



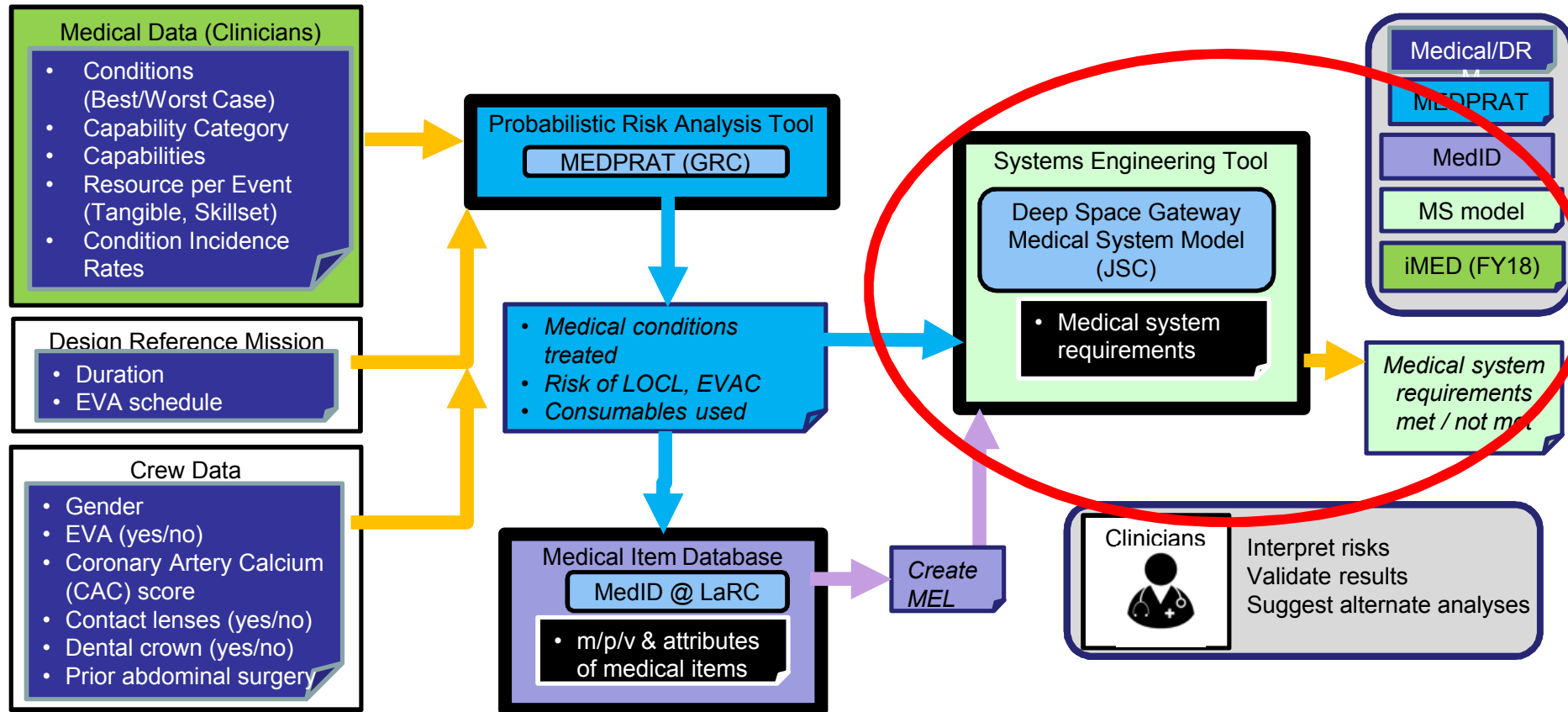
Medical Workstation Integration and Considerations

