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Capability and Fair Return in European and International Space Cooperation

Dipl.-Jur.-Ing. Cristian Bank
Astrium Space Transportation, Postfach 286156, D-28361 Bremen
cristian.bank@astrium.eads.net
Prof. Dr. Lesley Jane Smith
Weber-Steinhaus & Smith, Baumwollbörse, D-28195 Bremen
ljsmith@barkhof.uni-bremen.de

ABSTRACT

With the successful launch of COLUMBUS and ATV, Europe has become a partner in the operations of the International Space Station: COLUMBUS provides a working space not only for European scientists, but also for the international partners; the European astronaut corps participates in the operation and utilization of the ISS. Payloads, spare parts, consumables for the entire ISS are delivered by ATV. By doing so, Europe has demonstrated a political will to participate in the peaceful, cooperative endeavour of human spaceflight, following the Intergovernmental Agreement (IGA) between the USA, Russia, Japan, Canada and Europe

Although Europe has acquired a certain competence level in the area of human spaceflight through its own assets, one key asset is still lacking a solution: the launch and return of its astronauts. So far, European astronauts depend upon being launched by the US Shuttle and the Russian Soyuz.
This makes utilization of COLUMBUS difficult in the long run. Europe needs to decide if crew transport should be part of its human spaceflight activities. Such capabilities could be acquired through cooperation with other space-faring nations. In 2004, Russia has expressed such an invitation to Europe to jointly develop a new generation of spacecraft to follow the Soyuz family, at that stage under the name of Kliper.
Cooperation of this kind would be governed by principles already applied for ISS, such as a "no exchange of funds" principle, leading to barter agreements rather than classical prime contractor – supplier contracts. Barter agreements are difficult to achieve, as the value of hardware development, services, engineering support, risk allocations etc. have to be agreed. Some lessons could be learned from previous projects such as ISS or Spacelab.

This presentation describes what are the challenges in elaborating a barter agreement for a crew transport vehicle from an industrial point of view – among them, the high frequency of deliveries, liability and risk issues, and most of all, the fair share in the utilization of the system. It also draws some conclusions from the ISS deals, again viewed from an industrial perspective.

1. INTRODUCTION

Through the combined efforts of the United States of America, Russia, Canada, Japan, and a number of European States, the International Space Station (ISS) will be assembled completely by late 2010. After more than 12 years of construction and utilization in parallel, the ISS will switch into a fully operational state.

These initial and subsequent steady state phase of operation and utilization were all agreed to by the signatories states to the legal framework of the ISS Intergovernmental Agreement (IGA), the bilateral Memoranda of Understanding (MoUs), and other side agreements such as the Astronaut's Code of Conduct (CoC) which were all negotiated and signed in the early 1990ies.

From a legal perspective, these international agreements have a dual nature: On the one hand, they clearly refer to the international space treaties of the 1960's and 70's on the other, they incorporate some elements of private law. They constitute a turning point in the concept of international space treaties.

Although the IGA and the MoUs are nowadays considered a contractual *sine qua non* for the formal conduct of the ISS programme and its control at highest political level, there are indisputable implications for industrial development of the programme. These could surface in the exploitation phase, resulting from e.g. delays, damages, warranty, and intellectual property issues. Given the complexity of the endeavour, not all of these effects can be anticipated, let alone avoided. Some of the observed effects are so substantial in terms of the financial, organizational, and technical implications that it is worth while identifying and analysing them to avoid similar results occurring in future cooperative space programmes.

One project requiring special attention and preparation in this respect is the Preparatory Phase for the Crew Space Transportation System (CSTS) to be performed jointly between Russia (represented by the Russian Space Agency RKA) and Europe (represented by the European Space Agency ESA)[1].

The main goal of the present paper is to highlight lessons learned in the contractual setup of the ISS which may serve for CSTS, concentrating in particular on the *industrial* implications of such regulations. Secondly, some emphasis is put on the identification of potential programmatic and organisational problems which may appear mainly in the development phase of CSTS.
These considerations may contribute to the preparation of the future agreements for the Development Phase of CSTS which is due for decision in November 2008.

2. THE EUROPEAN - RUSSIAN CSTS PROGRAMME INITIATIVE

CSTS today is the most prominent initiative of RKA and ESA that aims to identify and define a future cooperative space programme. It represents the first potential application of aspects and conclusions discussed within this paper.

