POST-DISASTER MEDICAL EMERGENCY: PROJECT FOR THE REALIZATION OF AN ADVANCED MEDICAL STATION

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Abstract

Today, the AMS - Advanced Medical Station has a well-defined role in Italy in the post-disaster relief services and in the post-disaster first aid chain, but, in practice, it cannot rely on an appropriate organizational model, which is able to cope with the different factors characterizing it. From this perspective, the objective of this study is the systematic definition of the functions, procedures, organization and technology required by health emergency situations, as well as the synthesis of the system requisites which the advanced medical station must satisfy. Finally, it is our intention to propose a project solution meeting the requisites identified. In the first stage, the investigations on literature and legislation concerning health emergency conditions and the direct consultations with in-field experts have underlined the existence of a series of typical problems, producing many difficulties that the operators have to cope with. With the application of a meta-designing methodology for a functional and spatial analysis, starting from the systematic collection of the basic activities referring to an Advanced Medical Station, the second stage of the research has been the analysis of the potential basic environments, and, upon consistency and advisability considerations, the definition of spatial units, which have subsequently been ordered according to a specific functional organizational pattern. The ultimate stage of the study coincides with the elaboration of a project solution for the realization of an Advanced Medical Station meeting the underlined needs. The study marks the passage from the need of adapting the specific health service activities to the market non-devoted systems to the possibility of exploiting a shared-knowledge system for the definition of a new projected functional structure.

Keywords: Advanced Medical Station; health emergency, rapid deployable shelters, mobile buildings, design requisites.

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INTRODUCTION

The research activity has been carried out in the form of a final degree paper within the framework of the CESPRO (Civil Protection and Risk Management Research Centre, University of Florence) multi-disciplinary program; from this perspective, Prof. Boncinelli's indications have been extremely useful to understand the relevance of the AMS - Advanced Medical Station in the first-aid chain and how this station is not sufficiently studied today in organizational and spatial terms. Upon these considerations, the research activity has commenced with a survey on the available materials/resources, as the headway for future developments.

CULTURAL AND SCIENTIFIC BACKGROUND

Reference to legislation

Although the medical science has produced a huge quantity of literature regarding the role, the equipment and the functioning of an advanced medical station and although the topic is in Italy a topical issue, there are only a few legislative references or regulatory provisions defining the usage and the spatial-functional characteristics of an AMS:

Act of the Prime Minister's Decree of 13th February 2001:

The Decree includes the following definitions and features:

> ADVANCED MEDICAL STATION**:** Functional unit for the selection and treatment of the casualties/victims, situated beyond the external perimeter of the security area or in a central area with respect to the disaster frontline. It may be both a structure (tents, mobile containers) and an area functionally devoted to become a casualty gathering place, where first-aid resources are collected and the evacuation of the wounded individuals is organised.
>
> MOBILE FIRST-AID UNIT***:*** It is a mobile structure characterized by a prompt mobilization, fitted out to work as an Advanced Medical Station, including 2 (max. 3) air-inflated tents; light stretchers for 50 casualties; power generator plants (electricity and compressed gas); medical material divided into differently-coloured cases on the basis of the final usage.
>
> THE UNITS DEPLOYED IN THE FIELD must have the following characteristics:
> - rapid mobilization, complete autonomy for at least 3 days for the execution of their function (materials, drugs, power, etc.) and for the support to the employed staff and means of transport (food, water, clothing, fuel, etc.), intervention in all territory typologies and under all whether conditions, as normally foreseeable;
> - use of a suitable tele-/radio-communications system, able to assure connections outside normal usage area.

document n.139 "General criteria for the supply of drugs and medical devices to a 2nd level advanced medical station…."

The document specifies the difference between a first and a second level AMS, where a second level station:

- is ready to be used in the shortest alert time (3-4 h.);

- is able to treat a total of 50 patients with red-yellow severity code in less than 24 hours and for a period of 3 days;

- has an operative autonomy of 72 hours.

