DEGREE OF OPERABILITY OF WINTER MAINTENANCE MACHINES

R. CLEVELAND
Cisma, Technical Unit, Deputy Secretary General (France)
Chairman of the European Technical Committee CEN/TC 337 “Road Operation Machinery”
RICHARD.CLEVELAND@CISMA.FR

ABSTRACT

The diversity of designed and manufactured machines aims at answering various uses and practices from one country to another or more locally, from one territory to another.

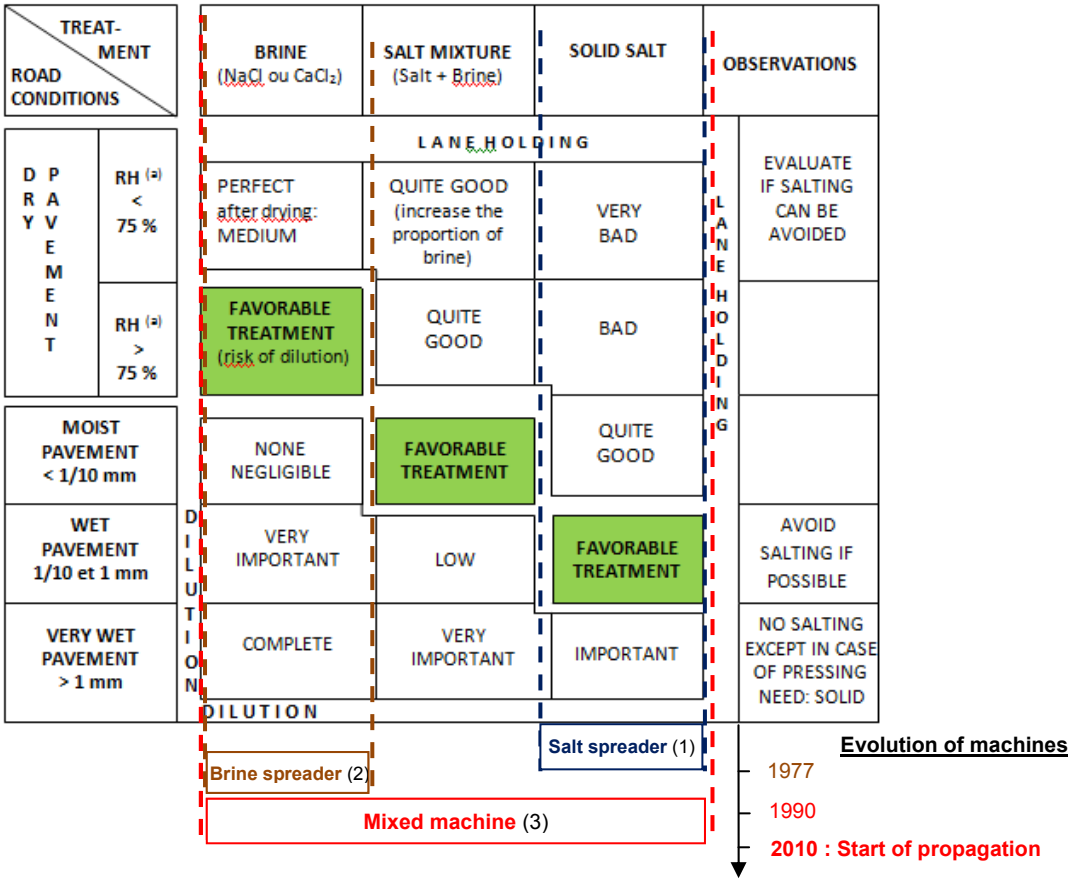
For many, the differences of practices are perceivable through the technical characteristics of the road network to be treated (length and width of ways, density of traffic, speed of progress) and depending of the weather conditions (intensity and frequency of snow falls and ice events).

A common fact which is more or less important depending on the country is the economic and environmental pressure which conducts inevitably to search for an optimization always bigger of the fleets of winter maintenance machines, while minimizing as much as possible the environmental impact.
The purpose of this communication is to investigate some areas which appear to be in the course of history, with regard to the French experience and taking into consideration some recent facts in Europe, by focusing every time on the degree of operability of machines (attachments, vehicles and systems integrated to these vehicles).
The machine users have to operate a more or less heterogeneous road network and their needs in products spreading on public roads can be very different from one area to another. Increase the degree of operability of machines can conduct to their versatility and confer a multi-purpose character which allows then to offer a wider range of solutions on the same machine during the snowfall event or the whole winter season, in order to better answer the specific and diverse needs of the users.
A better degree of operability can favor the multi-purpose character of a carrier-vehicle setting and increasing also its rate of availability over one year. A better compatibility between attachments and carrier-vehicles is a favorable factor to a better depreciation of the machines. It also encourages a “standardization“ and a reduction of delays of interventions on the machines, which can be respectively a productivity gain and a factor of reduction of accidents for the operators.
The main issue related to the integration of information and communication technologies in winter maintenance machines (road weather information systems, collecting and communication systems of snow clearing data), is the interoperability. With the current profusion of existing and emerging technical solutions and local initiatives, a technical harmonization is crucial to then build a solution around the real needs of the stakeholders in charge of the road operation.

