User Centred Design:
The Design of Ambulances and Related Equipment

What is User Centred Design (UCD)?
An approach to designing the environment for users, or to develop products, systems, layouts, and other items that aim to design the environment for users. It seeks to apply information from users who are affected by the process.

Who Should Use It?
A multidisciplinary team of paramedics, managers, and design engineers.

The 10 Steps to Apply Ergonomic UCD In Ambulance Design
1. Identify target population: paramedics, patients, fleet staff, and any other populations affected by the design.
2. Identify target population relevant characteristics (e.g., body size, visual abilities, literacy, skills, knowledge).
3. Accommodate the full range of physical dimensions using anthropometric database of the target population.
4. Use task analysis methods to identify and describe the demands, goals, and intended outcomes of each task.
5. Identify Physical (vibration), emotional (stress) organizational (workplace practices), social (attitudes and culture), and legal characteristics (specific requirements imposed by the authority having jurisdiction) that influence the design.
6. Apply ergonomic design consideration and requirements.
7. Ensure additional requirements are considered to address human performance and health, safety, wellbeing and comfort of end users.
8. Create design concepts that are reviewed by paramedics, managers and designers.
9. Evaluate early-stage design concepts against human factor and ergonomics criteria.
10. Develop physical mock-ups and props to evaluate later stage design concepts.

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a user-centred design (UCD) process requires the design team to identify the specific needs of the users. The following checklist is intended to help manufacturers identify additional user needs.

Manufacturers should
a) request procurement administrators to complete the checklist as a part of their Request for Proposal (RFP); and
Note: The checked boxes are the requirements from the Standard, and the unchecked boxes indicate a recommendation. However, the purchaser may provide additional specifications for each criterion, or add more features to meet the requirements of the authority having jurisdiction.
b) use the checklist to validate the final product against the specified user needs.

GENERAL
- All exposed edges and corners have at least a 3 mm chamfer or 15 mm radius
- All hangers or supports for equipment, lighting, controls, and other devices are mounted as flush as possible
- Energy-absorbent materials installed:
  - At the full width of the interior top sill of each door opening in the patient compartment
  - Adjacent to each seating position, where applicable
  - In areas to protect the elbow, shoulder, and head, where applicable
- Containment areas for the incubation of viruses (airborne or transmitted in fluids) are minimized

RESTRAINT SYSTEM
- All seating positions are equipped with the appropriate safety restraint for each type of seating configuration

LIGHTING
- All cabinets have sufficient lighting to see the cabinet contents
- Light switch is readily accessible from the primary or airway attendant seat

EQUIPMENT RETENTION
- Equipment mounts or retention devices provided for all equipment stowed outside of storage units
- Mounts that hold between 1 and 10 kg comply with the performance requirements of the Ontario Provincial Land Ambulance and Emergency Response Vehicle Standard
- Mounts that hold more than 10 kg comply with SAE J3043

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PARTITION WALL
Includes a window with a minimum opening of 75 000 mm²
Window is capable of being latched in the open or closed position and operable with one hand

SEATS
Two-bucket style seats are provided: capable of sliding the full length of tracks as designed by the OEM; capable of reclining a minimum of 10° in the most rearward tracked position; and having a minimum of one armrest to the innermost side of the seat

AUXILIARY CONTROLS AND EQUIPMENT
Mounted auxiliary controls and equipment are mounted such that they do not interfere with access to OEM controls; are accessible to both the driver and the attendant; are operable by a 5th percentile female or a 95th percentile male while the person is driving and restrained; and do not interfere with the airbag function

HEAD LINER
Alterations to the head liner do not reduce the ceiling height directly over the driver and passenger seats by more than 12.5 mm

Alterations to the head liner or attachments at the top edge of the windshield do not reduce the vertical viewing angle to less than 15° for a 95th percentile male

AUXILIARY LIGHTING
Driver cabin includes a minimum of one auxiliary light that meets the interior lighting requirements of BNQ 1013-110

MIRRORS
Powered mirrors
Heated mirrors and side convex mirrors (where available from the OEM)

CONSOLE
Includes a cover to prevent contents from escaping in a collision
Console and cover comply with equipment retention standards (see Clause 5.3 of CSA D500)

STEERING
Tilt and telescopic steering (if provided by the OEM)
Ergonomic Design: Patient Compartment

**GENERAL**

Accommodates at least one paramedic, one other passenger, and one patient located on the primary stretcher

**SEATING**

**General**

At least two primary seating positions available

Each seat
Permits upright seated posture with a torso-to-thigh angle not less than 90°

Accommodates a 5th percentile female and a 95th percentile male

Permanently affixed side-facing seats comply with SAE J3026

Occupant head clearance complies with AMD 025

**Primary Attendant Seat**

Seat pan width accommodates a 95th percentile male hip breadth

Seat pan depth is greater than 384 mm but less than a 5th percentile female buttock to popliteal length