Westin Messer

Summer 2018



ExMC Trade Study Pilot Project





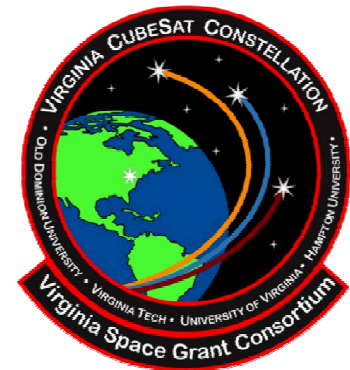
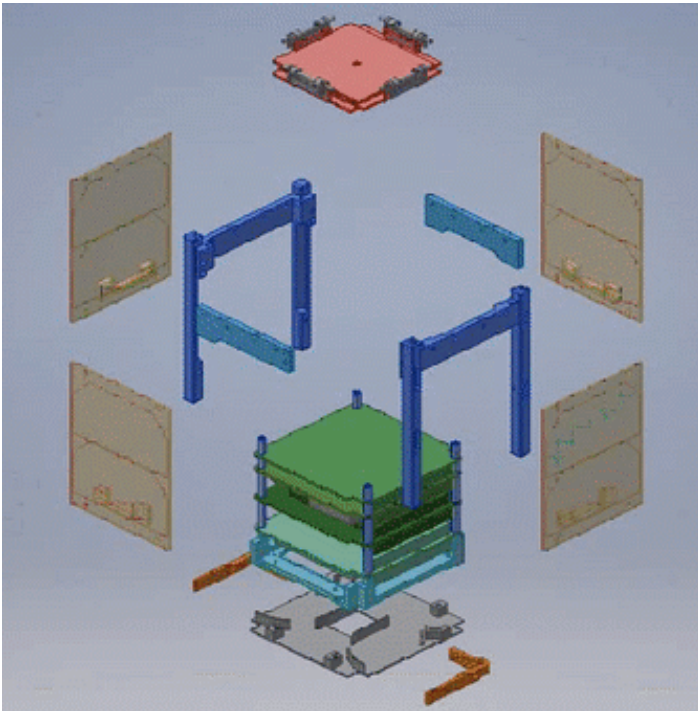
Contents

- About Me
- Objective
- Background
- Medical workstation breakdown
- Requirement calculations
 - Mass
 - Power
 - Volume
- Conclusion



About Me

- Student attending Old Dominion University – Norfolk, M.E. in Biomedical Engineering.
- Member of a NASA funded senior design project to build a 1U CubeSat with a launch date of January 2019.





Objective

- Gather all the data for the Medical Workstation (MW) on the Deep Space Gateway (DSG) this far and provide initial estimations for requirements.
- This is to help habitat designers be aware of the possible large constraints a medical workstation puts on a habitat due to the missions increased length.

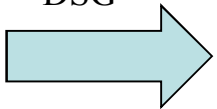


Background

- Up to this point in space exploration little concern has been put into complex medical care due to the “relatively” short distance from Earth we have traveled.
- Medical care changes dramatically when considering a mission to Mars because of its distance from Earth.

Level of Care	Capability
I	Space Motion Sickness, Basic Life Support, First Aid, Private Audio, Anaphylaxis Response
II	Level I + Clinical Diagnostics, Ambulatory Care, Private Video, Private Telemedicine
III	Level II + Limited Advanced Life Support, Trauma Care, Limited Dental Care
IV	Level III + Medical Imaging, Sustainable Advanced Life Support, Limited Surgical, Dental Care
V	Level IV + Autonomous Advanced Life Support and Ambulatory Care, Basic Surgical Care

DSG



Mars Mission



Background

- If a crew member is injured half way to Mars it could take them a year to get back to Earth to receive medical treatment therefore they must be capable of treating a variety of injuries and illnesses.
- Increased level of care results in a larger medical workstation (volume) with more equipment and supplies (mass and power).
- Increased size and weight of a medical station could result in a bigger crew habitat module or reduced size of other elements in the habitat.
- To design the Habitat module, designers need to know the mass, power, and volume requirements of the medical area and how it integrates into the Habitat.



Interface Control Document

- An Interface Control Document (ICD) was determined to be the best way to gather the data for the Medical Workstation and document it in a way Habitat designers can clearly interpret.
- The ICD was written at a high level consisting mainly of the following four parts:
 - Medical Workstation (system) description and breakdown.
 - Structural breakdown and description
 - Mass, Power, and Volume Calculations and totals.
- The purpose of this ICD is to provide a Phase A design concept that could be used to determine the feasibility and desirability of a suggested new system and inform development of the final mission concept and system-level requirements.