In addition to providing instructions on the optimal siting of the structure and to specifying that the structure "may be constituted by tent bodies at least for the triage, stabilization and evacuation operations", the document clarifies that the structure must:

- be easily identifiable through signs;

- have a separated entrance and exit to channel the victims flow along one direction;

- have adequate lighting

- have a complete autonomy of at least 3 days in implementing its function and in supporting the first-aid personnel and means of transport

The document also describes the functions pertaining to an AMS:

- clinical evaluation and triage (more complete than the general evaluation carried out at the disaster frontline on the part of the rescuers),

- stabilization of victims,

- definition of the evacuation towards the hospitals.

Upon these considerations, it is evident that the shortage of functional indications and the absolute lacking of distributive and dimensional guidelines leave a wide margin of subjective interpretations and points out the necessity of in-depth studies on the definition of the criteria.

Reference to the Post-Disaster Emergency Medical Literature

Though it represents the basis for further investigations, the generic information reported in the official publications underlines the need for further insight analyses

from different points of view; besides, this early survey has added new generic criteria emerging in the scientific literature and in the literature concerning the emergency architectural studies.

An Advanced Medical Station is required to:

- be adequately air conditioned,

- provide for adequate hygienic conditions,

- have good soundproof standards (in order to auscultate patients),

- be transportable through the use of a wide range of means of transport in relation to the mission typology.

- be dismountable into modular units with the dimensions and the weight required to be easily transported by hand without the use of mechanical lifting tools.

- be designed in a way as to allow the manual installation and assembly without the use of mechanical tools.

Generally an AMS is divided into 3 areas:

- *The Triage Area*: where the secondary triage is carried out;

- *The Treatment Area*: which divides into 2 sections:

    Therapeutic Section: for seriously injured patients (Red or Yellow code), where emergency operations are carried out;

    Waiting Section: where less seriously injured patients are gathered (Green code) together with the survivors and the persons needing psychological aid.

- *The Evacuation Area*: constituted by a station where patients are collected for a short period of time until the arrival of the rescue squads for their evacuation in the most appropriate means of transport, on the basis of their clinical conditions.

In addition to the above said functions, other accessory functions must be complied with by the Advanced Medical Station in case of emergency as follows:

- Casualty and resource gathering point,

- Coordination of rescuers,

- Subsistence of rescuers

With the help of the post-disaster medicine theory, it is possible to describe in detail the operations which the AMS must implement, contributing to the definition of the overall needs.

Clinical evaluation and triage:

The AMS requires a secondary triage area, also used as a reception point for the storage of the patients' personal effects. The triage area requires a series of simple diagnostic tools, such as a portable echograph device, instruments for dry chemistry tests and analyses, instrumentation for telemedicine.

Stabilization of victims:

In the Advanced Medical Station, the stabilization techniques of the Basic Life Support (BLS) are applied together with specific procedures coping with post-trauma lesions, as identified in the ATLS - Advanced Trauma Life Support treatment.

Definition of the modalities of evacuation:

AMS should not include hospitalisation rooms, except for short periods, because the philosophy of the "stay and play" only provides for an onsite emergency treatment before evacuation to another hospitalisation centre.

Particularities of the Italian situation

In most of the European Countries, civil defence and protection is the responsibility of one or few public institutions/organizations. In Italy, this function is instead assigned to different public organizational bodies, at a national and at a territorial level. Civic organizations are also involved in the civil protection, especially through the numerous volunteers organizations.

The use of the AMS can therefore involve a wide range of individuals, including those having no experience at all of post-disaster medicine: those in charge of transporting the structure, those who install it, those in charge of the AMS management, and those who finally use it. It is therefore important to underline as a fundamental requisite for the entire AMS system, as well as the capacity of COMMUNICATING with simplicity and clarity its own content, function and usage modality.

The AMS can foreseeably be used for different purposes, stretching from the mere "prevention" in case of large concourse of people to severe post-disaster emergency: the requisites of RAPID MOBILIZATION, RESPONSE MODULARITY, FLEXIBILITY and INTEGRABILITY to other structures are therefore essential.

