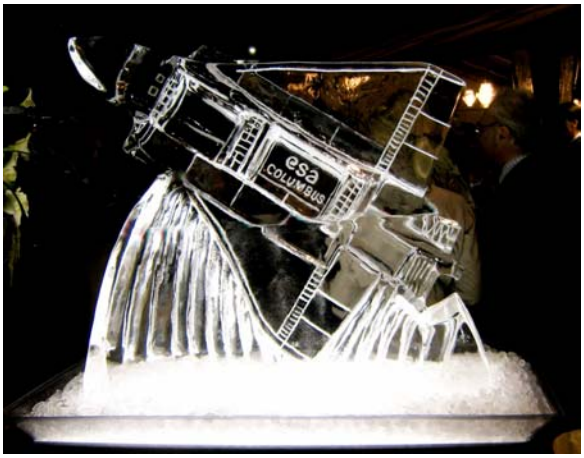
Columbus Launched, Finally!



Columbus "on the rocks"
After over 15 years of "hibernation"
Columbus rose to live on 7 February 2008.

The original launch date was set for 1992,
the 500th anniversary of Columbus` discovery.

The value of human spaceflight until now is unquestionable
And with Columbus' laboratory it will grow increasingly valuable.
Beyond the low Earth orbit
The future holds a further field,
That of explorations,
Of new worlds and destinations:
Initially to the Moon, Mars and Europa
Then to satellites and planets much further.
For there are many promises in the lands around us
Ice and water, stones and precious dust,
Like Helium-3, which will likely provide,
In future, clean and efficient energy might.
(*Excerpt from an Essay*)

Daniela Petrova
University College London, UK
ESA Columbus Essay Contest Winner
http://www.esa.int/esaHS/
SEMR5353R8F_education_0.htm

"**Col-CC is go**" – for those magic words the Columbus Control Center (Col-CC) within the German Space Operations Center (GSOC) had to wait for quite a while.

Almost 20 years to the day after the Columbus Program was approved by the ESA Council on Ministerial level at Rome in November 1987, STS-122 roared off into a clouded Florida afternoon sky on February 7th 20:45hr CET with the fully integrated European Columbus Laboratory on board.
What political turmoil and technical metamorphoses has this project gone through before reaching its final destination!

Columbus started as follow-on project to the successful German SpaceLab missions on a bilateral basis between Italy and Germany around 1983.

In 1985 – after the highly successful execution of Spacelab D-1 mission at the German Space Operations Control Center (GSOC) at DLR, acting as Remote Payload Operations Control Center (POCC), at Oberpfaffenhofen close to Munich, the "technology-enthusiastic" Bavarian Minister President Franz-Josef Strauss, supported by the German Government, provided approx. 25 Mio Euros as advanced contribution for the construction and outfitting of a DLR-Oberpfaffenhofen based control center for manned spaceflight (MSCC).
The projected launch date for the manned module was 1992, the 500th anniversary of Columbus´ historical voyage.

Soon it turned out that the Columbus project and its associated elements, at that time being called “In-orbit-Infrastructure” (IOI), was too ambitious for the two countries. Therefore it was proposed to ESA as a facultative (optional) project, i.e. member states could opt to join – in contrary to the ESA mandatory programs where each member state would have to participate according to its gross national product. ESA accepted with Germany picking up 38% of the cost.

Columbus Program (historical) Time Table

The highlighted **years** indicate decisive Columbus Project related ESA Council meetings on Ministerial level, i.e. all Research Ministers of the European countries participating in the Columbus Program were present and had to come to conclusions respecting the interest of their respective aerospace companies governed by the ESA geographical return regulations.

The **bold** mission names indicate GSOC´s experience/responsibility in human spaceflight operations.