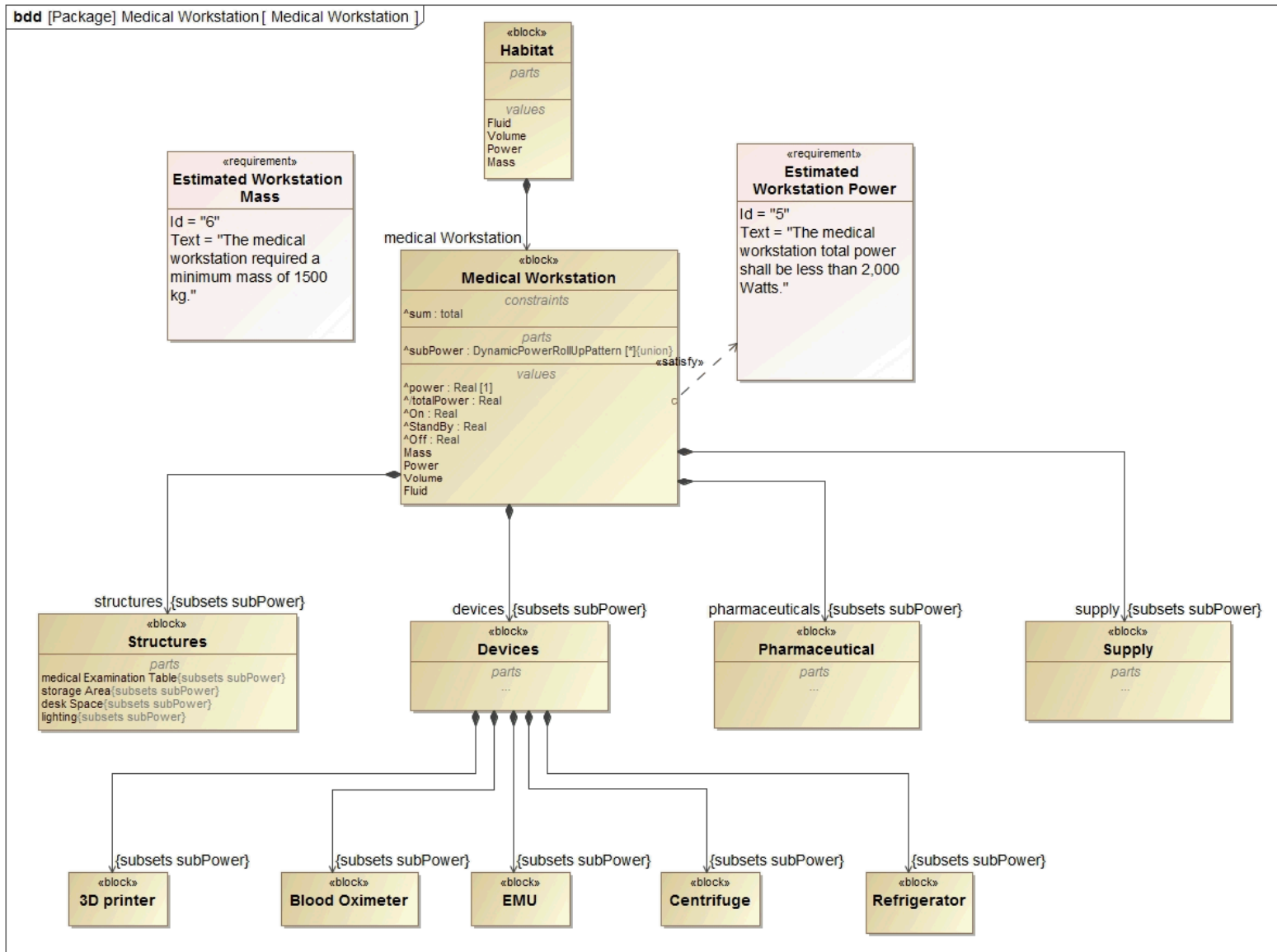


System Breakdown

- System organization was accomplished using MagicDraw which is a SysML modeling tool. SysML helps to:
 - Managing complex system development
 - Early and on-going verification and validation to reduce risk
 - Improved communications
- The system was broken down into four components which were determined to be the major areas of resource consumption.
 - Devices
 - Apparatuses
 - Appliances
 - Other articles intended for diagnostic and/or therapeutic purposes
 - Structures
 - Storage area
 - Medical examination table
 - Lighting
 - Desk space
 - Pharmaceuticals
 - Supplies