EXPERIENCE AND NEEDS COMPARED

Considered the shortage of sufficient information on the subject, a direct discussion with those who in Italy are personally engaged in the AMS management is crucial to find solutions to the various problems in terms of organization, technology and logistic. For this purpose, we have conducted a survey on the different Italian structures and the different approaches to the issue and we have interviewed the directors/managers of high-excellence emergency organizations in Italy.
In most cases, the contacted structures/organizations have proved to be sufficiently efficient, at least in relation to the working conditions; under these circumstances, the functions are adapted to the structures available in the market and are optimised through experience; but these structures are not specific for, or devoted to a specific intervention, and thus they present some limits as follows:

- the necessity of re-assembling the AMS configuration, cablage and electric plant during every intervention/operation.

- the difficulty of installing and positioning the technological equipment and the plants, which are placed on the ground or hung from the structure or walls, due to the absence of a specific housing/location.

- the large space available and the limited function paths.

- undifferentiated spaces, including the use of tents with no dividing walls/panels, which may result over- or under-size if compared to the usage needs.

- the general chaotic and unstable working conditions characterizing the entire structure

- the huge time required to set up the internal workstations.

- the impossibility of an adequate internal air-conditioning system due to the difficulty of closing the entrance and exit doors/ways.

- the difficulty in managing the consumable material stock, both in the non-operational and in the operational phase.

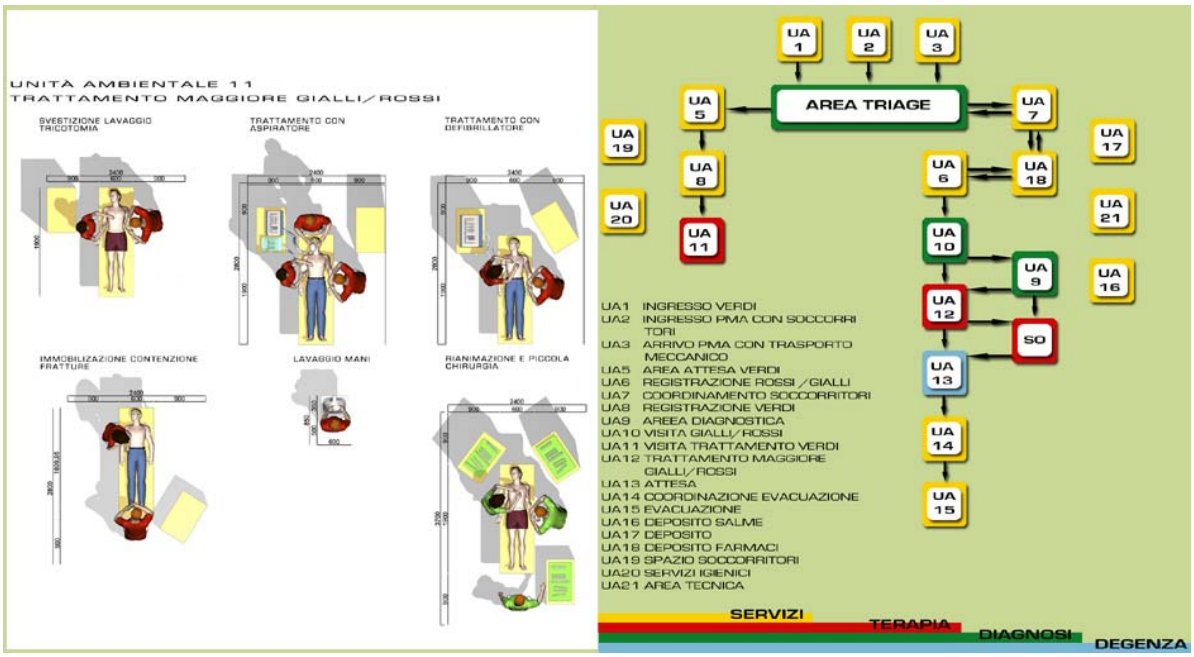
- the resources are stored in smaller packages/parcels which are divided on the basis of their content and not for their function. Hence the stocking is very disperse, and makes it more difficult to select the material for every mission, as well as the resources loading and distribution operations.