1. IMPROVED OPERABILITY THROUGH A VERSATILITY OF SOME WINTER MAINTENANCE MACHINES

1.1. Fundamentals

In France, the recommendation for using different spreading products taking into consideration the pavement condition is defined according to table 1:



Tab. 1 – Choice of spreading products in link with pavement condition [1]

1.2. An increasing need for multi-purpose machines

Machines that are associated to the spreading of these different products have changed over the years. Historically, the salt spreading machine (1) was used for road treatment through the spreading of solid salt only. The first brine spreading machine (2) that first appeared in 1977 for the need of motorway companies and the first mixed machines (3) allowing the independent spreading of salt, brine, salt mixture, salt and brine, appeared during the 90's again for motorway companies and also few departments (managed by decentralized services of French ministry of Transport).

Since 2 or 3 years, we have noticed an increasing demand for mixed machines, coming from Departmental Councils (DC) and few metropolitan areas. Currently, these machines offer a continuum of real-time spreading solutions from pure salt to pure brine, through variable brine content in salt mixture, in order answer to the more and more increasing precision needs of some users (e.g. passage of tricky points such as bridge, forests, etc.). The trend related to a start of propagation of mixed machines is the result of:
- success stories of motorway companies,
- the wish to limit the use of salt (especially, after the lack of salt during the winter season in 2010)

- the adaptation of machines to the road that these users (department councils and metropolitan areas) have to treat (spreading by a disc to treat 2 lanes as a maximum and not by a spray bar as for motorway companies).

The multi-purpose character of mixed machines [(3)] is obtained by:
- a size review of salt hopper or a particular design of the hopper, depending on brine tanks be positioned at the front (fig. 1) or laterally (fig. 2),
- a brine extracting system (in addition to the existing extracting system of salt) and sometimes by
- a spreading system by a spray bar and nozzles for motorway companies in order to treat 3 to 5 lanes (fig. 3) in addition to a disc which is only able to treat two lanes as a maximum (fig. 4)

Fig. 1 - Front brine tank of a mixed machine

Fig. 2 - Lateral brine tank of a mixed machine

Fig. 3 - Spreading up to 5 lanes by spray bar and nozzles

Fig. 4 - Spreading up to 2 lanes with a disc

The coexistence on the carrier-chassis of these additional systems allow multi-purposes of the machines through precise treatments a better adaptability to the pavement condition, in the service of salt savings.

The main upcoming challenge is related to the operators' training of department councils and metropolitan areas that have to manage more modern machines (electronic regulation) allowing new technical possibilities that will change their practices. Some training sessions are ensured in France by decentralized services of French public authorities (CETE of North, newly named CEREMA).

2. INTERESTS OF INTEROPERABILITY AND MEANS USED IN FRANCE

2.1. Definition of interoperability

"Interoperer" comes from Latin "inter operis", which means "work together". Interoperability is the fact that several identical or totally different systems, are able to communicate and operate together without any ambiguity or conflict.

2.2. Main characteristics of mounted machinery

We exclude here towed or trailed machinery which represent a small market share.
The winter maintenance mounted machinery is formed by a carrier-vehicle and equipments which will ensure winter maintenance functions.

The type and size of the carrier-vehicle can be very different depending on the expected uses by the end user: truck (> 3,5 tons) or small truck (< 3,5 tons), tractor or other self-propelled agricultural machinery, earth-moving machinery (typically, a loader or a grader), or a dedicated equipment-carrier (see chapter 3.5).

The type and size of equipments can also be very different depending on the expected uses by the end user: snow blower, front plough, wedge-shaped snow plough, side plough, salt spreader, brine spreader, mixed machine (or salt/brine spreader), with a wide variety of different designs and options for each equipment.

Among important elements composing a machine, we find interfaces (mechanic, electric, hydraulic) and any other system ensuring a liaison between the carrier-vehicle and equipments (controls mounted inside the cab of the carrier-vehicle) or between the machine and its external environment such as information and communication systems fitted in the carrier-vehicle (see chapter 3.6).

