Oak Ridge Centers for Manufacturing Technology

Advanced Surgical Suite for Trauma Casualties (ASSTC): From Concept to Reality

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*** Presenter**

Mission

The Advanced Surgical Suite for Trauma Casualties (ASSTC) will provide a self-contained, rapidly deployable, small footprint facility capable of providing trauma management, resuscitative surgery, ancillary services, or temporary patient holding.

Reconfigurable for Various Applications:

- Near combat area deployment for stabilization of patients immediately after injury
- Remote area health care
- Humanitarian relief

Background

- Original concept proposed by the US Army Combat Casualty Care Research Program
- Conceptual design furthered by San Jose State student design team
- Specific requirements contained in the Draft Operational Requirements Document (ORD) for the Multipurpose Facility for Health Services (MPF-HS) issued by the US Marine Corp.

Major Requirements

- **Mission requirements**
  - **Surgical area of ~10 ft X 12 ft**
  - **Triage and recovery areas for 3 persons each**
  - **Total enclosed/climate controlled space ~25 ft X 35 ft**
  - **Storage for medical supplies**

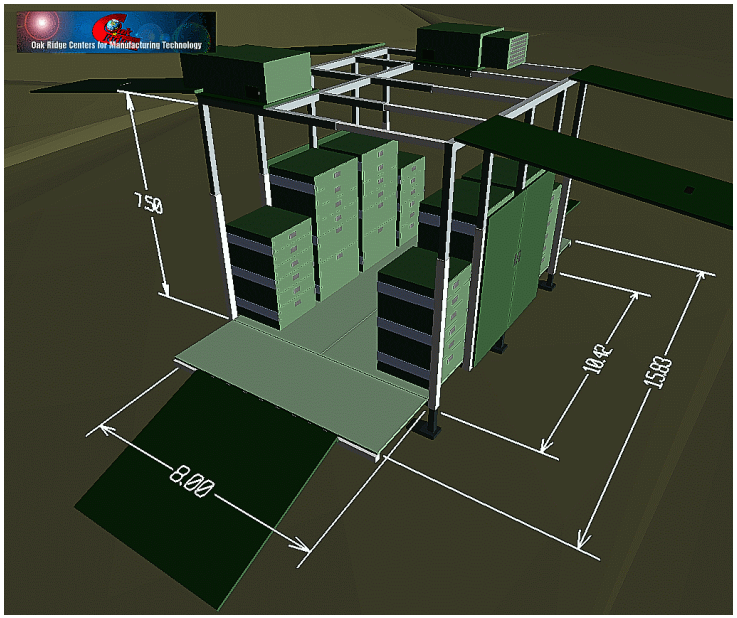
Major Requirements (cont.)

- **Must be transportable via MV-22**
  - **Size: 5 ft wide X 5 ft high X 10 ft long**

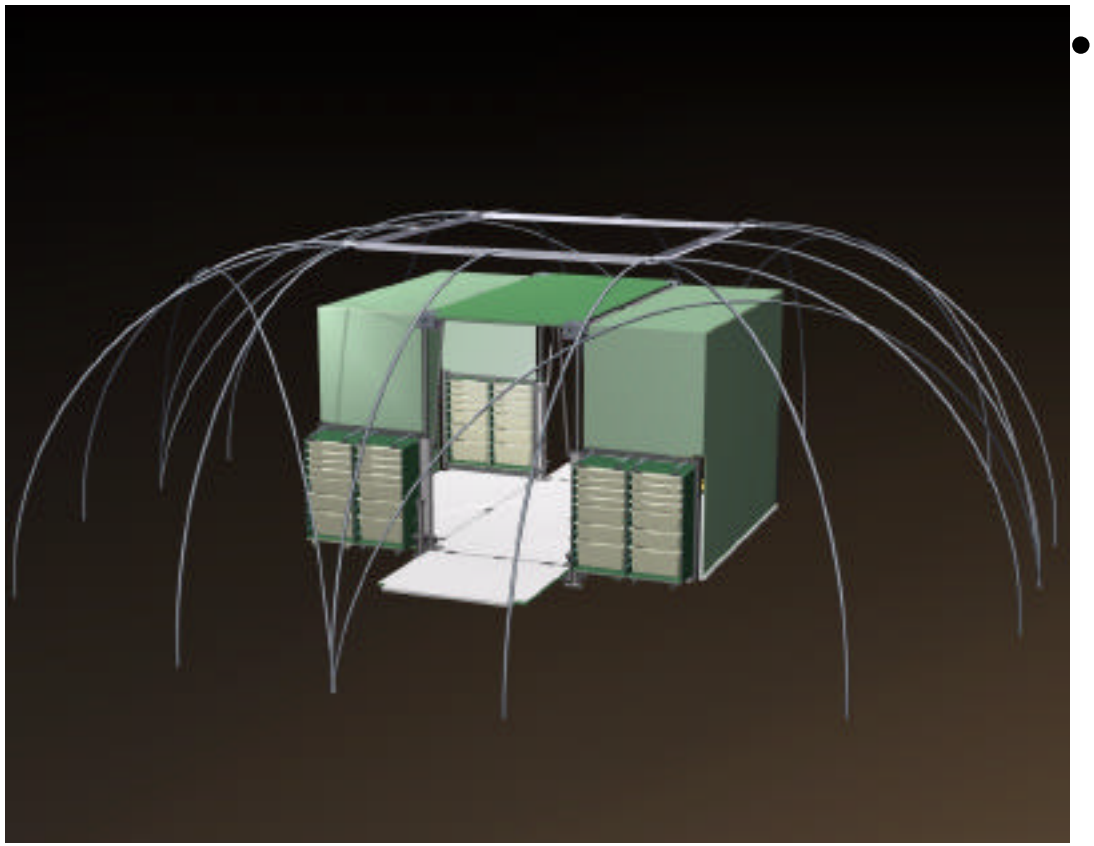
- **Must be towable via HMMWV (“Humvee”)**
  - **Weight: 4000 lbs max when loaded with required equipment including 1,000 lbs surgical supplies**
- **Deployment**
  - **Time: 30 min. max utilizing 10 people**