2.1. Programme Initiative

The first initiative to cooperate in the development of a joint Euro-Russian crew transport vehicle was taken in 2003, when the Russian space systems company RSC Energia, Astrium Space Transportation, Bremen, Germany, and Thales Alenia Space Italy, Torino, conducted a joint study on a future space vehicle. RSC-E had developed a concept for an advanced space vehicle as successor for the Soyuz spacecraft, an idea dating back to the 1960s. The new spacecraft dubbed Kliper was intended to transport a crew of 6 astronauts to low Earth orbit (LEO), e.g. to the ISS, or to perform self-standing flights of some days with 2 professional pilots and 4 space tourists. The vehicle resembled Russian and US "lifting body" concepts of the 60s.

Based on this, a larger "Preparatory Programme for the Crew Space Transportation System" (CSTS) was initiated in 2006[2]. This programme encompassed both system study activities, as well as predevelopment of specific technologies. Some 14.7 M€ were invested by the governments of Belgium, France, Germany, Italy, the Netherlands, and Spain. Given their experience in Human Spaceflight (HSF), Thales-Alenia Space Italy and Astrium Space Transportation were selected to jointly lead the study.
Technical definitions for the vehicle aside, the elaboration of programmatic and organisational concepts for cooperation was a key issue to be tackled during the study which is to be concluded in January 2009.

2.2. Goals and Conditions of the Potential European-Russian Cooperation in CSTS

To identify open or potentially critical issues in the envisaged cooperation, it is important to understand the motivation of both sides in pursuing this programme. Geographical conditions impose constraints on the setup and conduct of the programme that in turn may give rise to implementation risks.

2.2.1. European Goals for Participating in CSTS

There are four main goals to be achieved for the European side in participating.
Firstly, the investment in COLUMBUS, ATV, the Nodes, Cupola, MPLM, ERA, payloads etc. have established a strong engineering and research community in industry and research institutes, as well as in ESA. With the end of the development phase of these programmes, the capabilities risk fading away if there is no follow-up activity in field of HSF. CSTS would be the natural successor programme for the European engineers.
Secondly, access for European astronauts to the ISS and in particular to COLUMBUS needs to be assured beyond 2013, when the current agreements on this come to an end. Europe assumes that, by participating in CSTS, it will obtain utilization rights – i.e. crew transport – in CSTS. Even if CSTS were only to become operative after 2016, the European hardware contributions to CSTS could be flight tested already

on Soyuz, and translate into crew transportation opportunities for European astronauts within that operational system before 2016.

Even though COLUMBUS, ATV and the other programmes have achieved recognized and well-established know-how in industry and research institutes, as well as in ESA, European competence in crew transport is lacking. CSTS should be the starting point for Europe for advancing the know-how in this area and building capability.

Last, but not least, although there is a well-established technology basis and engineering community in the area of HSF, the political support for HSF is not stable. As ISS related-activities have shown, an internationally anchored programme is much less vulnerable to being cancelled or de-scoped where political or public interest is dwindling.

2.2.2. Boundary Conditions for Inter-Agency CSTS Implementation

Among the conditions that influence the organisational and contractual backdrop to the CSTS programme, three aspects are the most decisive:

The participating agencies agree to a "no exchange of funds" approach, which leads to the need to barter or offset any contribution, either by a similar contribution from the other partner or through future utilization rights. This requires not only identifying comparable workshares, but also agreeing on a metrics to evaluate the contributions.

The successful launch of COLUMBUS and ATV, as well as the installation of Node 2 and the flawless operation of DMS-R, have led ESA to insist on a partnership among equals in the definition of the vehicle, its operation and utilization plans, and the sharing of system level engineering work. This has to be seen in the light of some 40 years of operation of Soyuz on the Russian side.

Finally one of the basic principles of how to install an industrial team in an ESA project has a strong impact on CSTS: the geo-return principle. This means that industrial contracts are placed in those countries which contribute financially to that programme and the value of the contracts corresponds to the financial share. The identification of the European workshare is not only determined by technical necessities, but also by georeturn constraints, which are even more difficult to achieve in a cooperative programme than in a purely European project.

3. Contractual Arrangements for European ISS Participation

In the past forty years, many practical solutions have been found by ESA to implement large space programmes within Europe taking into account the above or similar boundary conditions. The setup of an international programme necessitates to set up international agreements, which is not necessarily tailored to respond to inner-European considerations and agreements. One of the most prominent programmes which had to overcome such problems was the ISS, where Europe however only played a minor role. The European model for ISS participation needs to be assessed to see how far the solutions found for ISS are suitable as a model for CSTS.

The ISS is based both on general international space treaties as well as on ISS specific international and bilateral agreements.