1983	Nov	**First SpaceLab Mission** (**FSLP**), Remote Payload monitoring from GSOC (German Astronaut: Ulf Merbold)
1984	Jan	President Reagan`s proposal to built a permanently manned space station and invitation to join for international partners: ”…to participate in the development of a permanently manned space station and to do it within a decade”! The “original” Partners became: Canada, Europe and Japan.
1985	Jan	**ESA Council on Ministerial level at Rom**: The European Research Ministers accept the US Presidents` invitation. A Phase-B study on potential European contributions was initiated, consisting of: > Attached Laboratory > Free Flying Laboratory (man-tended free flyer - MTFF) > Co-orbiting Platforms (serviceable) > Polar Platform (serviceable), became later the ENVISAT project > Manned and unmanned Service Vehicles (HERMES)
1985	Jan	**German SpaceLab mission D-1**, The first “Remote Payload Operations Control Center” (POCC) ourside the US SpaceLab missions was established at GSOC (German Astronauts: R. Furrer, E. Messerschmidt)
1986	Jan	Challenger explosion – critical assessment of program management by NASA
1986	Sep	Space station baseline configuration: “Dual Keel”
1987	Nov	**ESA Council on Ministerial level at The Hague**: ESA established the European In-Orbit-Infrastructure as facultative program comprising the following elements. >.Columbus Attached Laboratory (previously Attached Laboratory), >.Columbus Free Flyer (previously MTFF) > Columbus Data Relay Satellite System (DRS) – two satellites >.HERMES and Ariane 5 and the associated Ground Segment (IOI GS) to operate the above

		elements, to be set up in Germany (Oberpfaffenhofen, Darmstadt) Italy, France as well as multiple decentralized Utilization Centers (User Support Operations Centers - USOs) as national contributions. Main contributors to the Columbus program were: Germany 38%, Italy 25%, and France 14%. The total estimated Columbus program cost amounted to 3.7 Mio€ (Ref.: ESA Council Resolution ESA/C-M/LXXX/Res1) The co-orbiting Platform was deleted.
1988	July	US President Reagan names the station “Freedom”
	Sep	ESA/NASA sign the Memorandum of Understanding (MoU) for space station Phases C/D&E
	Nov	Start of construction of the Columbus Control Center at DLR/Oberpfaffenhofen as an advanced national contribution to the ESA Columbus Program
1990	Nov	**ESA Council on Ministerial level at Munich**: Cutback of Station funding, postponement of the final decision on Columbus and Hermes.
1991	Early	European Industry submits a revalidated program proposal
	March	NASA downscales Station configuration: single truss, shorter US modules, fully outfitted and tested on the ground
	June	Completion of the Columbus Control Center
1992	March	D. Goldin was installed as new NASA Administrator (faster, cheaper, better) by G. Bush.
	July	After the development leading to a disintegration of the UdSSR, the new NASA Administrator D. Goldin visits Russia to explore the Russian potential. ESA cancels work on Hermes and Free Flyer due to budget limitations and heavy weight (Hermes) cost-overruns (both projects).
		MIR-92: First German Astronaut flying on the MIR station (K.-D. Flade)
1993	Feb	President Clinton requests a Space Station redesign to reduce cost, the ceiling being 21 billion Dollars
	June	US Congress defeats the termination of the Space Station Program by only one single vote (216:215)
	April	German SpaceLab mission **D-2**, used for Qualification of the new “Manned SpaceLaboratories Control Center (MCC) at DLR-Oberpfaffenhofen acting as mission responsible POCC (German Astronauts: H. Schlegel, U. Walter)
	Dec	On 7th Dec Al Gore and V. Chernomyrdin sign the US/Russian agreement to participate in Space Station, Russia terminates plans for a MIR-2 station and grants US Astronauts to visit the MIR station in regular intervals using the Shuttle (altogether 10 STS flights with 7 US Astronauts accumulating 979 days in space took place). International Partners invite Russia formally to participate as a new partner in the Station activities. Start of ISS-A (Alpha) Program, later renamed ISS
1994	Early	Further cost cuts by ESA: Columbus length reduced, study of implications of the ISS redesign, use of an Automated Transfer Vehicle (ATV) together with Ariane-5 for Station logistics and