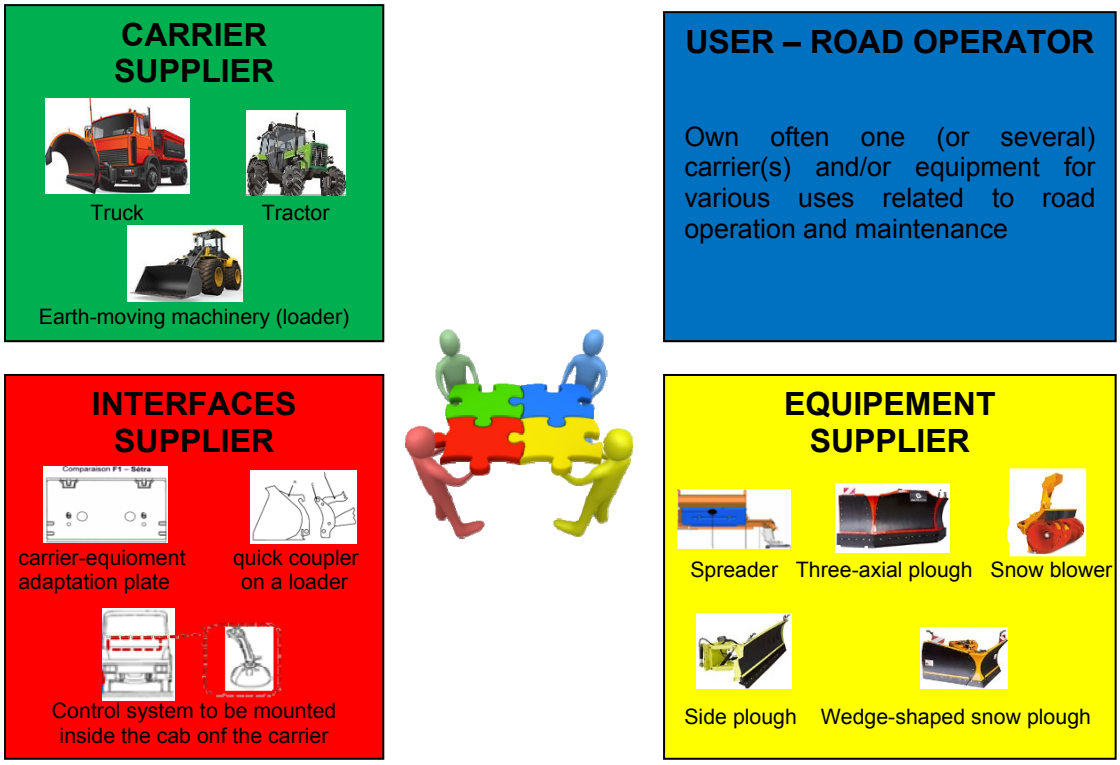


Fig. 5 - Main stakeholders involved in the design, manufacturing, assembling and use of a machine

Encouraging a more important degree of operability, giving back more progressive and compatible equipment and carriers between them, without being restricted by proprietary technologies are also very important factor for an optimized management of a fleet of machines for a road operator.

2.3. What is at stake?

Define the interoperability applied to winter maintenance machines doesn't make sense from a road operator's point of view in France since he has a general skill related to road operation and maintenance, which implies the use of machines for which the purpose is not the winter maintenance. Then, this concept could be defined as the fact that several road operation and maintenance equipments coming from the same or different suppliers

are able to be coupled with any kind of carrier, without any modification, adaptation or access restriction.
The same definition could be applied to information and communication technologies (ICT) through data acquisition and transfer systems integrated to carrier and which must operate with one (or several) server(s) (information supplier server and client application server).

The ability to change quickly an equipment with another (without any modification) and without restrict himself by proprietary technologies, as well as the capacity to avoid machines immobility (e.g. in case of failure or damage) are criteria that are taken into consideration by machines' users.

Consequently, the concept of interfaces (in the sense of § 2.2 and figure 5 above), is crucial. That's why this paper is essentially focused on this matter (interfaces linked to ICT being subject to a dedicated chapter, see § 3.6).

2.4. The standard: a tool in the service of interoperability

Taking into account the fact that the different elements of a machine (in accordance with fig. 5) are designed by different manufacturers, with variable methods, and that some of them have not been especially designed for winter maintenance purpose (case of most of the carriers), the simplest idea is to define an explicit basis, a standard or a set of standards that each element will consider in its proper functioning.
This standard can be seen as an indicator of the way the dialogue must operate between several elements, form the needs of this dialogue and then, create a "communication bridge" which will be adapt to changing needs of elements.

The standard is then the basis used for designing interfaces and is an efficient tool to tend toward a better operability.

2.5. Means implemented in France

This is one of the reasons why France, under the co-initiative of French Ministry of Transport and French manufacturers federation (CISMA) have created in 2000, the European Technical Committee CEN/TC 337 « Road Operation Machinery ». One of its Working Groups (WG3) deals with standardization of interfaces but also data acquisition and transfer systems regarding the need related to traceability.

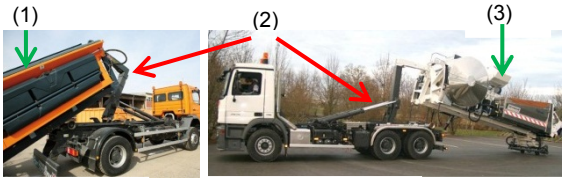
3. INTEROPERABILITY THANKS TO JUDICIOUS CHOICE OF INTERFACES

3.1. Choice of the truck-chassis mechanical interfaces

Several kinds of interfaces exist for truck-chassis in order to fit several equipments. They are the result of techniques developed by truck-body or skip designers, such as the « multi-skip » system or coming from other activity sector, such as the "twist-lock" system, used in ports to connect good containers to each other.