3.1. General Legal Framework for the International Space Station

The ISS was developed with the major space treaties as the primary international instruments. As between the Registration and Liability Conventions and the Rescue Agreement, the REG has a particular role in relation to the registration of space objects. A "Space Object" encompasses components or parts of a space object, as well as its launch vehicle and parts thereof. REG was written at a time when only single satellites were launched into space. The ISS is, however, a space object assembled in space (not on Earth). The Russian elements are launched separately by individual launchers, and approach the ISS independently as individual spacecraft until they dock. At this stage they become part of the ISS. The US, Japanese, and European modules, as well as the other Canadian and US constituents (arm, truss etc.) are, in turn, launched by the US Space Shuttles and docked to the ISS only after the docking of the Shuttle to the ISS. As a result, these elements never become individual spacecraft, but are always either part of the US Shuttle or the ISS. This eliminates e.g. the risk of these elements leaving their foreseen trajectory and posing a risk to other spacecraft or the ISS.

It is evident that the content of these Conventions addresses risks given by the technical limitations and the spirit of the human spaceflight programmes of the late Sixties, such as Gemini, Soyuz and Apollo. For the ISS, conceived after introduction of the US Space Shuttle and following decades of successful operation of the Saljut, Almaz, Mir, and Skylab stations, these regulations were far from satisfactory. The new technical opportunities and the political goal to join forces in space following the end of the Cold War had to be reflected in new, specific treaties. Still, all ISS Agreements are connected to the main provisons of of these three Treaties.

3.2. Agreements Directly Applicable to European ISS Contribution

The specific legal framework of the International Space Station is based on two cornerstones in the form of international cooperation agreements. The first and key document on governmental level is the IGA from 1998. The second group of documents are the Agreements at agency level, which means a total of 4 Memoranda of Understanding (MoU) between NASA and each cooperating Agency (ESA, CSA, RKA, and JAXA).

3.2.1. ISS Intergovernmental Agreement (IGA)

As for a co-operative programme, the ISS IGA was signed by the Governments of Member States of the ESA, the Government of Japan, the Government of Canada, the Government of the Russian Federation, and the Government of the USA in January 1998. The IGA provides the framework for design, development, operation, and utilization of a permanently inhabited civil Space Station for peaceful purposes while maintaining a long-term and mutually beneficial relationship.

All partners join in their efforts under the lead role of the USA for overall management and coordination. Given their extensive experience in human space flight, the USA and Russia produce the main elements which serve as foundation of the ISS.[3] Canada is an essential part of the Station, because of its contributions, as well are the European Partners and Japan, who both enhance the Station's capability with their contributed elements.

Pursuant to this IGA, the ISS is to be developed, operated, and utilized in accordance with international law, including the Outer Space Treaty,[4] the Rescue Agreement[5], the Liability Convention[6], and the Registration Convention[7].
The following summary briefly reflects the most important points in the IGA:

Ownership of Elements and Equipment:
The Partners, acting through their Cooperating Agencies shall own the elements that they respectively provide. The rights and obligations of the Partners are not affected by transfer of ownership of elements or equipment, as long as it is not a transfer to a non-partner or private entity:, any equipment and elements are not to be owned by, or transferred to any non-Partner or private entity under the jurisdiction of a non-Partner, without the prior agreement of the other Partners.[8]

Utilization:
The rights of utilization are derived from the estimated value share of the total ISS value of each Partner's provision to the ISS, e.g. a user element, infrastructure elements, or both. Any Partner that provides ISS user elements shall retain use of those elements and obtains a similar share of the ISS resources, e.g. crew time, power, air, communication, etc. All Partners have the right to sell or barter any portion of their respective allocations, whereas all terms of conditions of any sale or barter determined on a case-by-case basis by transaction parties. (Barter is the exchange of goods or services for other products or services, crew transportation, resources etc.) In case one Partner is not able to provide a certain service (e.g. the launch of its element to the ISS), he can barter this service from another Partner in exchange of providing a to be determined product or service for that Partner. As an example, Europe did not pay for the launch of COLUMBUS, but provided elements to NASA.

Operation:
All Partners are responsible for their elements provided, as well as for sustaining the functional performance of their provided elements. All operation regulations are in accordance with all implementing arrangements and the MoU's.

Cross-Waiver of Liability:
The Cross-waiver of Liability (CWL) is to encourage participation in the exploration, exploitation and use of Outer Space through the ISS and it is important to establish it by the Partner States and the related entities. For any damage resulting from protected space operations, each

Partner State waives all claims against another Partner State, a related entity of another Partner State or the employees of any of the entities of another Partner State or related entity from this.
Furthermore each Partner is to extent that the CWL as mentioned above to its related entities by requiring them to waive all claims against another Partner State, a related entity of another Partner State or the employees of any of the entities mentioned before. Moreover each Partner require of its related entities that these waive all claims against another Partner State, against a related entity of another Partner State or the employees of any other Partner State or related entity of another Partner State. Both options are to be realized by contract or otherwise.
The CWL is not be applicable in claims between a Partner State and its related entity or between its own related entities, as well as claims made by a natural person, his or her estate, survivors or subrogates (except it's a Partner State) for bodily injury, or other impairment of health of, or death of such a natural person, plus claims for damage caused by willful misconduct, and claims for damage arising from a failure of a Partner State to extend the CWL to its related entities,.