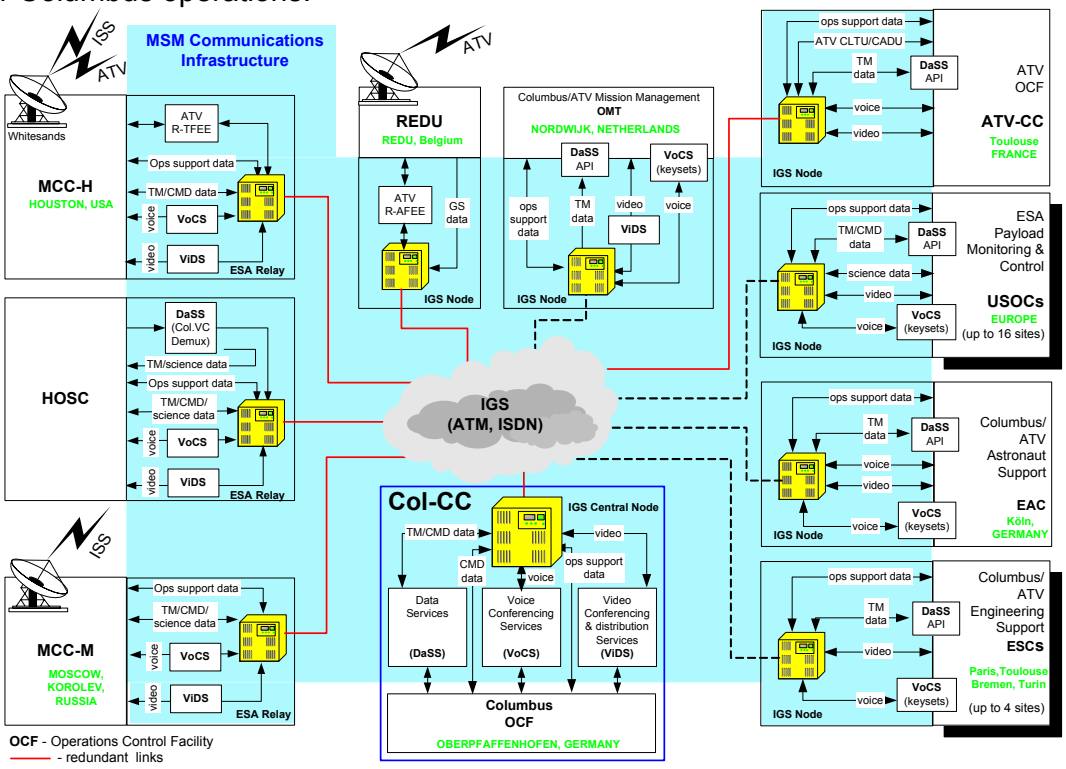
		decentralized operations from Europe for ESA elements (bulkhead approach approved)
	End	"Early" ESA Space Station contributions approved and development initiated: European Robotic Arm (ERA) for the Russian segment, Data Management System (DMS-R) for the Russian service module. In addition equipment for Utilization, the Pointing System Hexapod, Minus-80-degree-Freezer and Glove-box was agreed to be provided. Software Infrastructure for the US Software Verification Facility (SVF) and Environmental Control and Life Support System (ECLSS) for the Italian "Mini-", later: changed to "Multi"-Logistics Module (MPLM) was approved as well. The contributions were bartered with the Russian Space Agency RSA, NASA and the Italian Space Agency ASI.
1995	Sept	Launch of **EUROMIR95** operated from GSOC under ESA contract in preparation of Columbus operations (Thomas Reiter, 165 days in orbit, 2 EVA´s)
	Oct	**ESA Council on Ministerial level in Toulouse** finally approves ESA´s contributions to the ISS development program consisting of > Columbus Orbital Facility (COF), later became "Columbus" (Col), > Automated Transfer Vehicle (ATV), with Decentralized operations control centers at > DLR/Oberpfaffenhofen (Col-CC) and > CNES/Toulouse (ATV-CC) and the associated > Communications network (Interconnect Ground Network- IGS), > Crew Training Facilities (ESA Astronaut Training Center – EAC and > Engineering Support Centers (ESC´s) for the above elements > Multiple research facilities (User Support Operations Centers USOC´s)
1996	Early	ESA signs Columbus the Industrial development contract with DASA, later Astrium, now EADS.
1997	Oct	ESA/NASA barter agreement for all European ISS-contributions securing 8.3% of all ISS resources for European utilization.
	Nov	ESA/Japanese Space Agency barter agreement
		German **MIR-97** mission, controlled from GSOC (Astronaut: Reinhold Ewald)
1998	Jan	All participating countries and relevant Space Agencies sign the Intergovernmental Agreement (IGA)
	Nov	First ISS element launch (Zarya)
	Nov	ESA sings ATV Industrial development contract with Aerospatiale
	Nov	ESA signs the Col-CC Design, Development and Integration (DDI) contract with DLR. Formal assignment of operational responsibility to DLR/Col-CC
2001	March	On March 23rd the MIR station was de-orbited under ZUP control (MIR operations control center) after 15 years of useful lifetime
2003	Feb	Columbia accident
2004	Oct	Col-CC Inauguration
2006	Early	Formal acceptance and close-out of the Col-CC DDI contract
	June	Appointment of Industrial Operator (EADS) for Columbus operations

