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INTEGRATION OF TRANSPORT AND HANDLING EQUIPMENT AT CERN – CRITERIA TO SATISFY OPERATIONAL NEEDS AND SAFETY ASPECTS

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Abstract

Within the last four years TS-IC-HM (former ST-HM group) integrated about 150 transport and handling supplies including 29 cranes, 20 fork lift trucks, 60 tunnel vehicles. Most of these are standardised supplies, but very often special functionality has been implemented and the complexity of the equipment has been increased. With the Rocla cryo-dipol transporters even prototype equipment was integrated that had been specially designed for CERN. This paper discusses the differences regarding the actions that have to be performed when the different kind of equipment have to be integrated.

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1 INTRODUCTION

The installation of nearly every new accelerator and experiment at CERN makes it necessary to purchase new transport and handling equipment. Most of these can be considered as more or less standard equipment and can be found on the market as existing products. When transport operations have to be realized under very special conditions due to technical aspects of the transport goods and/or the environmental conditions of CERN, the transport and handling equipment have to be specially designed. The whole logistics of the 35 tons heavy weight cryo-dipoles of the LHC for example will be realized by 6 different types of transport and handling equipment that are technically high-end products and specially designed for their purpose.

In order to assure high operability and safety of technical equipment the CERN put in place general services for operation, maintenance and safety. Special rules exist describing the responsibilities for the staff owning technical equipment. Every new equipment has to be integrated into this environment. It is clear that the organization is generally prepared to integrate standard equipment. The more special the equipment is the more energy and resources have to be considered for its proper integration at CERN.

In the following it will be analysed what aspects have to be kept in mind when integrating transport and handling equipment at CERN. What is different in the integration of standard equipment compared to prototype equipment? For this first "integration" it will be discussed and success factors for the integration process will be defined. Next it will be worked out in which way the integration of standard transport and handling equipment fulfils these criteria. The results will be taken as a benchmark for comparison with the integration process of the prototype equipment. This approach allows to show up the differences and to define "hot spots" – important aspects that are essential for the successful integration of transport and handling equipment at CERN. Based on the gained results a proposal will be done for organising future prototype integration processes at CERN.

2 THE INTEGRATION PROCESS

2.1 General aspects and definition

The output and result of the integration of transport and handling equipment is a high level of operability and safety. Basic work for integration starts defining the technical specification and realising the equipment production. Practically the integration process starts with the hand-over of the equipment to the CERN users after reception. In the following this mentioned integration phase is discussed.

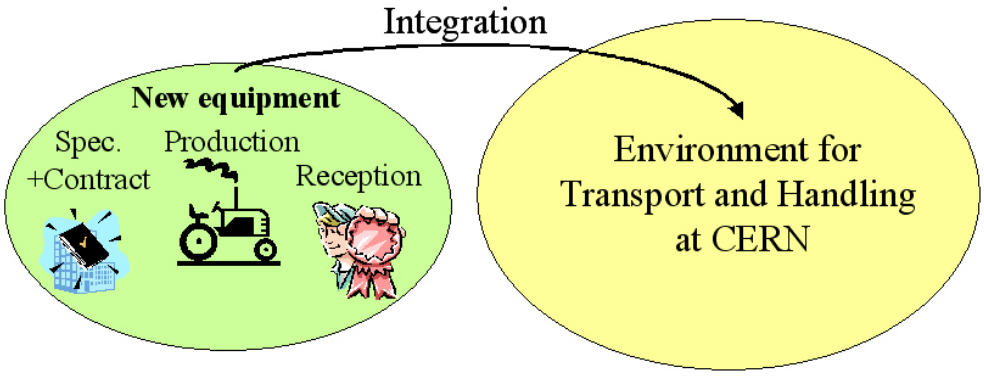


Figure 1: Integration of a new equipment

Definition of "Integration" (Webster Dictionary): "The act of (re)making whole or entire." In the sense of this definition, integration is the implementation of a new element into an existing system. The "whole" is in our case the environment at CERN, mainly defined by the organisation and functioning of ownership, safety, operation and maintenance (see Figure 2).