Exchange of Data and Goods:
Each partner shall transfer all necessary technical data and goods to fulfill the responsibilities of their cooperating Agencies. At the same time, this shall not require any Partner State to transfer any technical data and goods in violation of its national laws and regulations. All partners shall provide the protection of technical data for the purpose of proprietary rights. In general, all Partner States and their Cooperating Agencies shall take all necessary steps to prevent unauthorized use, disclosure, retransfer of, or unauthorized access to, any kind of such technical data or goods.

Intellectual Property:
"Intellectual Property" shall include pursuant to Article 2 of the Convention establishing the World Intellectual Property Organization the rights relating to literary, artistic and scientific works, broadcasts, inventions in all fields of human endeavour, scientific discoveries, industrial design, trademarks, service marks, and commercial names and designations; protection against unfair competition; and all other rights resulting from intellectual activity in the industrial, scientific, literary or artistic field.[9] For any kind of activity occurring in or on a Space Station flight element, the purpose of intellectual property law shall be considered to have occurred only in the territory of a Partner State of that element's registry.[10]

3.2.2. MoU NASA - ESA

The MoU is a more detailed amendment to the higher ranking IGA, which provides interpretation of the responsibilities and the provided items of each participating agency and respectively their Governments. The purpose of this MoU is to establish arrangements between NASA and ESA implementing the provisions of the IGA, including the respective rights and obligations of each party. An MoU provides a good possibility to arrange some facts and regulations perfectly matched to each of the participating agencies.
Neither the MoU between NASA and ESA nor the MoU between NASA and RSA inform in a detailed way about handling cases of liability. Both MoU's refer again to the IGA and the Liability Convention which discusses damages caused by Space Objects.
Many other aspects of the above descibed IGA are defined in more detail in the bilateral MoU, the detailed discussion of which would however exceed the scope of this paper.

3.2.3. ISS Astronauts' CoC

The ISS Code of Conduct (CoC) defines the rules concerning the life and behaviour on the ISS. All ISS partners needed to find an appropriate balance between the military heritage of the USA and the Russian spaceflight programme and the civilian and multi-national character of the ISS. They approved the Astronauts' CoC on 15 September 2000 through the Multinational Coordination Board, the highest ISS coordination body.[11]
The CoC establishes a clear chain of command and relationship between ground and on-orbit management, responsibilities with respect to elements and equipment, standards of work, and disciplinary regulations, together with physical and information security guidelines.[12] Furthermore the Code has to define for the ISS the ISS Commander's authority and responsibility to enforce safety procedures, physical and information security and crew rescue procedures. The Agencies are interested to persuade the astronauts to abide by the rules outlined in the Code,

albeit on a voluntary basis, enabling them to pursue astronaut activities as employees of a Cooperating Agency.

Onboard the US Space Shuttle these matters are covered by regulations adopted under the authority of NASA. For crew members being launched or returned on a Russian space vehicle, specific Russian regulatory apply.

Legal requirements imposed on the ISS crew:
Primarily the provisions of the IGA, the MoU's and the ISS Flight Rules are directly applicable to astronauts' activities. The CoC applies to an ISS crew member from the time he or she is assigned to a specific ISS expedition until completion of post-flight activities.[13] It furthermore applies to visiting crew members, who stay just for a few days.[14]
All Crew members have the responsibility to protect and conserve all property to which they have access for ISS activities. Furthermore they don't have the permission of altering or removing such property for any other purposes than those necessary for the performance of the ISS duties.[15]
Moreover one of the main objectives of the Astronauts' CoC is to obtain the person's consent to be subject to the authority, direction and orders of the Commander, as well as to limit the disclosure of data which are protected, and to stop them from using their position or information obtained in the course of the mission for private or financial gain for himself or herself or other persons or entities.

Authority of the ISS Commander:
The ISS Commander can be any national of any Partner state, and he or she is the highest authority among the ISS crew members on-orbit. His task is to maintain a cohesive relationship among the ISS crew members which duly takes into account the international and multicultural nature of the crew. During on-orbit operations, the Commander is responsible for ensuring the safety of the ISS crewmembers and the protection of the ISS elements. Moreover he ensures the successful completion of the mission. He is directed by the Flight Director on ground. The ISS Commander is entitled to change the daily routine of the ISS crew members to address contingencies, perform urgent work associated with crew safety and the protection of the ISS elements, equipment or payload, or conduct critical flight operations.