In general, there exists a wide a range of AMS realizations in the practice; this underlines the lack of a precise correspondence between spatial configurations and functional needs; this aspect makes it absolutely necessary to carry out a precise analysis of the basic activities, the required spaces/facilities and the possible

aggregations in order to achieve the projecting of a specific STRATEGY for the management of the SPATIAL SYSTEM which creates the structure and the SYSTEM of INSTRUMENTS which makes it efficacious.

THE META-DESIGNING OF AN AMS

Due to the absence of specific information, the meta-designing process has commenced with the research and classification of the basic activities implemented by the main AMS units, as specified above. The work approach has adapted to our purposes what was already consolidated in the hospital meta-designing and has looked for information directly from the filed experts/operators' experience. We have thus defined in detail what was already reported, up to the definition of the single ATLS operations, which amount to 95 basic activities as a total, divided among ordinary and one-off activities. The basic activities have been grouped on the basis of their functional affinity, identifying 21 spatial units; the spatial units represent a sort of general "zoning" of the activities within the Advanced Medical Station, according to criteria of localization as per homogeneous contexts. Starting from a non-structured system of basic activities, we have then achieved a structured system of Spatial Units (SU). These categories represent groups of activities which are consistent among each other in spatial terms and which are strictly interrelated on the basis of the behavioural patterns gathered from the discussion with the experts/operators. As it is composed of inseparable basic activities which are steadily defined in their functional and spatial characteristics, each SU represents a structural component of the system. To achieve a definition of spatial unit, a fundamental step is the study of the spatial dimensions of each basic activity, and then to group it into one SU and placed into relation one with another in a system of relations.



The organization of the functions: the content.

The 21 spatial units have further been aggregated into 13 functional units, starting from the analysis of the spatial implications and upon further compatibility considerations. Each of this functional unit has been defined considering the space and equipment required to operate with the maximum efficiency. Once this phase has been concluded, provided the complexity of the topic, we have divided the possibilities of intervention on the main AMS system into 2 action fields: CONTENT and CONTAINER. The AMS is essentially a functional area which includes a series of actions to carry out, a container hosting these actions and an organic system of relations between the different functions. In other words, the intention has been to separate the different aspects and to focus on the main function/action: THE SUPPLY OF THE FUNCTIONS.

We have thought it appropriate to organize the system-required material for the 13 functional units into 13 lots of equipment. Some spatial units have therefore been incorporated into larger compatible categories. We have assumed to store the material of each functional unit in separated “cases” (boxes, trunks) equipped with lighting, cablage and all the required operational facilities. In this way, the stored resources could be easily inspected and controlled during peacetime, and be ready for the usage and rapidly deployed in case of intervention. The objective is naturally that of speeding up the decision-making process, the load and download operations and the setting up of the AMS. The assumed organization also implies a significant reduction of the time required to supply the first-aid services, which are currently subject to the setting up of the whole AMS and to the activation of all its functions. With an organization into single "fully equipped" modular units, it is possible to rapidly install a medical unit for early ambulation and to start the supply of the first-aid services before the setting up of the whole AMS is completed. In addition, every

pre-wired unit only needs the connection for the execution of the function/s in the camp, significantly reducing the cablage bulk and the time required to install the electric wiring plant. Another advantage of this modular organizational pattern is the possibility of adapting the structure to the specific needs and, above all, to the quantity of the operative personnel. Here below, per each function, are the containers, differentiated for their colour, to which other optional containers/functional units have been added. These units are not an integral part of the AMS, but, according to necessity and in case of prolonged emergency, they could be added to the AMS camp and require an integration to the whole system:

1) triage area (green grey)

2) rescuers coordination (kaki green)

3) red-yellow patients/drugs registration (pink)

4) red-yellow patients main treatment (red)

5) diagnostics (purple)

6) evacuation waiting area (orange)

7) evacuation (yellow)

8) rescuers area (turquoise)