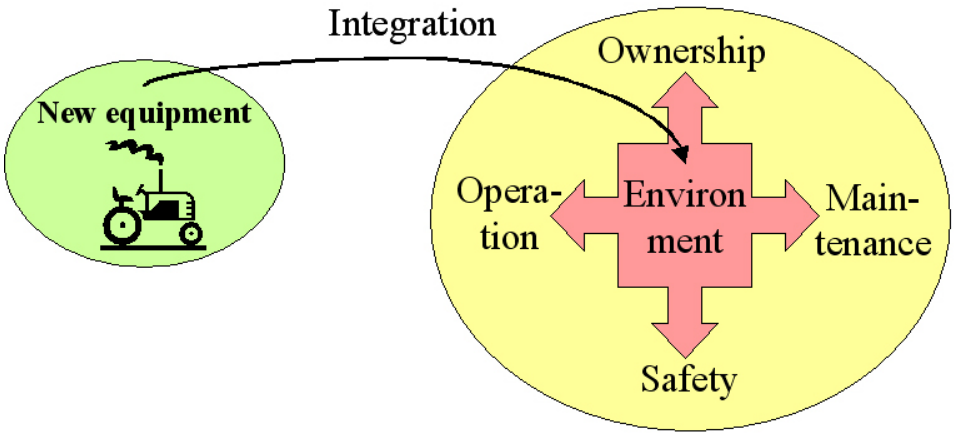


Figure 2: Integration into an environment with multiple interfaces

2.2 Success factors

Figure 2 well illustrates the integration process. A new equipment is introduced to an environment with multiple interfaces. Analysing the criteria that are responsible for a successful integration process, it is necessary to see the factors of both sides that are helpful for this process.

2.2.1 The environment is well prepared for the integration of new equipment.

The primary factor of success for integrating new equipment is a well prepared environment. The different interfaces that have to deal with the new equipment have to be organised for receiving new equipment in terms of rules and responsibilities. The owner, safety, operators and maintenance technicians have to know about their responsibilities and have to follow the rules that are mandatory to operate the concerned equipment safely and efficiently. If in addition to this the interaction and communication between these interfaces work well it can be assumed that the integration new equipment is not a problem.

2.2.2 The complexity of the equipment is transparent

The secondary factor of success for the integration is very much depending on the complexity of the equipment. If the equipment to integrate is standard and easy to understand, the "usual" procedures can be applied. If the operation of the equipment is very complex or if the equipment is some kind of special or even a very sophisticated kind of prototype then a lot of efforts have to be made to transfer information to the different people who have to deal with the equipment. In order to get a satisfactory operability and safety using the equipment it is necessary to analyse well what complications can come up in case of breakdown or any other conflict.

3 INTEGRATION OF NEW TRANSPORT AND HANDLING EQUIPMENT AT CERN

The above discussed theory of the integration process is the basis for the following analysis of criteria for the integration process of transport and handling equipment at CERN. The way is to examine if and how the criteria for a proper integration of new standard equipment at CERN are fulfilled. The results will be compared with the circumstances of prototype equipment integration so that possible differences become visible. As a final result some conclusions can be made to get integration processes successfully done in all cases.

3.1 Integration of standard transport and handling equipment at CERN

The following table describes in how far the successful factors are fulfilled when standard transport and handling equipment has to be integrated to the CERN environment.