3.1.1. « Multi-skip » system

The « multi-skip » system (see 6.1 and 6.2) is composed of a cradle fitted with an anchorage point and a hydraulic arm as integral part of the truck-chassis. The cradle contains rollers which roll in a guide frame integrated to the truck-chassis.
The hydraulic arm function is to load and unload the skip in which the equipment is fitted. Then, the same carrier can be easily fitted with several different equipments.



(1) Spreader (2) Loading arm (3) Bitumen sprayer

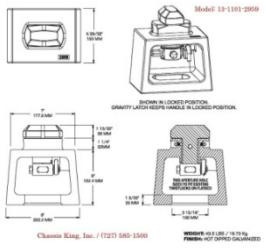
Fig. 6.1 - « multi-skip » system

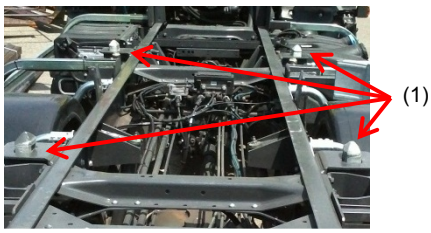
(1) Lifting point of the cradle

Fig. 6.2 - Spreader on its cradle after removal

3.1.2. « Twist-lock » system

This system is based on an intermediate frame which will be in contact with the truck-chassis. The « twist-lock » system (see fig. 7.1) is constituted of male parts (twist-lock) and female parts (corner fittings) which will ensure the locking/unlocking of the intermediate frame on the truck-chassis.



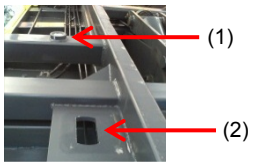


(1) Twist-lock systems mounted on the chassis

Fig. 7.1 - « Twist-lock » system

This system implies the removal of the equipment with its intermediate frame directly on supporting legs (see fig. 7.2). With the additional hydraulic removal function, the intermediate frame is designed to be lifted by hydraulic cylinders (see fig. 7.3). When lifting control is activated from the side of the truck, the hydraulic cylinders lift the equipment without any human force and facilitate the installation of supporting legs before the removal of the equipment.

Fig. 7.2 - Spreader on supporting legs after removal



(1) Hole towards the hydraulic cylinder will push
(2) Corner fitting in which twist-lock is inserted

Fig. - 7.3 View of the intermediate frame fixed under the spreader

The « twist-lock » fixing system ensures finally the engagement and locking functions of the equipment on the carrier and are standardized on dimensional aspects.

When a road operator has several vehicles or trailers and different equipment, it is relevant that chassis and intermediate chassis of these vehicles or trailers all have the same size, at least regarding the location and form of fixing means (twist-lock). Generally, the body that has the strongest strength requirements is the body which determines the location of « twist -lock ». This matter is part of the discussions between the road operator (customer) and the equipment supplier in such a way that the supplier will take into consideration as much as possible the existing fleet of vehicles of the road operator.

3.1.3. Preference for the « twist-lock » system in France

In both cases, the two described systems above offer an availability of the carrier within a whole year.

Even if « multi-skip » system has the undeniable advantage of a faster loading/unloading operation than a « twist-lock » system, it has also the serious disadvantage to limit the loading capacity of the carrier, because of the weight of the skip and the hydraulic arm. Moreover, with equal carrier, the equipment's height from the level of the ground is more important if the skip is maintained, which can be incapacitating for some material spreading applications.

Therefore, the « twist-lock » system is preferred in France, mainly due to the limit of the loading capacity of the « multi-skip » system, especially when the winter maintenance equipment is used in association with road maintenance equipment such as a bitumen sprayer, aggregate spreader, or sprayer-spreader.
Indeed, in that case, during a whole year, a road operator will be able to easily use a salt spreader, a brine spreader or mixed machine during the wintry period and use a bitumen sprayer during the summer period for example, with only one change per year of the equipment.

3.2. Choice of other mechanical interfaces

3.2.1. Front mechanical interfaces

Whatever the carrier (truck, agricultural self-propelled vehicle or earth-moving machinery), from now on, the equipment suppliers design and manufacture front adaptation plates fulfilling European technical specifications standardized through the standard EN 15432-1 « Winter and road service area maintenance equipment - Front-mounted equipment - Part 1: Fixed front mounting plates » [2].

The EN 15432-1 standard defines especially dimensional requirements (location and dimensions of holes, pockets, fixation cones, etc.) and strength requirements of the plates, depending on the weight of the carrier with a distinction of three cases (GVWR < 3,5 t., 3,5 t < GVWR < 9 t. and GVWR > 9 t.) and of the weight of the equipment. In reality there are three main families of plates (F1, F2 and F3) which are standardized at European level through EN 15432-1.