9) material deposit (cyclamen)

10) toilets (blue)

11) green patients waiting and registration (grass green)

12) green patients treatment (wood green)

13) corpses deposit (dark grey)

Optional:

14) junction module (lemon)

15) operating theatre lobby (beige)

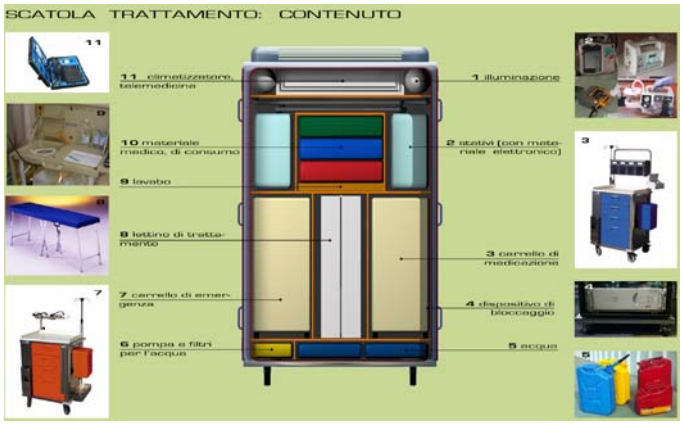
16) operating theatre (white)

For each container, the analysis also reports the required material/resources:

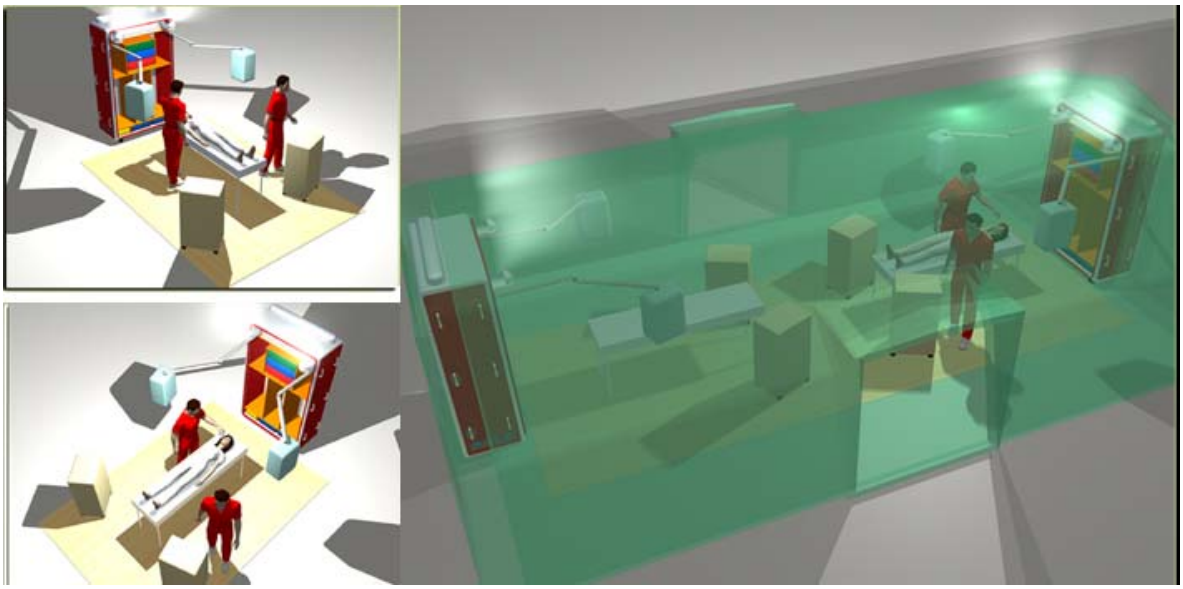
From this analysis of materials, it is evident that each unit requires "cases" of different dimensions, but, in order to define only one case to be used for all the functions, an ideal case size has been designed. The designed Case - inspired by the so-called flight-case used for the transport of fragile equipment and technologies - is made in extruded aluminium and includes anodised aluminium caps and details in ABS - Alkyl Benzene Sulfonate.