Table 1: Discussion of criteria for integrating standard equipment

Interfaces	**Primary Success Factor: "The environment is prepared"**	**Secondary Success Factor: "The complexity is transparent"**
Ownership	Rules and responsibilities of utilisation and ownership for standard equipment are well defined and published at CERN (Safety codes, applicable laws and norms)	Standard equipment itself is common and transparent in functioning. The documentation describes well utilisation and related risks. Rules and responsibilities for ownership are precisely defined. Information cover related laws and norms, helpful tables and templates, recommended licences and trainings for the use of the equipment.
Safety Aspects	Safety specialists do inspections on all technical equipment of CERN on yearly basis. Safety codes, notes etc. prevent conflicts between standard equipment and the CERN infrastructure.	Safety instructions are fixes in multiple norms and standards, which are repeated in the documentation.
Operation	Professional and licensed operators use the standard handling equipment at CERN. Special training and licences are available to operate almost every transport and handling equipment that is standard. The operators become familiar with its use and the related risks.	Operation instructions and procedures are precisely defined. Special attention is given to related risks. Due to lots of experience with the utilisation of standard equipment related risks are well known and can be eliminated by proven preventive measures.
Maintenance	Maintenance service is available for all industrial transport and handling equipment. The technicians are very experienced to carry out all kind of work on standard equipment.	Instruction and procedures for maintenance are standardised and well approved by lots of experience. Construction is almost advanced so that service can be carried out efficiently.
Conclusion	**At CERN the environment is generally well prepared for the integration of standard transport and handling equipment!**	**The complexity of standard transport and handling equipment is very transparent for everybody dealing with it!**

In summary it can be said that concerning new standard transport and handling equipment the infrastructure at CERN is well prepared and knows how to properly deal with it. If for some reasons this is not the case, well informing documentation is available, training is standardised and can be ordered at any time also outside of CERN and after sales services of the constructors are almost available and well capable to help.

Conclusion: In general the integration of standard transport and handling equipment at CERN is not considered to be a source of problem.

3.2 Integration of prototype transport and handling equipment at CERN

The tables below allow comparing the criteria between standard equipment and prototype equipment integration. The first columns mainly repeat the results of chapter 3.1. The second columns describe the situation at prototype equipment integration and the right columns define what has to be done in order to bring the situation of prototype equipment integration in line with the requirements.

Table 2: Comparison of environmental aspects

Primary Success Factor: Is the environment well prepared integrating new equipment		
Standard Equipment	**Prototype equipment**	**How to close the gap**
Rules for the utilisation + **ownership** responsibilities for standard equipment are well defined and communicated.	Not standardised! Ownership differs from project to project	For every individual case: Definition of owner Definition of responsibilities and rules for utilisation
Annual **safety** visits for every equipment.	Same as standard equipment.	
Maintenance is very experienced in servicing standard equipment.	Maintenance is contractually available. The result depends on the technical complexity.	Possibilities to become familiar with the system (trainings and information follow-ups)
Professional and licensed **operators** use standard transport equipment.	Operators are contractually available. Complex functionality may cause problems.	Possibilities to become familiar with the system (trainings) Constant information about risks and equipment status

Conclusion: A lot of efforts have to be made in order to get the organisation ready for the new equipment. Mainly trainings and constant information update are necessary in order to get the people comfortable with the new equipment, when it is not standard transport and handling equipment.

Table 3: Comparison of aspects related to the equipment

Secondary Success Factor: The complexity of the new equipment is transparent		
Standard Equipment	**Prototype equipment**	**How to close the gap**
Precise rules + responsibilities are given in order to support the users **ownership** (laws, norms, risks, maintenance, etc.)	Documentation has to be individually developed and adapted to the CERN environment.	Experience during run-in phase has to be implemented into owners documents
Safety instructions fixed by norms (info in documentation).	Not standardised! Multiple norms and regulations do apply	Needs special attention – eventually revisions necessary
Instructions and procedures for **maintenance** are standardised.	Maintenance instructions are only provisional and on theoretical basis	Experience during run-in phase has to be implemented into maintenance documents
For **operation** instructions and procedures are precisely defined. Special attention is given to related risks.	Procedures for standard operation are available. Low level of experience!!!	Experience during run-in phase has to be implemented into operators documents

Conclusion: Prototype equipment is by definition not evaluated completely before it comes into service. The complexity of the equipment is detected on the job. As a consequence all documents and instructions have to be revised intensively after the run-in phase. Experiences with operators' faults, safety risks, technical wear and breakdown problems, infrastructural conflicts etc. have to be implemented into the related manuals.

3.3 Integration of transport and handling equipment at CERN - Examples

The following examples are given in order to explain the above.