Fig. 8 - F1 European plate on several carriers

The front adaptation plate is mounted directly at the front of the carrier (truck for example) or integrated to coupling system already fitted on the carrier. For example, in the case of loaders, there are many different types of coupling systems that require adaptations (see fig. 9.1 and 9.2) through the integration of the front mounting plate fulfilling EN 15432-1, in such a way that the carrier can be fitted with any front equipment, without prejudice of safety aspects (i.e. taking into account the weight category of course).

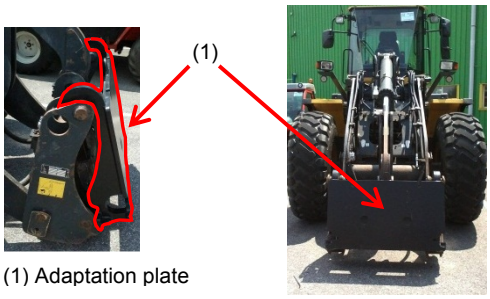


Fig. 9.1 - Adaptation of an European plate to a loader coupling system

Fig. 9.2 - European plate integrated to several different coupling systems

As indicated in the title of the standard, the adaptation plate is designed to be fitted with other road operation equipment, such as for example, front-line grass-cutting machines for road service area maintenance, sweepers, stone ploughs, or other front equipment.

For that matter, an equipment supplier is specialized in the integration of standardized plates to particular coupling systems in order to offer the ability to some carriers to be mounted with multiple road operation equipment.

The European standard EN 15432-1 is now included the same in the collections of the national members of CEN (all EU countries), which broadcast them as national standards.
It should be noted that there are also specific coupling systems with lifting system which are also standardized now through the European standard EN 15432-2 « Winter and road service area maintenance equipment - Mechanical interface on vehicles for front-mounted equipment - Part 2: Interchangeability on lifting systems ».
Among current evolutions, it should be noted also that front configurations of carriers are changing more and more and therefore require a constant adaptation of professional responsible of the assembly of front adaptation plates.

3.2.2. Lateral mechanical interfaces

Lateral adaptation plates are the same as those employed at the front of the carrier and fulfill the requirements of the European standard EN 15432-1.
It should be noted also that air pollutants regulatory requirements for trucks (new trucks have to fulfill now the Euro VI phase) create new constraints for professionals responsible of the assembly of plates on the carrier. Indeed, they have to face a size issue during the installation of lateral plate and equipment, because of the important volume occupied by the new exhaust system.

3.3. Choice of electric and hydraulic interfaces

Electric and hydraulic interfaces must not be neglected also. They have been standardized also at the same time as adaptation plates. They have to fulfill the European standard EN 15431 « Winter and road service area maintenance equipments - Power system and related controls - Interchangeability and performance requirements » [3].

In this field, it should be noted the interest often given to quick couplers designed to avoid connection errors and to facilitate the coupling/uncoupling operation (1 multi-socket block to connect instead of multiple connections of individual sockets).