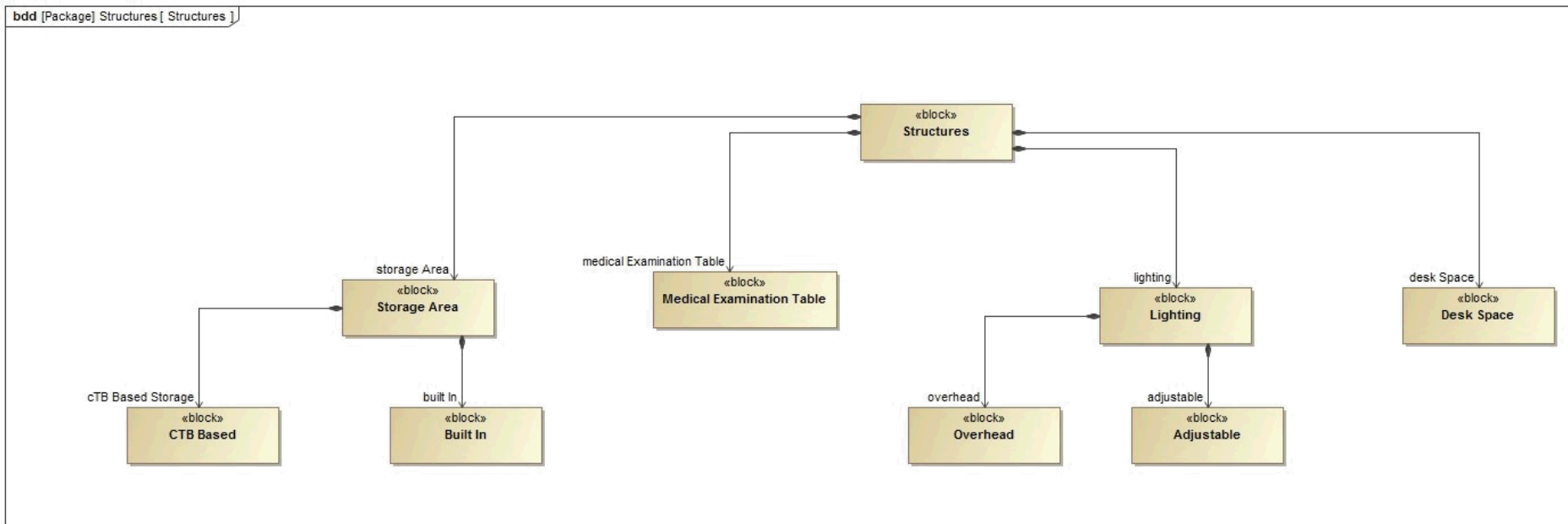
System Breakdown





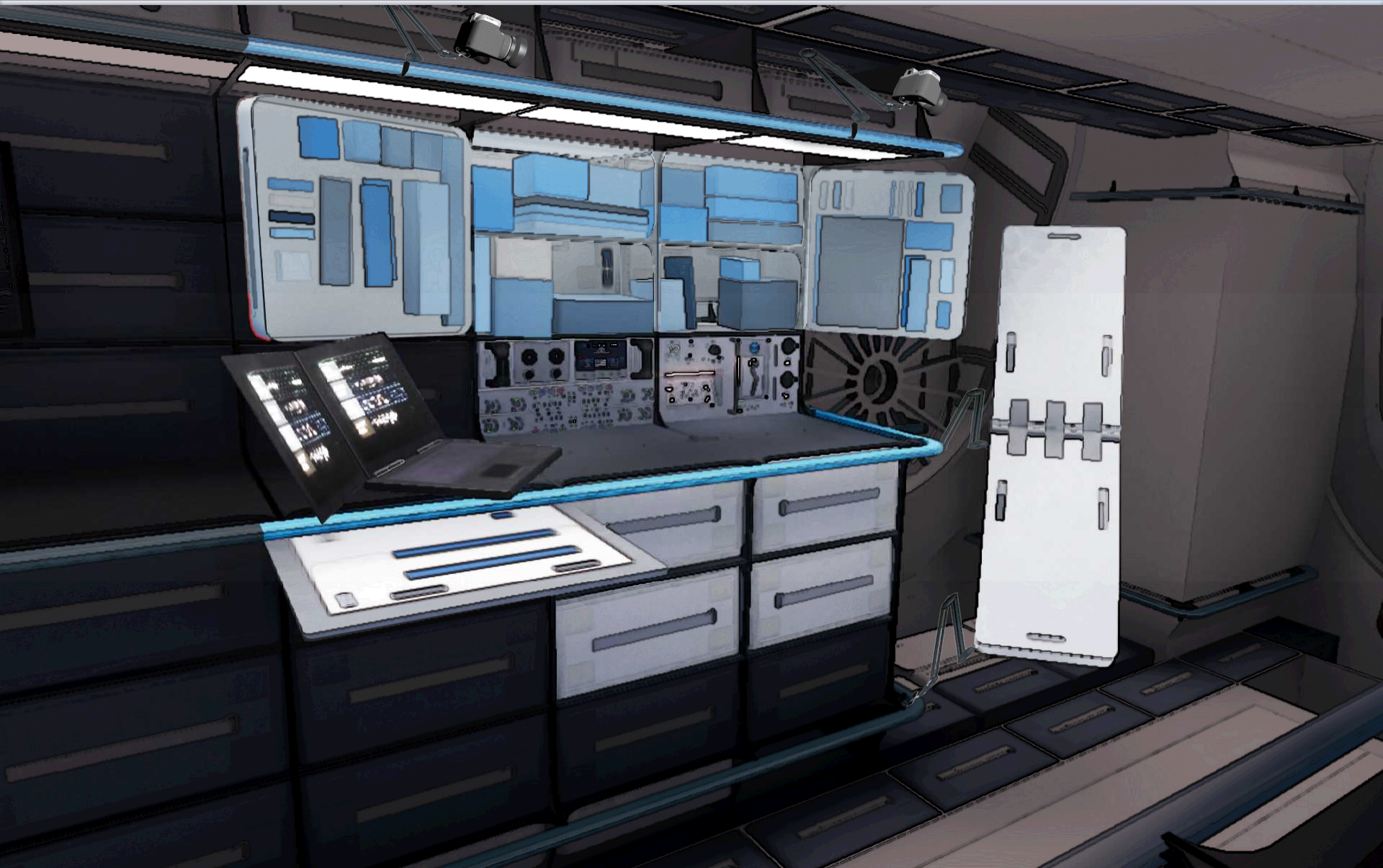
Structural Breakdown

- The structural break down came from a recent CAD mockup of the MW for the DSG.
- Structures is a more complex block with components that take up a lot of the “bulk” of the MW and was therefore broken down into subcomponents.





CAD Design



- The goal of the requirement calculations is to describe how the medical workstation affects the Habitat design.
- This is important because habitat designers need to know how the medical workstation reacts with its environment to be able to design a space appropriately for it.
- The analysis in this paper primarily consists of estimated totals of mass, power, volume and fluid for the MW.
- The data came from a spreadsheet that has every resource needed for the medical workstation and detailed information on mass, volume, power, quantity, supplier, etc.

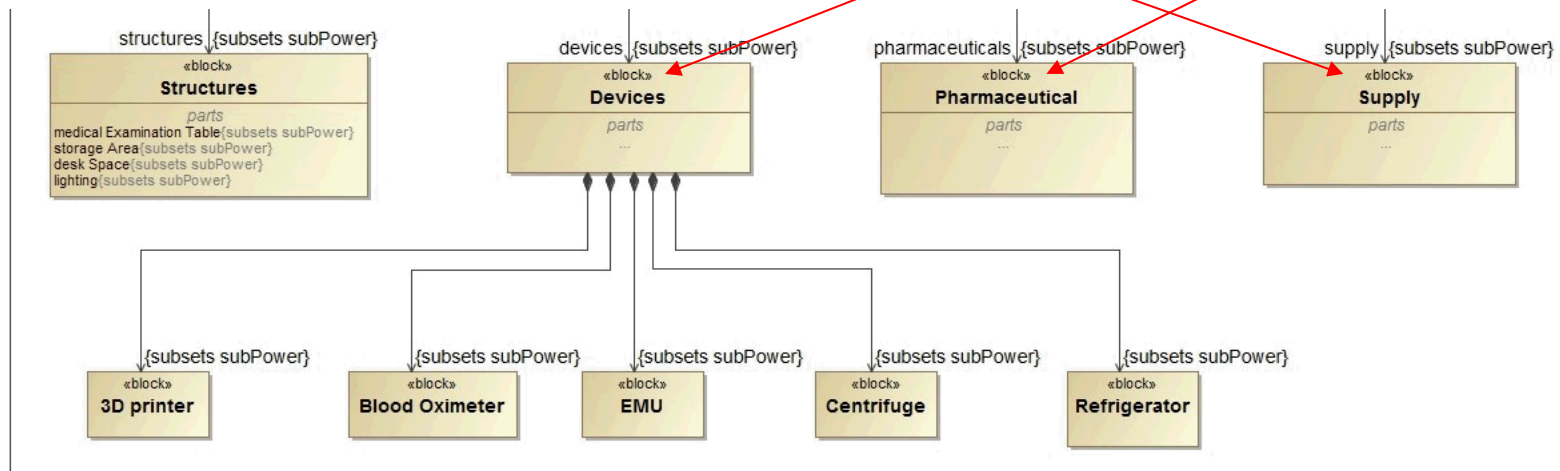
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	A	B	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	
