services, or computing resources, available over the internet. The Open Grid Services Architecture is progressed by the Global Grid Forum.
The benefits of Grid computing are:

Grid computing enables organizations to take advantage of computing resources in ways not previously possible (e.g., running an existing application on a different machine). They can take advantage of under utilized resources to meet business requirements while minimizing additional costs.

The nature of a computing grid allows organizations to take advantage of parallel processing, making many applications financially feasible as well as allowing them to complete sooner.

Grid computing makes more resources available to more people and organizations while allowing those responsible for the IT infrastructure to enhance resource balancing, reliability and manageability.
One interesting outcome facilitated by Grid computing is the Access Grid (AG).

AG is an ensemble of resources including multimedia large format displays, presentation and interactive environments and interfaces to Grid middleware and to visualization environments.

It is used to support group-to-group interactions for large-scale distributed meetings, collaborative work sessions, seminars, lectures, tutorials and training.

There are over 3400 certified users across 47 countries which have AG nodes or “designed spaces” that contain high-end audio and visual technology.

Also Access Grid is an open source product developed by a web community.
Technologies

Components of an AG Node

- Digital Video
- Digital Audio
- NETWORK
- Display Computer
- Video Capture Computer
- Control Computer
- Audio Capture Computer
- Echo Canceller
- Mixer
- RGB Video
- NTSC Video
- Analog Audio
Technologies

Modelling and Simulation techniques are widely adopted and in order to provide immersive representations for the users, Virtual Reality (VR) applications are currently used.

VR provides detailed representations of the items under definition to facilitate common perception for all participants.

Installation and accessibility trials are performed. Virtual rigs are used to preliminarily assess.
Technologies

- desktop, immersive, and mobile virtual reality
- 3D object (remote) visualization
- multimodal interfaces
- virtual prototyping
- mixed and augmented reality
In the context of a Western Italy Network of Excellence among aerospace involved academia, industries and institutions aimed to improve the know-how transfer, it has been identified the need to realize a Collaborative Engineering system to achieve the following goals:

- improve the quality (effectiveness and efficiency) of products through improved interactions and better decision making
- “time-to-market” and related cost reduction
- support the effective implementation of concurrent engineering practices
- promote a cultural change on the territory capable to operate in this new environment
An application case

The initiative has then led to the following course of actions:

- development of mid-long term research projects in collaboration with the local scientific and industrial community (including small and medium industries)
- activation of collaborations with other research centres to participate to national and international research projects in conjunction with the main institutions
- exchange of existing competences, laboratories and tools
- maturation of modelling and simulation capability and experimental methodology through the development of technological demonstrators
- involvement of national and international experts
An application case

To achieve the assigned tasks, a system with the following characteristics have been proposed:

- **allow users to collaborate and share information in a distributed way**, this will permit to:
  - remove the need to have the experts in a single location
  - dynamically introduce services, resources and data in the system
  - relax the time and space constraints

- **allow users to interact both in real-time or deferred**, this second option allows a different work flow within the system and to have:
  - longer session than those possible today
  - users turn-over
  - involvement of experts everywhere in the world at any time
An application case

- allow users to have transparent access to heterogeneous data and services. This is possible with standardization and definition of the interfaces between modules through the possibility to:
  - add new modules and update the old ones respecting standards and interfaces
  - scale and adapt the system according to the needs
  - integrate and make available to the users, in a single context, services and information located in different places

- system based on open source technologies, with the following benefits:
  - different actors can contribute to modify and improve the system
  - better tempt new companies and industries to adopt it
  - GRID technologies are well suited to this system
An application case

The system is intended to be composed by a number of collaborative work-places that will be combined, depending on the needs, in virtual teams where one or more experts can perform collaborative working sessions.

Work-places can range from personal devices (e.g. PDA’s) up to clusters of work stations in multimedia theatres. Work-places are connected using modern network technologies (e.g. wireless or GRID).

Every work-place is implemented in accordance with the tasks (e.g. information/application sharing), role and location associated to its operations.
An application case

Some applications require the implementation of simulation and virtual reality techniques, in particular to allow the users to benefit of innovative interactive devices (e.g. multimodal for voice, video and images).

The system will be scalable depending on complexity and required response time, unavailability of suitable tools and connections, occasional experts participation.
An application case
THANK YOU for your attention

Questions?

contact:
Fausto Bruni
Alenia Aeronautica
fbruni@aeronautica.alenia.it