3.4. Summary

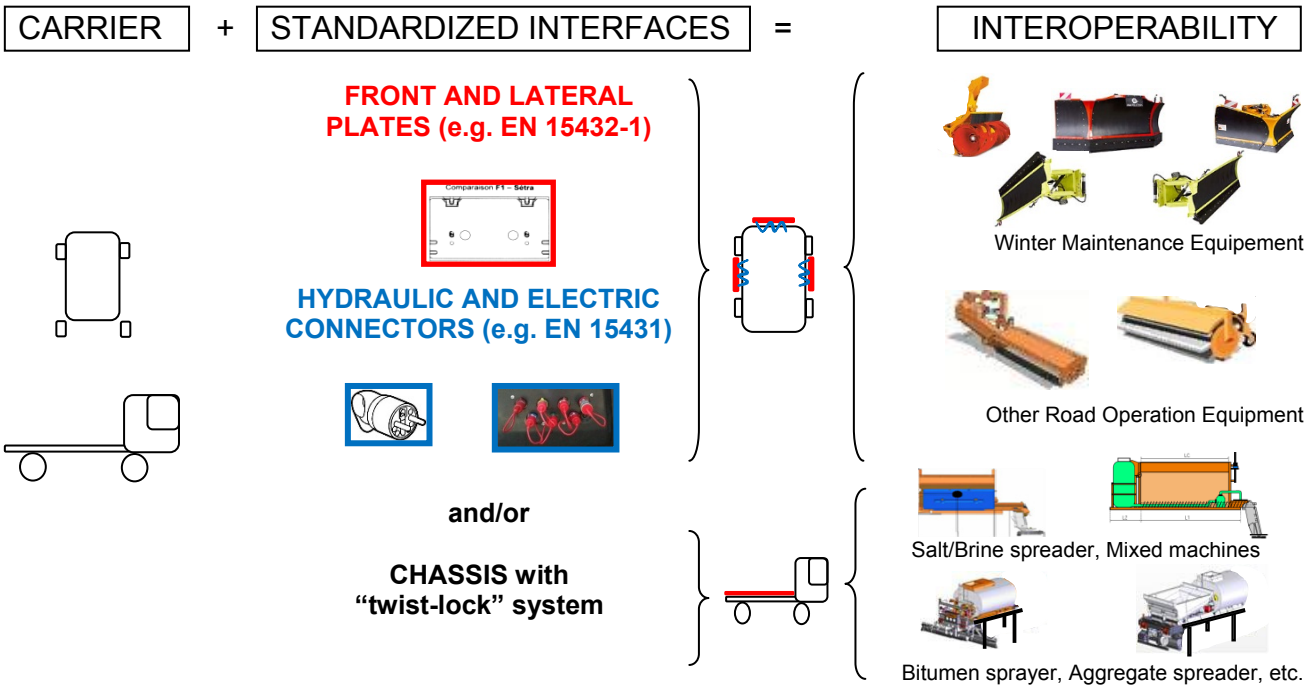


Fig. 10 - Drawing summarizing some possibilities in case of interoperability

In addition to the fact that standardized interfaces offer the possibility to consider new applications of the carrier, standardized interfaces allow also an interchangeability between carriers and equipment within a fleet of machines and vehicles of a road operator, which gives undeniably a better availability of the machines and improves also the safety, because there are no more modifications or adaptations done by the user. The fact that these requirements for interfaces are standardized at European level eliminates local and national non-harmonized practices which give up their place to a homogeneous and harmonized fleet of machines within Europe, at the service of all stakeholders.

3.5. A new trend for dedicated equipment-carrier

3.5.1. From the adaptation/transformation of carriers to the complete design of dedicated equipment-carrier

Few suppliers have been specialized for a long time in the adaptation of carriers directly coming from manufacturing plant to the specific winter maintenance application (see §. 3.1.2 related to the adaptation of intermediate chassis or § 3.2.1 related to the adaptation of coupling systems on loaders or other agricultural vehicles) even, in the transformation into a specific machine.

Among those transformations, it should be noted the interest for hydrostatic transmission which allows maintaining the advantages of the carrier and at the same time the possibility to have a very low and progressive advancement speed. Combined with an automatic regulation, the advancement of the carrier is regulated taking into account the power taken by the equipment during working process. This hydrostatic function is interesting also with regards to energy savings, since the equipment only takes the power needed for the work to do.

As indicated above (see 3.2.1 and 3.2.2), the sophistication of mass produced carriers (trucks, tractors) permanently creates new constraints for equipment suppliers who have to adapt their mounting procedure to take into consideration for example:
- size occupied by the existing control system of the carrier which complicates the adjunction of a 2nd control system inside the cab for the use of a road operation equipment
- size of the exhaust system of trucks (see 3.2.2)

Moreover, mass-produced carriers (tractors, trucks, earth-moving machinery) are not specifically designed for road operation and maintenance purpose and are not always adequate with some specific needs, in terms of visibility (road traffic and tool), ergonomic and comfort for the operator/driver and in terms of safety.

The standardization of interfaces and the increasing need to tend toward a better operability of machines (carriers and equipment) in the service of road operators and drivers in general, the increasing constraints related to mass produced carriers and sometimes their incompatibility with the best use of some equipment, are some justifications of the arrival of dedicated equipment-carrier in France.
This trend is observed since several years, but is recently getting bigger in France.

3.5.2. Advantages of Dedicated Equipment-Carriers

With the arrival in France of these new dedicated equipment carriers, we observe that they are not limited only to winter maintenance purpose but are also designed as road operation equipment-carrier (winter maintenance, grass-/brush-cutting, cleaning of pavement and traffic signs, forestry works grinding, grass collection from road service areas, pruning,..).

First of all, the interface issue can be integrated at the design step of the equipment-carrier taking into consideration all intended uses of the future machine, i.e., depending on the collection of equipment that the equipment-carrier will be fitted with, in respect of safety requirements (European Machinery Directive 2006/42/EC). For example, it is possible to integrate by design the possibility that a chassis is equipped as standard of devices for 3 points linkage and for adaptation plates according to EN 15432-1.

Moreover, a new design allows to totally reconsidering:
- the means of access to the service of safety (see fig. 11.1) or
- the design of cabins (see fig. 11.2) in order to improve safety with a better visibility on tools, road traffic and road sides and install a dedicated control station, in accordance with ergonomic and comfort rules for the operator/driver. The training of drivers can be facilitated due to a better appropriation of the machine by drivers.