	Owner	Name	Mass (kg)	Mass Est	Vol (mL)	Vol Est	Peak Power (W)	Power Est (W)	Batteries	Gateway	DRIM	Quant	Notes	Length (m)	Width (m)	Height (m)	Shape	Source	Source
2	Device	Blood Oximeter Sensor - SpCO	N/A	0.06804	N/A	0.00014	N/A	15,000		180612			1 Estimated from 14 Pulse Oximeter	0.06096	0.02794	0.08128		https://www.amazon.com/dp/B00RT3PBDX	https://www.apple.com/shop/product/HL62V74in
3	Device	Blood Oximeter Sensor - SpHb	N/A	0.06804	N/A	0.00014	N/A	15,000		180612			1 Estimated from 14 Pulse Oximeter	0.06096	0.02794	0.08128		https://www.amazon.com/dp/B00RT3PBDX	https://www.apple.com/shop/product/HL62V74in
4	Device	Braslet cuffs	N/A	0.45359	N/A	0.00060	0.000	N/A		180612			1 similar item; height, mass, vol estimated from image	0.85	0.07	0.01	cubeid	https://occlusioncuff.com/orcuff-silite-2	https://occlusioncuff.com/orcuff-silite-2
5	Device	EMU I	N/A	75.00000	0.00000	2.76089	N/A	1000.000		180612	vehicle	Mass and Volume						https://occlusioncuff.com/orcuff-silite-2	https://occlusioncuff.com/orcuff-silite-2