		phases
	July	**ASTROLAB** mission, 150 days long-term flight by Thomas Reiter on the ISS, controlled and co-ordinated by the Col-CC Flight Team at GSOC under ESA contract in preparation for Columbus operations
2007	6 Dec (Thur)	First Columbus Launch attempt, countdown halted because of 3 faulty Engine Cut-off Sensors (ECOs)
	8 Dec (Sat)	Second Launch attempt, halted again because of ECO problems
	10 Dec (Sun)	Third Launch attempt halted because ECO problems persist, the next launch attempt is set not before January 2nd 2008
2008	**7 Feb** 20:45 CET	**Launch of Columbus** and begin of the operational phase, planned for approx. 10 years of continuous operations

An unprecedented, new operations concept leading to expanded Col-CC responsibilities were introduced by the so-called “bulkhead” approach defined in 1994: It grants each Partner of the ISS program to be responsible for his own contributions, Col-CC therefore being responsible for Columbus system operations, including operations of the life-support systems and Astronaut support for all activities within the Columbus module including health support. This activity is closely supported by the ESA Astronaut Center (EAC) located at DLR Cologne.
The second main Col-CC responsibility is Payload operations co-ordination for up to sixteen decentralized User Support and Operations Centers (USOC) located throughout Europe.
The third responsibility is the facilitation (provision, operations and maintenance) of all European and transatlantic communications concerning Columbus operations, but not limited to Columbus, since part of Automated Transfer Vehicle (ATV) communications uses this Col-CC Ground Support Network (IGS) as well.

The following pictures shall illustrate the results of the Ground Segment development process.
The first picture shows the completed Col-CC building (status 1993), ready to be used for the execution of the SpaceLab D-2 mission.

The second picture gives an impression of the highly complex Columbus ground communications infrastructure (Interconnect Ground Subnet –IGS) as it will be used for Columbus operations.



Legend

MCC-H Mission Control Center Houston	VoCS Voice Control System
HOSC Huntsville Ops Support Center	ViDS Video Distribution System
MCC-M Mission Control Center Moskau	DaSS Data Servicing System
REDU Artemis Gounf Station at Redu Belgium	IGS Interconnect Ground Subnet
OMT Operations Management Team (ESTEC, Noordwijk)	TFEE Transfer Front End Equipment
IGS Interconnect Gound Network	AFEE
Col-CC Columbus Control Center	MSM (ESA) Manned Spaceflight and Microgravity
OCF Ops Control Facility	TM Telemetry Data
ATV-CC Automated Transfer Control Center (Toulouse)	CMD Command
USOC User Support and Ops Center (in 13 ESA Member States)	VC Virtual Channel
EAC European Astronaut Center (Cologne)	
ESCS Engineering Support Centers (Germany, France, Italy)	

The next step was the official Col-CC Inauguration on 19th Oct 2004 and formal acceptance by ESA.