To explain it better, we now consider the most qualified meta-design for the case of the materials required in the area RED-YELLOW PATIENTS MAIN TREATMENT. This functional unit has been analysed in depth as it represents the most complex function which responds to the strictest distributive instructions, in addition to being the most advanced unit in terms of technology. The case has been designed to house the medical material available in the market. The dimensions have been determined on the basis of specific objects, of which we have given our preference to the objects with the smaller dimensions; a further optimisation of spaces could be

achieved through the study of medical instruments and equipment devoted to this typology of organization.



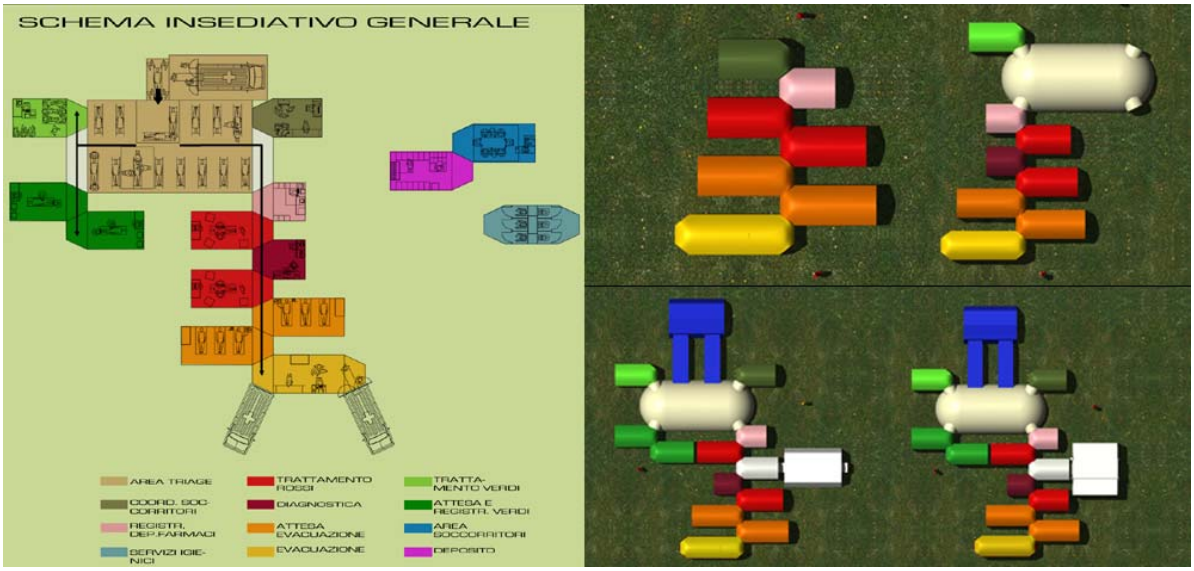
The case so designed can be used in any circumstances apart from the typology of the container; from the gymnasium to the traditional tent, from the French to the German model. Obviously, as seen from the analysis of the existing marketable structures, it is recommendable to consider the AMS as structured at least into 3 pneumatic tents, as those normally available in the market. This system can fit a wide range of transport modalities given its overall dimensions. It can be stowed in most vans and is equipped with appropriate handles: where the territory does not allow for transport on vehicles, 6 persons can easily transport it by hand.



The overall system

Starting from the functional modular structure, it has been assumed a further step forward in the general management of the AMS camp: to supply every functional unit with a specific case designed on the basis of the lay-out obtained from the