Disciplinary Regulations:
All crewmembers are subject to a disciplinary policy, which was developed and revised by the MCOP (Multilateral Coordination Organisation Panel) and which is administrative in nature and intended to address violations of this CoC. However, this policy does not limit a Cooperating Agency's right to apply relevant laws, regulations, policies, and procedures to the ISS crewmembers it provided, consistent with the IGA and the MoUs. It shall be borne in mind that the IGA concerted that each State retains jurisdiction and control over personnel who are its nationals. Physical force or restraint may be used by the ISS Commander only when immediate safety is jeopardized for the crew and after exhaustion of other possibilities.

Proprietary and export controlled data generated in or on the ISS:
There is a need to protect data generated by activities conducted in or on the ISS when such data can be considered to be "proprietary" or "export-controlled". Under Article 19 IGA that protection of the corresponding data is linked to the fact that they are marked with an appropriate notice or otherwise identified. It is up to the Cooperating Agencies, the data owner, or provider to give instructions for the marking of data generated on board of the Station.

3.3. Implications for European ISS participation

Apart from the barter items such as Node 2 & 3, the Cupola, DMS-R, or MELFI, the main contributions of Europe to the ISS are COLUMBUS, ATV, and ERA. ERA is not be examined within this paper, as its operational role on the ISS still remains unclear. In contrast, COLUMBUS and ATV, as the two largest items under European design authority, are shortly to be introduced:

COLUMBUS was designed as a permanently docked general-purpose ISS laboratory to accommodate payloads in a pressurized environment.[16] It was constructed and developed by an industrial consortium under the lead of Astrium Space Transportation, and is the cornerstone of Europe's contribution to the ISS. Once COLUMBUS was attached to the ISS and checked, ESA became an active partner in the operations and utilization of the ISS. COLUMBUS is designed for ten years of operations, and will be controlled by the COLUMBUS Control Centre located near München. The laboratory fits into the cargo bay of a Space Shuttle and was pre-equipped with five internal racks during launch. It will be able to conduct experiments in life science, materials science, fluid physics, and a lot of other disciplines in orbit.[17]

The Barter Arrangements relating to COLUMBUS included a provision that NASA launch the COLUMBUS module and its initial payload on the Shuttle. This launch is barter in compensation for ESA's provisions to NASA of the fully integrated Node-2 and Node-3 ISS Modules, Cryogenic Freezer and Crew Refrigerator / Freezer equipment for ISS and spares and sustaining engineering for the Laboratory Support Equipment items.[18]
It also falls within ESA's provisions to NASA of hardware/support for software development and integration in the NASA ground software test and integration facilities for ISS.

Bartering for the COLUMBUS launch included at least two benefits for Europe: firstly, the risk of price uncertainties and cash payment to NASA was regulated through fixed conditions, secondly the creation of additional industrial work for Europe in high-technology domains.

ATV is the Automated Transfer Vehicle, which was developed in Europe for the supply of cargo to the ISS.[19] The ATV has acapability for carrying different kinds of freight to the stations in evacuated and/or pressurized containers, and is able to dock automatically to the ISS. The ATV provides delivery of dry and liquid cargo (e.g. experiments, foods, compressed air and water), refueling of the Station, which means the transport of propellant to the FGB, Reboost and attitude control during reboost of the whole station, i.e. orbit corrections using the ATV propulsion system to compensate for the continuous loss of altitude by the Station, and removal of waste from the Station followed by controlled destructive reentry of the ATV.[20] After completion of its mission, the vehicle will be brought on to a reentry trajectory which will cause the vehicle and its on-board disposable items to burn up in the Earth's atmosphere.

ATV is directly connected to the European COLUMBUS module because of ISS Common Operating Costs. The ATV provided the cargo which is used by the European ISS Partners as bartering for the utilization of the ISS with COLUMBUS. So far, the production of additional ATV's depends on the duration of use of COLUMBUS. The longer the ISS is operated as a whole, the longer COLUMBUS can be utilized by the Europeans. Under the agreement, Europeans must pay ISS Common Operation Costs to the United States for its use. To avoid price escalations, political changes and cash payment to the USA, the ESA pays with cargo transport through ATVs, so that this again is a barter deal. Until 2013, the ISS Operation Costs are bartered with a total of some 18t cargo transport. This is distributed to 5 ATVs. The capacity of cargo transport for one ATV is down to 9.5t, therefore each ATV has the capacity to transport some 5t for European purposes only.