3.3.1 Standard equipment integration

Transport operations with a mobile crane are very complex; risks for safety due to environmental conflicts are high. Nevertheless the integration process had been representative for standard equipment integration: Operator service was available at once. Technical service is delivered by the constructor. TS-IC-HM is aware of all responsibilities for ownership.

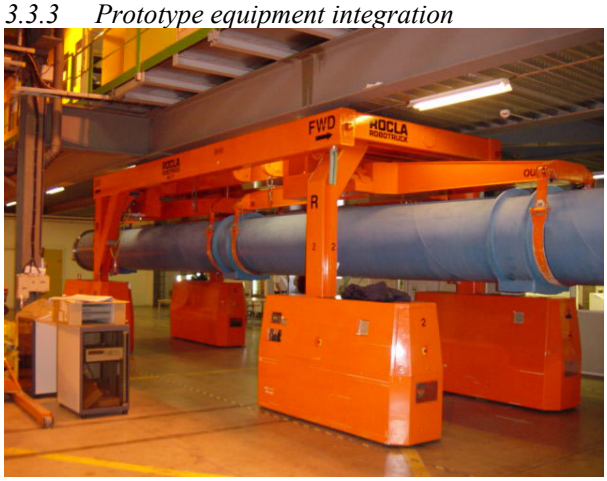
Figure 3: Liebheer Mobil crane 160 t

3.3.2 Special equipment integration

Generally transport operations with overhead travelling cranes are simple, risks and environmental conflicts are well known and generally low. Since this crane is equipped with some complex functionality the integration process had been nevertheless problematic. The cranes sensitivity against load variation provoked several stops and interventions of the constructor. It took about 6 months until most phenomenon's had been studied and eliminated.

Figure 4: Brunnhuber Overhead travelling crane (40 t) in SMI2

3.3.3 Prototype equipment integration



The two Rocla transport vehicles are specially designed for CERN for the cryo-dipole transport in SM18 area. The use of these vehicles is very complex. There are multiple infrastructural aspects to respect and the risk of collisions is high.
Technically the vehicles got a lot of start-up problems and after the use of 1-2 years the equipment already shows up with important wear. The integration of these vehicles is still not completely done, since the different interfaces could not organise the utilisation properly and the vehicles have the mentioned technical problems.

Figure 5: Rocla Cryo-dipole transporters (40 t) in SM18 area

4 CONCLUSION

4.1 An integration process of more relevance

It has been shown that CERN is well prepared for the integration of standard new transport and handling equipment. Problems come up when the equipment to integrate is complex and special. The more special the equipment to integrate is the more operators and maintenance personnel working with the equipment have to be involved. The more sophisticated and sensitive the equipment is from the technical point of view, the more resources are required to overcome start-up problems, ensure proper operability and manage the equipment throughout its whole life cycle. These tasks require a very intense cooperation between the users and the different services such as design, maintenance and operators for the complete duration of the project until the integration is completely finished and utilisation is standardised.

To improve the integration of special equipment it would be helpful to treat the run-in phase as a project on its own. Figure 6 below illustrates that this integration project would work in parallel to the equipment operation. Since it seems that after reception the resources are not sufficient to realise the upcoming additional tasks listed in chapter 2.3, this approach would allow eliminating main problems within a defined period of time.