From left: H. Pieterek (ESA), Prof Wittig (Head of DLR), Wiesheu (Bavarian Minister for Economics and Transport) J. Feustel-Buechl (ESA), Prof. Wittmann (Director GSOC, DLR) J. Kehr (DLR)

Picture curtesy of DLR

In total approximately **twenty** Columbus Control Center Phase-B design and development studies were conducted with changing industrial partners under ESA authority covering the time span between 1987 (Col-CC Concept) and the final Phase-B2X-Extension (completion of Ph-B) in 2002 (16 years).
The Col-CC Phase-C started in 2002 (Col-CC Design & Development contract signature) and ran in parallel with the Columbus Operations Preparation Phase contract. The CoFR (Columbus Flight Readiness) took place in 2007.

On October 13th 2007 the GSOC Columbus control team re-initiated an old Bavarian custom: before heading into critical phases of live people made processions to a nearby monastery to beg for fortunate outcomes.
Since Oberpfaffenhofen is located close to the world famous Benedictine monastery “Kloster Andechs”, the whole Columbus team made a day-long pilgrimage up to the “holy mountain” to be welcomed by Abbot Emeritus Odilo Lechner, donated a special ISS dedicated candle and received his blessings for a save return of the STS-122 crew.
As known, Christopher Columbus received similar, as history has proven successful support from the Spanish Church as well.

In summary two important observations concerning this long and sometimes thorny Columbus program development process should be noted:

Large scale International projects are not automatically financially “safe” because of the multi-national agreements, particularly when they are subject to dramatic cost overruns because of operational, technical and programmatic changes. Government agencies will invariably initiate cost reduction initiatives, in efforts to contain cost growth. This is especially true when that cost growth is criticized as resulting from requirements changes caused by programmatic redirection.

On the other hand some programmatic changes can secure the future of a major project like ISS. For example, the unexpected participation of Russia with its own resources and tremendous know-how secured the survival of the ISS, not only from the political and financial aspect, but also providing operational capabilities for transportation services while the Space Shuttle was unable to fly. However, the addition of yet another international partner in the ISS program would bring even more challenges for intergovernmental and programmatic agreements and technical complexities with additional interfaces to dissimilar flight and ground systems.

The final conclusion is exactly that complex system interfaces between agency-unique implementations cause both, financial and operational handicaps that endanger major programs. Within ESA, of course, past lessons of the benefits of commonality drove the consolidation of technical approaches for data exchange between the ESA member agencies. However, across the whole of ISS, the many industrial companies and mission facilities from all of the ISS Partners (US, European, Japanese, Canadian, Russian Space Agencies, and other smaller participants) introduced a lot of different data management approaches. Most of the main facilities had to deal with incoming interfaces from other agencies, each with their own technical peculiarities, and a resulting cost to convert the unique data formats into operationally usable information. The figure below from a NASA presentation at the SpaceOps 2004 conference illustrates the “worst case” scenario on the left side, and an idealized optimization on the right side. It is clear that the harmonized picture with common data exchange formats would result in reduced cost and a much more capable and manageable operations capability.

The goal of common data exchange formats will not likely be achieved in the ISS, because they need to be established at the outset of a program, in collaborations such as the “Consultative Committee for Space Data Systems” forum (CCSDS). The hope is that future programs, such as upcoming Lunar/Mars exploration programs, will learn from this experience and begin those collaboration efforts early in the formulation stage of the programs and projects. While the operational and science benefits of Columbus are just beginning to be achieved, longer range benefits can already be secured as we incorporate such lessons into the new programs under development. The legacy of Columbus is already reaching into the future, even at this early stage.