Both programmes, COLUMBUS and ATV, after their successful development, launch and in-orbit operations, are now valuable contributions to the ISS. However, throughout the development phase and, to a certain extent even now, the legal arrangements contain some considerable risks for Europe, both for ESA and the industrial prime contractor. To mention a number of these issues:

Ownership of Hardware and Data

- COLUMBUS is registered as spacecraft by ESA, but first became part of the US Shuttle during launch, and later, after docking to Node 2, part of the ISS. It is doubtful whether, in case of a Shuttle launch failure and subsequent damage caused by COLUMBUS, there was a clear position in relation to ESA and NASA liability. The same consideration applies in case of damage by the ISS when reentering the atmosphere at the end of its lifetime (currently expected around 2020). It would be interesting to see whether, in such a case, the principle of "joint and several liability" does become applicable.
- The regulations about the "Exchange of Data and Goods" and the protection of IP between the industrial partners are anything but satisfactory for the European industry as against the US and Russian Primes. While industrial documents from the US and Russia are usually declared confidential and must not be disclosed to the international industrial partners by standard US and Rus-

sian domestic regulations, the Western European states have failed to install and enforce similar regulations. This is mainly due to the safety regulations which require all Partners to disclose their design documents to NASA and RKA for review, while NASA and RKA have no reason to disclose any of their design data to the Partners. The implementation of this regulation became even more stringent after Sept., 11, 2001. Practically, industry had to negotiate and install Non-Disclosure Agreements (NDA) on a very detailed level.

- Similarly, the fact that scientific and engineering data needs to be transmitted through the US data relay network [21] casts doubt as to confidentiality of the data, particularly when industry and research institutes consider using COLUBUS for non-public research. Even worse, in case of internal encryption, the key must be disclosed to NASA. The regulations in the IGA and the CoC are unfortunately weak – the data owner needs to be pro-active in declaring the data confidential, otherwise protection is difficult to maintain.

COLUMBUS Utilization

- One positive result of the regulations on utilization is the compatibility of all experiment installations in the Western modules (Destiny, COLUMBUS, Kibo) with the International Standard Payload Racks (ISPR), which makes them exchangeable.
- After experiencing the transfer of ownership of Spacelab to NASA after the first flight[22] in the 1980's, the fact that Europe keeps ownership of COLUMBUS and NASA gets 46.7% of the COLUMBUS research capacity may be considered a step forward. The limited research capacity and storage volume is theoretically a drawback for Europe. (It is questionable whether the contributions to the ISS by the international partners was – and could be - correctly evaluated at the beginning of the endeavour.) For the time being it appears that these constraints have been handled very flexible by the partners, but it remains to be seen if that still is true when the ISS starts to get crowded by stored spares and payloads.
- The fact that NASA payloads will be installed in COLUMBUS required the inclusion of the US Payload LAN and specific TM/TC avionics. This caused late definition of interface data, late changes and additional compatibility tests with schedule and cost impact on industry. As there was no direct contractual relation between the industrial consortia, these changes could only be introduced by a complex and painstaking process governed by the Agencies.
- Outside of the IGA and MoU, but part of the same discussion: A lot of effort was spent by ESA to obtain early access to the research capacity of the ISS: ESA provided experimental and system hardware to Russia and the US in exchange for ISS crew time and resources. Unfortunately, mainly due to delays in the ISS launch manifest and malfunctions, only few flight opportunities and crew time - which means research opportunities for European scientists & industry - was received in return or was provided very much later than originally foreseen.
- The most prominent "late delivery" of a bartered service was the launch of COLUMBUS: originally foreseen for 2002, it slipped considerably due to Shuttle launch manifest delays, which resulted in loss of research time or even "brain drain" within the European research community, additional costs for ESA and industry, late start of P/L development activities, while all along the bartering costs for Europe had been incurred much earlier. The legal construction did not foresee any offset for this kind of delay. On the other hand, payment in cash of the launch service would have been very costly for Europe and would have meant a loss of workload for the European industry.

ISS & COLUMBUS Operations

- The international agreements state that NASA & RKA operate the ISS, while ESA only contributes. This is a clear distinction in the roles of the International Partners. While this may have had

good reasons in the early 1990's, a similar distinction in the future would hardly be acceptable for Europe, given the experience meanwhile obtained in the meantime in Human Spaceflight. Such a distinction also has consequences for industry, as was shown in the COLUMBUS programme: not only that certain work packages would again not be accessible for the European industry, but also fundamental system operations principles could be taken into account only late in the design process, which would results in additional design and schedule risks.
- The Joint System Ops Panel with experts from each agency allowed the exchange of lessons learned and early coordination of P/Ls and experiments.