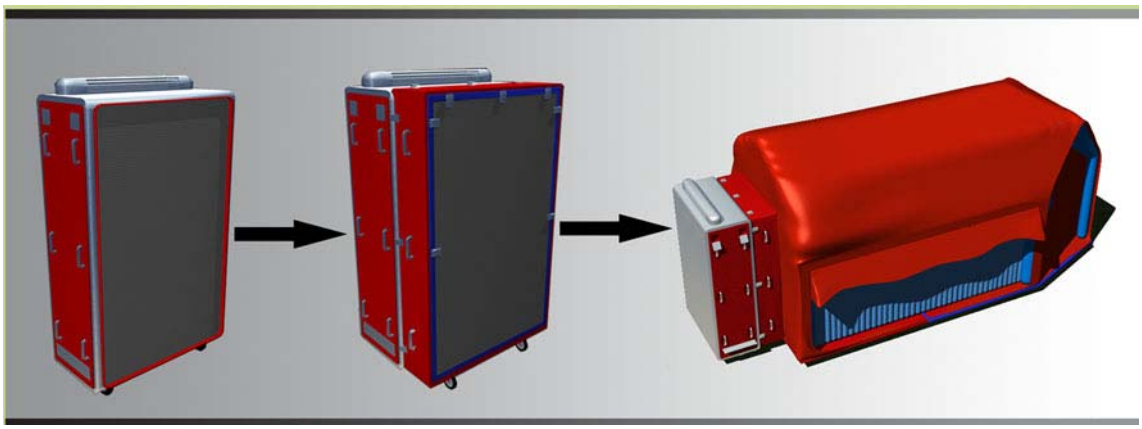
analysis of the spatial units, and then, to separate the functions from the shared paths on a conceptual basis.



The result is a system which can potentially be realised with the use of different technologies: traditional, pneumatic, geodetic or pantograph tents; this system puts the function into relation with a part of the first-aid path, which is completed only if connected to the other tents composing it. The solution is extremely flexible as it can be configured in function of the event and of the available resources. Besides it can be integrated to other typologies of structure which may eventually be installed in a subsequent phase. The tents have a variable length and a width of 2.75 meters (about 9.02 feet) to host all the required resources.

The meta-design of the container

Once the overall modular system has been elaborated, the following step has been to develop a meta-design combining all the properties of a pneumatic structure and, at the same time, representing an additional element of the case. A sort of accessory item or tent bag which can be hooked to the main case for the supply of an easily installable tent. The tent is located in a bag also containing its folded floor plan; if the mission requires for its usage, the tent bag can be hooked to the main case in the warehouse with a simple operation and is ready for its usage once you arrive at the mission camp. The tent is composed of a main pneumatic frame (coated polyamide polyurethane fabric), a second tubular pneumatic layer to insulate the internal environment (in cotton polyester) and a higher leak tightness layer connected to the subgrade layer (EMC reinforced plastomer fabric, PVC coated polyester) as in a traditional tent, which covers the whole structure surface and is separated from the insulating layer. The tent pressure is kept constantly through a junction tube connected to a compressor housed in the main case. The compressor automatically starts inflating when the pressure falls under a certain level. The operation is made easier thanks to the reduced dimensions of the tent.



In general, the advantages of this solution are:

- speeding up of the material selection and management

- reduction of the time required to upload and download the material

- reduction of the time required to setting up the AMS

- reduction of the time required to supply early ambulation and first aid services before the installation of the AMS is completed

- rationalization of the work areas and the operational paths

- an easier cablage installation

- an extremely modularity of the system as a whole, fitting every mission typology

- the differentiation of the work areas and a quicker understanding of the system functioning

CONCLUSIONS AND PROSPECTS

Undoubtedly this study does not represent an executable project, but rather it is a meta-designing initiative aimed to widespread a systematic and shared awareness of the issue. At this stage, the objective is that of supplying the designer with a series of useful analytical data for the development of different architectural solutions. However, we have elaborated a hypothesis of configuration as a possible solution trying to meet the existing needs. The proposed architectural solution has been determined on the basis of the available technology with a good degree of technical feasibility. At this point, the engineering of the solution has not been taken into consideration yet, as this activity should be carried out in strictly cooperation with private companies/organizations considered the particular nature of the technology applied. Without pretending to be exhaustive, the study intends to mark the passage from the tendency to optimise the existing products to the designing of

new solutions; for this purpose, new contacts have been established with the Regione Toscana to examine, verify and spread a new model of first-aid intervention.

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