Project Approach - Phase I

- **Conceptual Design**
  - **Detailed definition of requirements**
  - **Concurrent Engineering Center at Oak Ridge**
  - **Virtual modeling**
  - **Partners include University of Tennessee Trauma Center and Hancock County EMS**
  - **Completed in first six weeks of project**



Project Approach - Phase II



- **Detailed Design**
  - **ORCMT Central Engineering**
  - **Solid model CAD system design**
  - **Included all support systems**
  - **Involvement of manufacturing organizations**
  - **Mockup review in project month 5**
  - **Heavily concentrated in project months 3-6**

Project Approach - Phase III

- **Prototype Manufacturing**
  - **Primary Composites Center and Fabrication Division**
  - **Support from Engineering**
  - **Identified outside partners**
    - » **Tent Design and Fabrication - Duvall Design, Inc.**
    - » **HVAC Design and Fabrication - EBAC Limited**
    - » **Composite Panels - M.C. Gill**
    - » **Tooling for Drawers - Smith Pattern**
  - **Build components and subassemblies**
  - **Integrate entire unit**
  - **Project months 7-10**

Design Basics

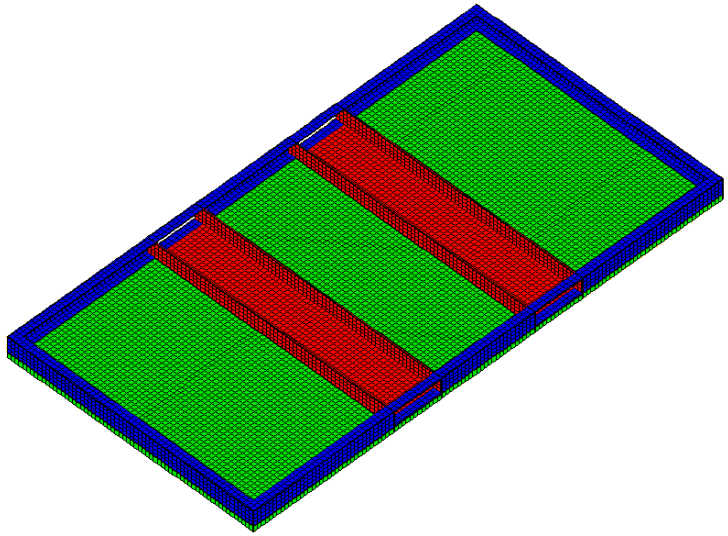
- Carbon composite/Nomex® honeycomb core composite floor is primary structural member
- Aluminum frame ties unit together and provides lifting attachment points
- Carbon composite bottom sheet for stiffness in handling and deployment on uneven terrain
- Carbon composite/Nomex® honeycomb core walls fold down to become expanded floor
- Glass composite/Nomex® honeycomb core panels used for other hard structural walls

Structural Integration

- Aluminum posts for height expansion and attachment points for swinging cabinets
- Gas pistons provided to assist in lifting top
- Double acting floor hinges - seal when unit open and closed
- Cabinets removable from deployed and storage configurations
- Foldout tables provided for supplies and instruments

Structural Design/Analysis

- **Spreadsheet approach to size sandwich core structural panels**
- **Finite element analysis of structural deflections**