COLUMBUS Design
- While it makes sense that NASA provides the overall ISS specification, safety regulations, the launch manifest etc., there is an unavoidable impact on the assessment of the associated costs for the European industry by late changes or, even worse, late definition after contract signature within Europe, impact on milestone and review planning, etc.
- Even if safety regulations, test specifications etc. are defined, there is always room for interpretation. It is doubtful whether this interpretation was always the same for each of the International Partners.

ISS Code of Conduct
A definitely positive regulation was established with the CoC:
- the clearly defined hierarchy and roles within the ISS crew,
- the discussion of the use of force (even if the conditions remain somewhat vague), and
- the openness of any role to any nationality (onboard Soyuz / Shuttle there is always a Russian / US commander)

make the CoC certainly one of the most balanced of all ISS related agreements.

4. Identification of Potential Problems and Open Issues in CSTS

As discussed in the previous chapter, the international regulations governing the cooperation on the ISS have produced some innovative legal constructions, yet they have left some points open. The agreements address specifically those issues which could have been foreseen at the early 1990's as typical situations when operating an all-prototype, multi-national, permanently operated, revolutionary in-orbit research facility. CSTS would generate a completely different development and utilization scenario, as it is a series production type, evolutionary, bi-national vehicle which will see short missions and frequent launches. It is obvious that such a system requires an additional regulatory framework between Russia and Europe, the former has already achieved decades of successful manned spacecraft operation, while the latter is striving to obtain this capability.
The following paragraphs name but a few of these specific questions pertinent to CSTS that are already surfacing at the beginning of the development phase:

Relation of Contractual Situation between the industrial partners
- There must be a Technical Exchange Agreement put in place before the start of the next phase for a save transfer of information on technology employed as well as know-how, dealing with intellectual property rights, licensing of existing and protected IP if needed for CSTS as well as those IP generated in the programme. Also, clear directions concerning the transfer of Property and Possession respectively transfers of Ownership and Security Rights (see below CSTS vehicle) need to be formulated.
- Regarding the Exchange of Goods, Services, and Information encompassing the main products of the programme, it is understood that an up-front clarification of the general "payment" approach (e.g. bartering) should take place at agency level. However, industry and agencies need to agree on a "second level" approach and processing of direct B2B solutions for additional engineering support or maintenance, supply of attrition, spares or so-called "forgotten

items", commercial products, etc. at short notice.
- Furthermore, there should be an explicit position elaborated between both industrial partners related to liability (e.g. product liability, risk sharing...), in relation to the roles of ESA and RKA (defined conditions for share of risk, encompassing financial and liability risks). As NASA is doing more work itself than RKA, which involves more industry for performing review work etc., there is a higher risk for European industry when disclosing proprietary data to RKA.

Metrics to evaluate the values of each product and service
- It is necessary to clarify the value of each individual product, the integrated element, and any service. Therefore it is important to develop metrics or a method of evaluation. Each contribution to the jointly developed system should be evaluated and added up to determine its contribution to the overall value, and to deduce thereafter the corresponding utilization rights.
- This process needs to be consistent throughout the system's lifetime and allow for continuous update as a means of reflecting future evolutions, updates, add-ons, changes in workshare, etc.
- Any additional effort by one party resulting from requirements and interface changes with the other party during the development phase needs to be addressed, esp. liability and compensation (e.g. by utilization rights);
- As an operational transportation system, the launch & operations costs of CSTS are a significant part of the overall value and need to be assessed and fixed for a long time in advance, also cost escalation mechanisms need to be agreed.

Ownership of CSTS vehicle, elements, and equipment
- It is a major issue to align ownership of the CSTS vehicle and its elements when combining the elements to a full vehicle during the integration and test phase in order to allocate liability between the industrial partners. (note: Ownership is one key aspect which also governs all issues of registration and thereafter liability at international level., This aspect is, however, assumed to be regulated at agency level).
- Moreover, the basis of industrial claims relating to the following remain to be clarified:
    - Participation in intellectual property rights (IPR) & know-how obtained during the programme;
    - Handling of IPR relating to vehicle design;
    - Handover of IPR in case of withdrawal of one partner from the programme to allow the other partner to build and operate the system.

Identification of Settlement Procedures
- It is unlikely that, even with the utmost care, preparation and negotiation, all eventualities that may appear throughout the development, verification, and operation of the system can be fully clarified. It is therefore vital to set up bodies and procedures which allow for settlement of political issues. Any uncertainty may result in a considerable risk or even cost-impact on the partners. On the other hand, clear decision authority and responsibility for the product must be defined and allocated to industry.

Operation and Utilization
- A more detailed discussion about both the joint operation and utilization of the system as well as the related liability issues should be done between all governmental and industrial partners involved in the next phase of the programme. This is a critical point for industry, as it addresses e.g. the compatibility with more than one launcher, as the option to use the system for purely European missions requires a clear settlement of this issue.