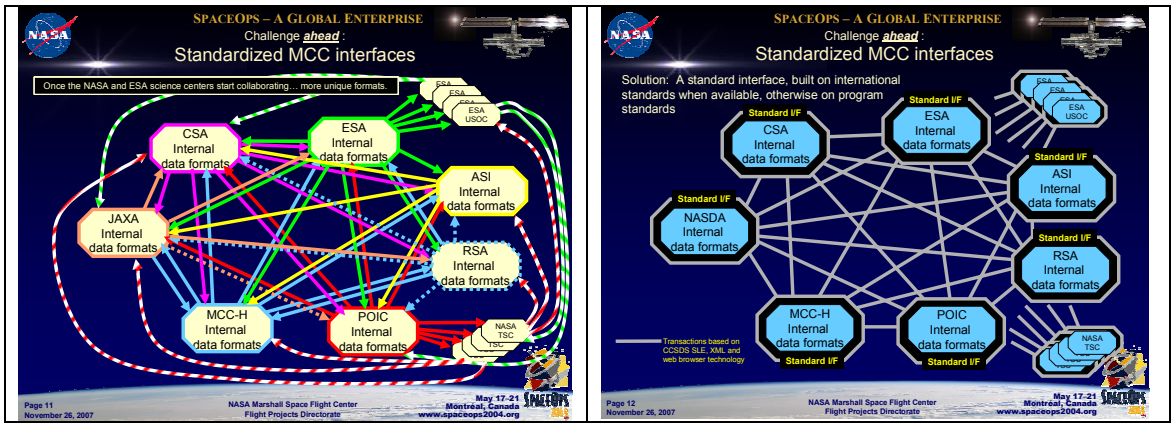


Illustration of the impact of agency-unique formats for operational data exchange in ISS, and the potential benefit of a common data exchange format (SpaceOps 2004 plenary, Mike Kearney, NASA MSFC).

Legend:

ESA European Space Agency	RSA Russian Space Agency
CSA Canadian Space Agency	ASI Italian Space Agency
JAXA Japanese Space Agency	MCC-H Mission Control Houston
POIC Payload Operations Integration Center	USC User Support Center
	USOC User Support and Ops Center

After the first Columbus launch attempts in Dec 2007 the ESA General Director, Jean-Jaques Dordain expressed during an official reception what many Columbus participants felt:
”I am proud of our Astronauts changing form “visitors” to becoming a key element of the ISS crew – now they are making dreams become true”.
Pointing out that with the Columbus hatch opening to the ISS Harmony node, ESA will also open doors for unprecedented scientific operations, meaning that ESA and the scientific community are going to harvest the fruits of 20 years of European investment.
This statement was proudly seconded by Bernardo Patti, Columbus Program Manager: “Columbus is the best module ever built by mankind”.

This enthusiasm about the nearly completed ISS was also expressed by Clay Anderson, NASA Astronaut speaking to ground controllers in Russia and the United States Nov. 3, 2007, his last day aboard the ISS after 152 days in space:

“What we are doing here is very important for all of humankind. It´s worth the risk, it´s worth the cost and you folks on the ground are the people who make it happen. So I want you to take pride in your work and constantly look toward the heavens, for it is there you will see your future.”

Jean Jaques Dordain of ESA said at a press-conference after the launch of Atlantis on February 7th: “Columbus has discovered a new world, and we will discover a new world with Columbus.”

Johann-Dietrich Wörner, Head of Chairmen, DLR offered his congratulations to Michael Griffin, NASA Administrator, for the successful launch of Altantis. Pointing out the significance of Columbus for Europe he said: “With this Shuttle launch the permanent presence of Europe at the ISS will begin. With Columbus the scientific possibilities on board of the ISS will gain a new quality. **The long-years efforts by European engineers and scientists have reached a further culmination point**.”

--…--

The links indicated below will show the two “nameplates” accounting for over 700 design- and operations engineers, many of them having spent their lifetime carrier to make Columbus become true. The two commemorative plates are mounted close to the hatch inside the Columbus module. The plates also show the indication of the nationality of the various engineers thus demonstrating the true Internationality of the European world-class Laboratory.

Columbus Module Built By European Engineers Link to nameplate-1 (A-L)	*Columbus Module Built By European Engineers* Link to nameplate-2 (L-Z)

Joachim J. Kehr Editor SpaceOps News