Backrest and lumbar support provided

**Airway Attendant Seat**

If swivel seat is installed, it has a locking system only in the 0° and 180° positions with a tolerance of ±5°

If non-swivel seat is installed, it has a locking system only in the 180° position with a tolerance of ±5°

**STORAGE UNITS**

**General**

All interior enclosed stowage devices comply with BNQ 1013-110, Clause 8.2.4.3

Maximum weight to be secured within a storage unit is clearly labelled

Attachments and safety nets are quick-release

Easily opened but do not come open due to vibration, ambulance motion, or collision

**Pressure Vessels**

Fire extinguisher weighs at least 4.5 kg

Space provided for the fire extinguisher is large enough to allow the fastening system to open

Fire extinguisher is accessible without entering the ambulance

Pressure vessel mounts comply with SAE J3043 and AMD 028
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Stretcher Retention
Stretcher retention system complies with SAE J3027
Ambulance floor and substructure comply with SAE J3102
Provides user with immediate visual or auditory feedback to indicate that the stretcher has been safely secured

IV Holders
At least one IV holder is installed in the patient compartment
IV holders are able to fold and recess; are non-sway; provide hooks; and are able to hold a minimum of two 1000 cc IV infusion solution bags
Do not have rigid support arms

Sharps Containers
Puncture-resistant construction, leak-proof on sides and bottom, and consistent with the current legislative colour requirements
Remains upright

Stair Chair
Storage space for stair chair is no higher than a 5th percentile female standing waist height (measured from the bottom of stair chair); and permits users to retrieve or replace stair chair without exceeding a horizontal reach distance equivalent to a 5th percentile female elbow to fingertip distance

Spare Tire
When carried internally, a storage area is provided of sufficient size to accommodate the winter tread model of the certified tire for the ambulance

INGRESS AND EGRESS
Door handles, handholds, and steps permit safe entry and exit to/from the patient compartment in various weather conditions (in dry, wet, wintry, and reduced visibility weather conditions) while wearing gloves and boots
Door handles, handholds, and steps accommodate the standing reach and size of a 5th percentile female or a 95th percentile male

DOORS
General
Includes a minimum of two openings: one at the rear and one at the primary attendant side of the patient compartment
Rear door permits ready loading of a stretcher
Primary attendant side door permits ready loading of an ambulatory patient
All doors have effective seals for sounds, fluids, and gases
Doors have door stops

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Height of rear doorsill does not exceed a 5th percentile female waist height

Door Latches, Hinges, and Hardware

Hinges, latches, and door-checks do not protrude into the access area when doors are opened

Hardware for the type and size of doors prevents inadvertent closing

Vertical hinges of rear doors open to a minimum door angle of 150°

Weather-resistant hardware used

Door handles accommodate the hand length, circumference, and breadth of a 5th percentile female and a 95th percentile male; and provide hand clearance of at least 63.5 mm (measured between the mounting surface and the handle)

Door Locks

Lock and unlock from inside without key

Lock and unlock from outside with key

All patient compartment door locks are identically keyed

Door Dimensions

Minimum rear door opening: W: 1120 mm × H: 1270 mm

Minimum side door opening: W: 660 mm × H: 1600 mm

Door-Activated Switches

Side door(s) fitted with switch(es) that operate primary attendant interior patient compartment lights and primary attendant scene lights when opened

Rear entrance door(s) fitted with switches that operate primary attendant interior patient compartment lights and the rear scene lights when door(s) is (are) open

Audible and/or visual warning signal when any external door is not completely closed when ambulance ignition is on

Handholds

Mounted on the inside of entrance doors and immediately inside each entrance to the patient compartment

Grab handles and grab rails are installed in a position to assist persons moving around in the ambulance, seated in the ambulance, or entering and leaving the ambulance

Grab rails or grab handles comply with Ontario Provincial Land Ambulance and Emergency Response Vehicle Standard

Finished with a high-visibility material

One overhead grab rail, with a minimum length of 1500 mm, and between 22 mm and 32 mm in diameter, is located on the ceiling centrally over the primary stretcher, with padded or curved-up ends and rounded corners

Grab rails do not interfere with the stretcher or incubator

Emergency Egress

Emergency opening system is provided for rear access door and side access door

Emergency opening system has at least two separate locks per door, independent from the usual door-leaf opening mechanism, and is able to operate at all times (not applicable to Type 2 ambulances)
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**STEPS**

**General**
- Minimum depth of 254 mm
- Illuminated when the door is opened in accordance with CSA D409
- Free of sharp edges
- Surfaced with ridged anti-skid open grating material
- Comply with AMD 018
- Reflective stripe on the leading edge

**Rear Step Design**
- Step(s) installed for ambulance that exceed 425 mm (measured from the ground to the finished floor)
- Leading edge of the step is lower than the top edge of the ambulance floor when folded
- Height of each step does not exceed 425 mm