Requirement Calculations

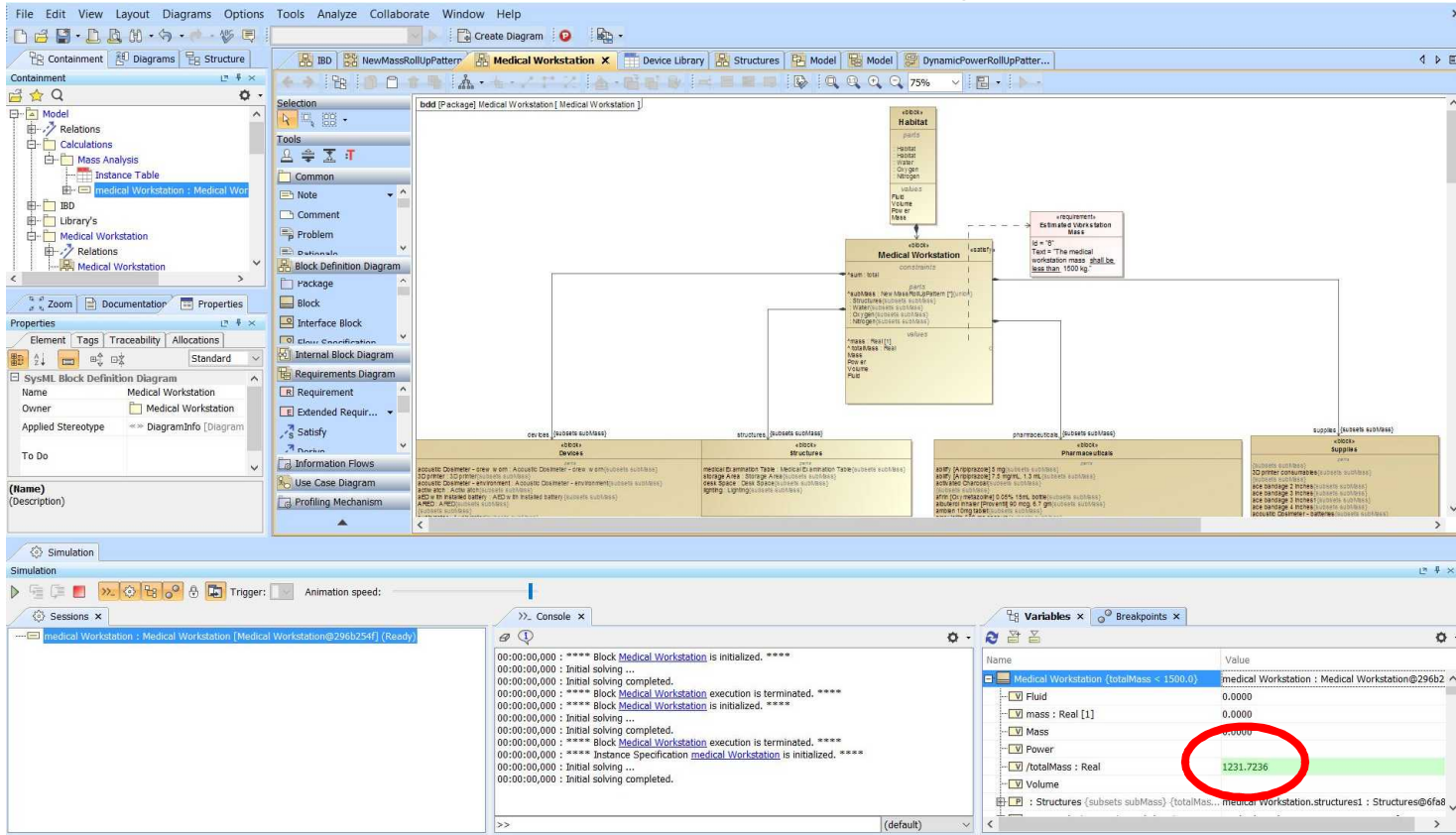
- Data from the spreadsheet was imported into MagicDraw to perform the calculations.