Fig. 11.1 - Safe access from the rear of the cab via a standing platform in the size of the carrier

Fig. 11.2 - Cab redesigned to improve visibility and ergonomic of the control station

The cab can also be movable in some cases and be positioned at the front for snow blowing, in central position for a better visibility on lateral equipments (e.g. side plough) or also lifted for truck loading. In the field of winter maintenance, a central control system offers the possibility to drive with only one operator (instead of two).

A dedicated design offers more freedom to the designer to reconsider the weight allocations and the lowering of the gravity center of the equipment-carrier in order to offer a better stability of the machine fitted with its equipment (unfolded for working mode and folded for transportation mode) and allow more comfort for the simultaneous mounting of several equipment on the same vehicle (see fig. 12.1 to 12.3).


Fig. 12.1 - Dedicated equipment-carrier for snow blower, wedge-shaped snow plough, side plough or huge grass-cutter



Fig. 12.2 - Dedicated equipment-carrier for snow blower, wedge-shaped snow plough, spreader, branch pruning of grass-cuter

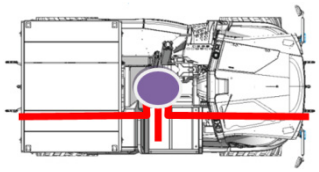


Fig. 12.3.a - Dedicated equipment-carrier with integrated grass/brush-cutting arm able to be fitted simultaneously with three different equipment






Fig. 12.3.b - Dedicated equipment-carrier for road operation

Moreover, the level of noise and vibration emitted inside the cab can be decreased taking away the engine from the cab and a mounting of the cab on an intermediate frame linked to main chassis via silent block. The cab can also be mounted on the chassis with silent blocks.

Finally, the engine speed can be automatically configured depending on the selection of equipment by the operator/driver. This system allows consuming only the real useful power and protecting the engine from changing engine speed due to equipment (this can occur when the regulation of the engine speed is manual).

The design of a dedicated equipment-carrier allows to eliminate constraints and some incompatibilities of mass production carriers, but also gives new advantages to the carrier, in the service of the operator/driver in terms of comfort and ergonomic of the control station, and in the service of the road operator in terms of productivity, staff training, energy savings, optimization of the fleet of machines (interchangeability between dedicated equipment-carriers and equipment) and in terms of new uses in the field of road operation in general.

3.6. Interoperability for data acquisition and transfer

3.6.1. Stakes of interoperability in the field of information and communication technologies (ICT)

Develop interoperability in the field of ICT means:
• guarantee that the exchange of information can be operated without being dependent of software used
• avoid restriction access or implementation access, such as the impossibility to read some formats of files…
In general, this means develop standards, clearly established which define requirements and recommendations in such a way that two informatic systems can operate together without problem.
The main obstacle to achieve the interoperability is the use of machines or software of formats which can only be readable by their designers (proprietary software).

3.6.2. Interoperability in data acquisition and transfer for winter maintenance activity

The data acquisition and transfer for winter maintenance activity allows:
- survey of any machine from any position (in real time or recorded)
- follow the interventions in real time (or recorded) in order to report quickly on previous and current operations
- focus the activity of the operator to the driving of the machine
- facilitate maintenance and repair
- define a winter maintenance policy

This is a tool already considered as a factor of optimization and resources management for some road operators (e.g.: knowledge of the quantity of spread materials, real time evaluation of the availability of machines, etc.).

The traceability system must be designed to be adaptable in order to take into account the future proper feedback of the road operator (e.g. in terms of quantity of spread materials...) and the changing circumstances (mapping of the road network)

The issues are the following:
- spreaders perform one or several routes during their work.
- spreaders treat roads for one (or several) purchaser(s).
- spreaders of a same fleet of a road operator can come from different manufacturers.

Moreover, a driving assistance is now taken into account when machines are intended to be used by « non professional » operators/drivers who don’t have the required experience to ensure a winter maintenance task or when a road operator decides to have only one operator/driver in the cab instead of two.
The management of routes allocated to one or several machines can allow the reallocation of a spreader from a secondary road to a primary road with a new definition of parameters (the driver is then in automatic mode).

With remote assistance, maintenance and assistance are done through internet:
- management of access profiles
- control of the spreader for repair assistance
- assistance adjustment of actuators
- control of box parameters
- automatic or manual collection of parameters

- data centralization and storage
- adjustments history
- grading report

In that case, the grading and the remote control of boxes of the manufacturer are integrated to the issue in such a way that the spreader can be controlled.

Finally, the surveying issue of winter maintenance machines must be able to integrate also other kinds of vehicles which are not used for winter maintenance.

Fig 13 - An issue not only limited to winter maintenance machines

In general, for the design of a data acquisition, transfer and management system, it is needed to:

- interface with the customer route creation module
- interface with the road operator accounting software.
- edit automatically the account depending on route of each spreader, quantity of spread materials, working time, etc.
- integrate data from different manufacturer's boxes.