If the step(s) does not cover the full width of the rear opening, the portion that does not have the step(s) has a clear, highly visible indication on the floor stating “NO STEP”

**Side Step Design**
- If the distance from the ground to the finished floor of the ambulance at the side entry location exceeds 300 mm, a step or steps are installed
- Height of each step does not exceed 425 mm

**WINDOWS**

Fixed tinted windows are mounted in the rear and primary attendant doors
- Designed to ensure patient privacy
- Permit between 3% and 7% light transmission
- Window material is transparent polycarbonate and bears a permanent identifying mark that certifies compliance with local regulations for motor vehicle glazing
- Each rear access door has a fixed window
- Primary attendant door has a fixed window (might or might not be capable of opening)

**LABELLING AND IDENTIFICATION**

Signage in both official languages is installed to convey operating or occupational health and safety instructions pertaining to chassis design, conversion design, or equipment installations
- Gauge function of voltmeter is clearly labelled
- Illuminated voltmeter is provided to monitor the condition of both the OEM and conversion batteries
Fixed decals are provided for incubator plugs, accessory receptacles, and other electrical outlets.

Clearly visible (either illuminated or etched on back lit panels) and permanent signage is provided for all switches, indicators, and control devices supplied by the manufacturer.

**LIGHTING**

Two independently controlled lighting zones on the left and right sides of the patient compartment are provided.

Lighting zones are capable of high and low settings or are dimmable.

- Off switch for patient compartment lights is provided in the driver cabin.
- Lights do not protrude more than 30 mm from the ceiling.

When the side or rear access doors are opened, the dome lighting automatically activates at an intensity of 75 to 250 lx and automatically switches off 15 s ± 2 s after the access doors are closed.

Lighting is provided to illuminate the side and rear entry doors and steps to a value of 100 to 150 lx when the doors are open, in accordance with The Lighting Handbook of the Illuminating Engineers Society.

Each interior storage cabinet has a minimum of one cabinet light.

One independently operated light is located in the approximate centre mass of the patient and stretcher with a value of at least 1000 lx; light switch for this light is readily accessible from both the primary attendant seat and airway attendant seat.

- All interior lighting is of a uniform colour range of 2700 to 3500 K (with the exception of blue cabinet lighting).
General
Shoreline power input is located between 1016 and 1371.6mm from the ground.

Patient Compartment Seating Layout
Seated and restrained 5th percentile female or 95th percentile male in the primary attendant seat can reach a restrained supine 95th percentile patient’s body from the crown of the head to the kneecap.

Seated and restrained 5th percentile female or 95th percentile male in the airway attendant seat can reach a restrained patient’s head, neck, and upper torso with both hands.

Airway attendant seat is located at the head of the stretcher and centred in relation to the middle of the stretcher’s width (tolerance of ± 75 mm).

Waste and Sharps Disposal Layout
Disposal units are located within reach of a 5th percentile female from a seated and restrained position.

STRETCHER CLEARANCE
Foot of Stretcher
Minimum clearance of 205 mm between the rearmost part of the stretcher and the nearest obstruction.

Side of Stretcher
A minimum 250 mm wide clear aisle is provided between the main stretcher and the face of the primary and airway attendant seating locations.

IV Holders
IV holder is not placed directly over the patient’s head.

Action Wall
General
Located where it is accessible and within the functional field of view of the primary and airway attendant seats while in a seated and restrained position.

Switches
Switches are accessible from both the primary and airway attendant seats: patient compartment light switches and the exhaust fan.
Switches are accessible from either the primary or airway attendant seat: main oxygen outlet and controls; suction outlet and controls (if prescribed); attendant control console; thermostat for HVAC system(s); and reading light

**OXYGEN OUTLETS**

Safe clearance is provided and includes space for the flow meter, humidifier bottle, etc.

If an additional outlet is installed on the ceiling of the patient compartment above the stretcher (located in the first third from the foot of the stretcher), it protrudes no more than 20mm from the ceiling

Location of oxygen ports and outlets allows a 5th percentile female or a 95th percentile male to readily access and use oxygen for patient care while not introducing risks to the safety of the patient or the paramedic

**SUCTION SYSTEM**

Location of suction outlet is readily accessible to a 5th percentile female or a 95th percentile male in a seated and restrained position while not introducing risks to the safety of the patient or the paramedic

**INCUBATOR RECEPTACLES**

Two 12 V polarized outlets are installed in the ambulance, of which one outlet is located near the head end of the primary stretcher

**FIRE EXTINGUISHER**

Fire extinguisher is accessible without entering the ambulance

**RADIO MOUNTING SPACE**

Remote handset mounting space is located on or near the primary attendant action wall, and is accessible to a 5th percentile female seated and restrained in primary attendant seat

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