Sandwich Panel Design-Graphite/Phenolic Cross-Ply Skins w/ Nomex Honeycomb Core

Total Thickness (in.)	Facing Thickness (in.)	Weight (lbs.)	Deflection for Uniform Pressure q=150 lb/ft²		Deflection for Three-Point Bending P=250 lbs.	
			Span = 48 in.	Span = 24 in.	Span = 48 in.	Span = 24 in.
0.50	0.012	20.550	4.3641	0.2797	0.6882	0.1720
	0.024	27.776	2.3749	0.1558	0.3660	0.0915
	0.048	42.198	1.4198	0.0969	0.2036	0.0509
	0.072	56.630	1.1490	0.0811	0.1509	0.0377
	0.096	71.063	1.0670	0.0774	0.1259	0.0315
	0.120	85.495	1.0852	0.0806	0.1124	0.0291
0.75	0.012	27.216	1.9003	0.1233	0.2972	0.0743
	0.024	34.432	1.0112	0.0679	0.1564	0.0391
	0.048	48.865	0.5743	0.0409	0.0843	0.0211
	0.072	63.297	0.4368	0.0328	0.0603	0.0151
	0.096	77.729	0.3759	0.0294	0.0485	0.0121
	0.120	92.162	0.3474	0.0282	0.0417	0.0104
1.00	0.012	33.883	1.0604	0.0697	0.1638	0.0409
	0.024	41.099	0.5594	0.0384	0.0860	0.0215
	0.048	55.531	0.3115	0.0231	0.0457	0.0114
	0.072	69.964	0.2315	0.0183	0.0322	0.0080
	0.096	84.396	0.1938	0.0162	0.0254	0.0064
	0.120	98.828	0.1735	0.0152	0.0215	0.0054
1.25	0.012	40.550	0.6766	0.0450	0.1031	0.0258
	0.024	47.766	0.3557	0.0250	0.0542	0.0135
	0.048	62.198	0.1964	0.0151	0.0286	0.0071
	0.072	76.630	0.1445	0.0120	0.0199	0.0050
	0.096	91.063	0.1196	0.0106	0.0156	0.0039
	0.120	105.50	0.1055	0.0099	0.0130	0.0032

Core density = 8 pcf
Total length = 120 in. (10 ft.)
Total width = 48 in. (4 ft.)

Sandwich Core Panel Details

- **Primary structural panels**
  - **1.25-in thick with carbon facings**
  - **8-lb density Nomex® honeycomb core**
- **Wall and cabinet panels**
  - **0.415-inch thick with glass facings**
  - **1.8-lb density core**

Fork Lift Channels

- Glass protected carbon fiber composite fork lift channels for stiffness and light weight
- Bonded to main floor panel
- Bottom panel bolted to channels for removal

Drawers

- General purpose drawers
  - 3-inch, 6-inch, and 9-inch sizes
  - Size and strength adequate for almost any medical supplies
- Simple tooling for prototype
- Fiberglass epoxy materials
  - Low temperature curing
  - Colored “hospital green”

Tent Design

- Center section supported by top of box - arching wall poles anchor to center section
- Tent slides down poles into place
- Multiple fabric layers for insulation
- Walls and floor zips together
- Port and ductwork for HVAC system

Other Components

- **HVAC**
  - **Surgery area comfort for external temperatures of -20°F to 120°F**
  - **30,000 Btu/hr cooling**
  - **10 kW resistance heating**
  - **CW/BW overpressurization with 120 CFM filtered makeup air**
- **Electrical distribution system**
  - **Tube and track lights supplied with unit**
  - **Multiple receptacles for medical and communication equipment**
- **Standard Army surgical table supplied**

Results

- **Design Criteria**
  - **Weight: ~3000 lbs with limited supplies and equipment**
  - **Size: 10 ft X 13 ft surgery area, 30 ft X 30 ft tent area**
  - **Deployment: Average time required less than 20 minutes**

- **Operational Utility**
  - **Sponsors and other organizations are pleased**
  - **Field testing at initiated at Ft. Bragg in late October**
  - **Testing indicates that unit meets operational requirements**

ASSTC Assembly

Future Composites Work

- **Improve "Manufacturability" of Current Product**
  - **Injection mold drawers**
  - **Pultrude fork lift channels**
  - **"Assembly line" production of panels**
  - **Tools for other fabrication and assembly**
- **Incorporate Feedback from Field Testing**
  - **"Beef up" where necessary**
  - **Use glass face sheets to replace carbon if/where possible or increase sandwich material thickness where space is available**
  - **Solicit input from other potential users**

Conclusions

- Successful integration of Army and Marine organizational requirements
- Successfully integrated capabilities in Oak Ridge and with External Partners
- Entire Unit Completed in less than 10 months of project activity
- Initial feedback is positive - “exceeds expectations”
- Prototype demonstrates effectiveness of concept