The management of data must consider at least the following general modules:

- routes management
- operation of spreading data registered by the remote control box : asymmetry, width, dosage, quantity of spread materials, identification of imperfections during the itinerary (over dosage, machine imperfections, …)
- remote assistance
- accounting/management
- mapping
- …

Each module must interlink with others in such a way that the whole system can operate.

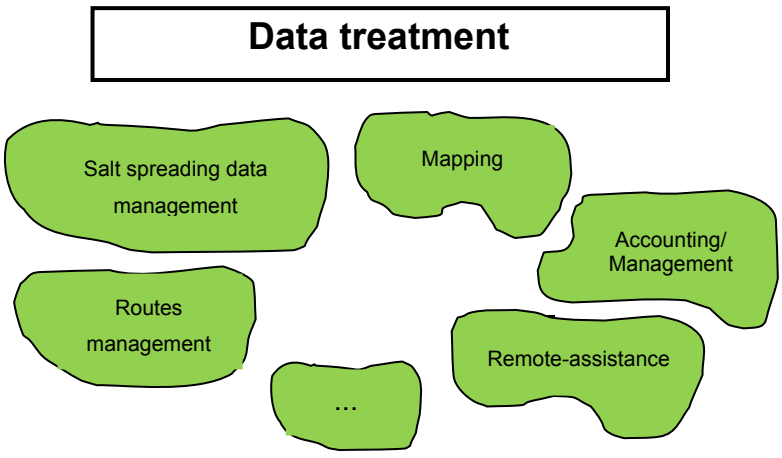


Fig. 14 - Interoperability of modules for data treatment

The European Working Group (WG 3) of Technical Committee CEN/TC 337 has also addressed this issue and the result of technical works is the publication of the two following European standards:

- EN 15430-1+A1 « Winter and road service area maintenance equipment - Data acquisition and transmission - Part 1: In vehicle data acquisition » [4].
This 1st part of the European standard specifies a standardized protocol for downloading data from the control unit of an embedded material (data emitter) to an on-board computer to ensure interchangeability between vehicle and different material that this vehicle can ship. It specifies the connection interface, as well as the variables (spreading width, quantity of spread products,..), records, and reports that allow the standardized protocol to cover applications with the most varied equipment, not only for winter maintenance.

- CEN/TS 15430-2 « Winter and road service area maintenance equipment - Data acquisition and transmission - Part 2: Protocol for data transfer between information supplier server and client application server » [5].
This 2nd part defines the structure of data (type, size, protocol and initialization parameters), between the information supplier server (ISS) and client application servers (CAS) with a combination and synchronization of different data sources. In other words, the respect of this standard ensures that equipment (e.g. spreader, snow plough), on-board data acquisition systems (e.g.: on-board computer or control box unit) and client application software (e.g.: databases, accounting software) can communicate between each other.

Fig. 15 - An open and adaptable architecture fulfilling European standards

Then, this is essential that the architecture of communication is open and adaptable in order to take into consideration the future needs of the road operator. The European standards give a general minimal framework to fulfill. Some equipment suppliers who are also service providers in this field look and go further than this minimum framework.

4. CONCLUSION

For users (road operators, drivers), the concept of operability of machines is essential. The advantages of an increased operability are numerous and the needs formulated by fleet managers in France show an interest in terms of:

- global optimization of fleet of machines (immobilization reduced in case of failure with the possibility to change quickly an equipment with another one, higher using rate of machines within a year)
- productivity (compatibility ensured via dedicated interfaces avoids numerous questions and compatibility investigations between carriers and equipment, mounting/dismounting operations are simplified, similar or identical and fast),
- safety (due to interoperability, there is no more risk related to adaptation of machines)
- administrative management (documentation management is simplified if the fleet of machines is homogeneous regarding interoperability)
- resources savings (oil savings with dedicated equipment-carrier, salt savings with mixed machines)

at the service of a better comfort for the operator/driver and global economy for the road operator.

The European standardization is the route followed by French stakeholders since 13 years, after the creation of the European Technical Committee CEN/TC 337. The publication of several European standards, applicable now in all 28 member states of the European Union are the first stones to tend toward interoperability for winter maintenance machines and more generally for road operation machines.

The increasing demand of winter maintenance mixed machines, road operation multi-purpose machines on dedicated equipment-carrier and data acquisition and transfer for vehicles management are currently observable trends which are fully in the wake of technical works conducted until today.

REFERENCES

1. Ecology, Sustainable Development and Energy Ministry
2. NF EN 15432-1:2011 « Winter and road service area maintenance equipment - Front-mounted equipment - Part 1: Fixed front mounting plates».
3. NF EN 15431:2008 « Winter and road service area maintenance equipments - Power system and related controls - Interchangeability and performance requirements »
4. NF EN 15430-1+A1:2011 « Winter and road service area maintenance equipment - Data acquisition and transmission - Part 1: In vehicle data acquisition »
5. CEN/TS 15430-2 « Winter and road service area maintenance equipment - Data acquisition and transmission - Part 2: Protocol for data transfer between information supplier server and client application server »