6						
	Device	AED with installed battery	Circulation - Defibrillation/Pacing/Cardioversion	3.30000	N/A	0.00726 N/A
7						
	Device	AED	Aerobic Exercise Aerobic Exercise - Rowing Resistive Exercise Musculoskeletal - Physical Therapy	544.31000	N/A	5.97500 N/A
8						
	Device	Artificial light (mood therapy)		0.82100	N/A	N/A 0.00859 N/
◀ ▶ ... Sheet1 Gateway Condition-Capability#85 Gateway#85Supply Gateway#85Device Gateway Pharm						



Mass Calculation

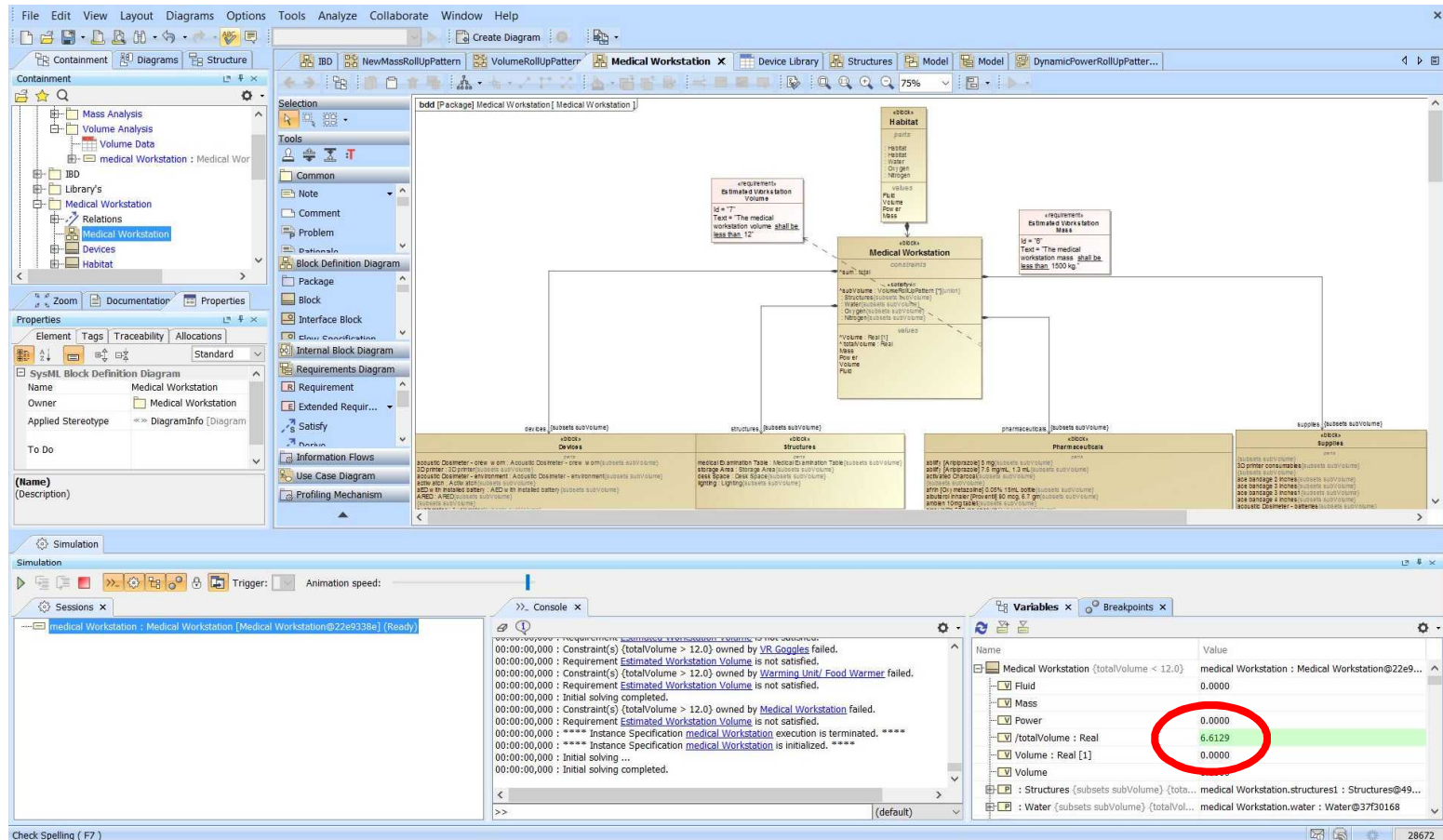
- Important number because it could impact the design of the Habitat