5. Evaluation of the ISS Legal Framework with Respect to CSTS

In the light of the above discussion, there are indeed regulations developed for the "all-prototype" permanently operated orbital research facility ISS which could serve as blueprint for CSTS. Some questions specifically relating to the development, operation, and utilization of a quasi series production evolutionary crew transportation system require new answers.

Suitable regulations to be transferred from ISS to CSTS for adaptation and application could encompass

- the CoC with its definition of crew roles, tasks distribution, and conduct;
- the IGA/MoU regulations about bartering, safety, and operations coordination.

Regulations which seem to need review before being applied to CSTS are e.g.

- the IGA / MoU regulations about ownership of the system's constituents, launch, utilization rights, and data confidentiality.

The ISS Cross Waiver of Liability may have been suitable as a very special way of dealing with potential damages for ISS purposes, but whether all or part of it can be applied to a crew transportation system the purpose, operational mode and hence risk structure of which differs greatly from the ISS, requires thorough analysis.

Regulations to improve the direct interaction between the industrial partners, especially for interface definition and in critical phases of the programme such as specification, integration and test, are definitely missing from within the ISS framework.

All in all, the balance of bartering is positive, because it helps to substantiate cooperation at an early stage of programme definition. A barter arrangement avoids the risk of changing political and economic conditions, as well as the risk factor of scheduling problems. The allocation of additional work to the European industry was a huge support for the barter arrangements: this supported the spirit of partnership in the global environment of the ISS. Bartering has had an advantage, especially for ESA, in those cases where a barter arrangement avoided cash payments to non-Member States and instead permitted that money to be invested in contracts with European industry. On the other hand, some barter agreements causing considerable costs suffered from late or modified fulfillment.

6. SUMMARY

This paper has reviewed some of the industrial implications of the intergovernmental regulations governing the ISS. It also highlighted some open legal issues emerging at this early stage of discussion for the potential future cooperative project CSTS. It is evident that the regulations put in place in some instances for ISS resulted in implementation risks for industry. These are far from being suitable to serve as a blueprint for future cooperative space projects. This is particularly true when the cooperation encompasses not only operation and utilization, but the continuous production and launch of elements. Such shortcomings require significant work in the legal domain over the coming years, in particular with a view to the plans for Lunar exploration programmes. As the ISS experience has shown, it is highly recommended to perform this exercise in close cooperation with industry with a view to subsequent programme implementation. This is the best way of averting industry exposure to risks which are avoidable through proper preparation.

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[1] ESA CSTS Programme Declaration, 2006
[2] ESA IPC Paper on CSTS, 2006
[3] ISS IGA, Article 1.2.
[4] Treaty on Principals Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (3 Dec. 1968).
[5] Agreement on the Rescue of Astronauts, the Return of Astronauts, and the Return of Objects Launched into Outer Space (10 Oct. 1967).
[6] Convention on International Liability for Damage caused by Space Objects (1 Sept. 1972).
[7] Convention on Registration of Objects launched into Outer Space (15 Sept. 1976).
[8] ISS IGA, Article 6.3. / 6.4. and subsequent articles.
[9] http://www.wipo.int/treaties/en/convention/trtdocs_wo029.html#P50_1504 (Convention establishing the World Intellectual Property Organization, 1967, § 2.8.).
[10] Ibid. IGA, Article 21.2.
[11] http://portal.unesco.org/shs/en/files/8480/11224719601Farand.pdf/Farand.pdf, Seite 1/ Article 11 MoU.
[12] http://www.esa.int/esapub/bulletin/bullet105/bul105_6.pdf, pages 64 ff./ Article 11.6. MoU.
[13] Astronauts' CoC (hereinafter CoC), Article II.A.
[14] http://www.esa.int/esapub/bulletin/bullet105/bul105_6.pdf, p. 65.
[15] Ibid. CoC, Article II.B and subsequent articles.
[16] Messerschmidt, E./ Bertrand, R., Space Stations, 13.2.2, 480.
[17] http://www.esa.int/esaHS/ESAAYI0VMOC_iss_0.html
[18] http://www.nasa.gov/centers/johnson/news/releases/1996_1998/97-36.html
[19] Messerschmidt, E./ Bertrand, R., id. 12.1.3, 425.
[20] Messerschmidt, E./ Bertrand, R., Space Stations, id. 12.1.3. 426.
[21] Due to the deletion of the COLUMBUS Data Relay Terminal in the 1996 baseline development contract.
[22] The European Spacelab was considered an in kind contribution to the „US National Space Transportation System". The "utilization rights" were limited to one joint ESA-NASA mission.