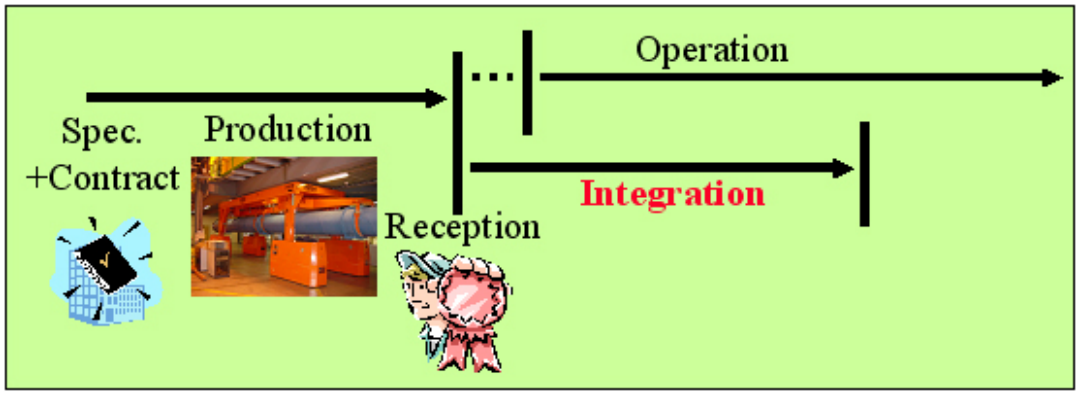


Figure 6: A projected integration phase for the integration of special equipment

4.2 An improved ownership for knowledge transfer from project to integration phase

It has to be mentioned that at CERN roles and responsibilities in terms of equipment ownership are often not well defined and this has for sure a consequence for the integration process. Tasks, authorities and responsibilities of the different parties are principally defined and committed, but they are only as long respected as the situation is not stressed. So for standard equipment the level of organisation is sufficient because there are not too many conflicts. For the integration of special equipment it seems that the level of organisation is too low, so tasks, authorities and responsibilities have to be defined more precise. A responsible mandated to be the owner of a transport handling equipment is a role which does not exist at CERN presently. As a consequence some decisions are not taken or are taken too late.

A proposal covering this aspect is visualised in Figure 7 showing already the solution. Actually the project leader is the design specialist or project engineer (sometimes one and the same person) of the realising unit. After the reception, the equipment is handed-over to the users. The equipment responsibility stays partially with the project leader (at the minimum for the guarantee period). The other part is transferred to the users, operators and/or maintenance unit without having clearly defined the tasks, authorities and responsibilities of everyone.

In the proposed solution the users department mandates a project leader for the purchase and integration of the transport and handling equipment within its own resources. This person would be also the later owner of the equipment. As a client of the service units he would follow the project

advancement, take part in decision taking and gain all necessary information for later utilisation and ensure the knowledge transfer during the whole life cycle of the equipment.

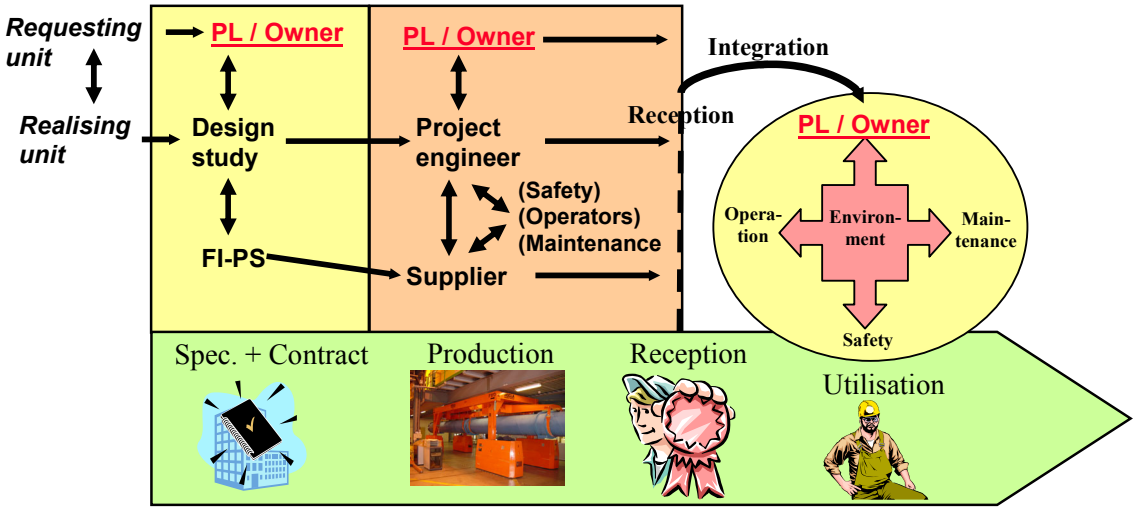


Figure 7: The equipment owner is more integrated into project and integration phase