Volume Calculation

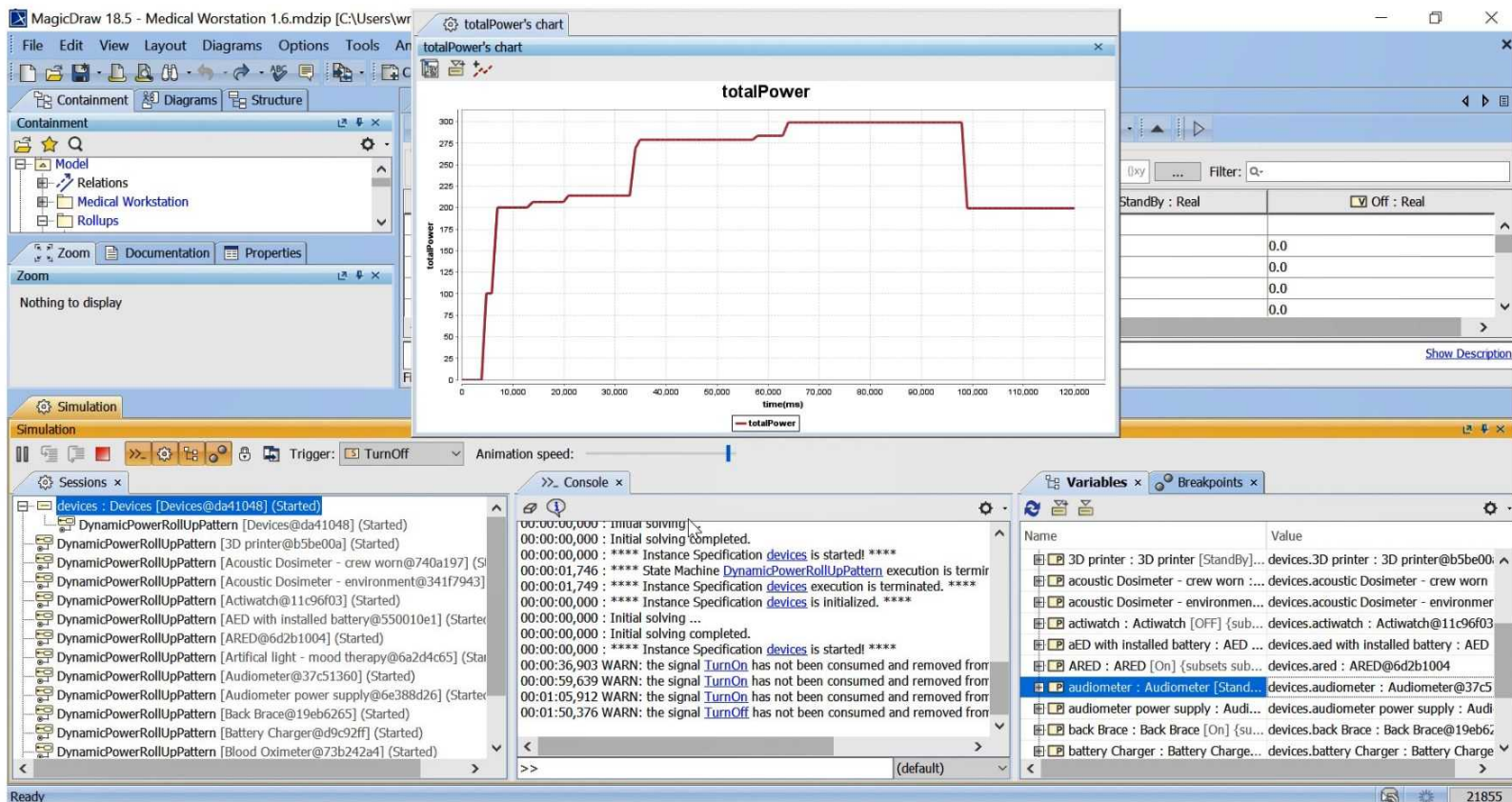
- The medical workstation total volume was calculated in a very similar manner as the mass.
- However this volume total only consists of the total volume needed for devices, supplies and pharmaceuticals.





Power Calculation

- The total mass of the current workstation was calculated by performing a rollup of the data in the model.
- The mass rollup analysis was performed to provide an estimated value for the total mass of the MW.
 - Important number because it could impact the design of the Habitat





ICD Summary

- After reading the medical workstation ICD, a Habitat designer will now have important insight of the medical workstation to aid in their design process.
 - General visual of the medical workstation and its make up
 - Descriptions of its biggest structural components and how they might integrate into the habitat
 - Mass, Power and Volume totals
- This ICD is also a useful document to organize progress and get a sense of what has been accomplished thus far.
- The MagicDraw medical workstation system is a useful program which can continue being updated to keep track of progress.



Next Steps

- This initial ICD was written at a very high level discussing only the primary design constraints of mass, power, and volume.
- As progress is continued to be made the scope of the ICD can begin to narrow and get more detailed.
- Some ideas for further research include:
 - Physical anchors and mounting devices for the medical workstation.
 - The need for more precise and adjustable temperature control.
 - Ways to eliminate excess weight and volume
 - Does the workstation need its own air supply and exhaust air vent?



Questions?

