Design Improvements & Implementation to Strengthen 6-Axis Robotic Additive Repair Platform

Jesse Mertz, Finn Milutinovich, Maria Wheeler

- John Olson Advanced Manufacturing Center, University of New Hampshire, Durham -

Objective

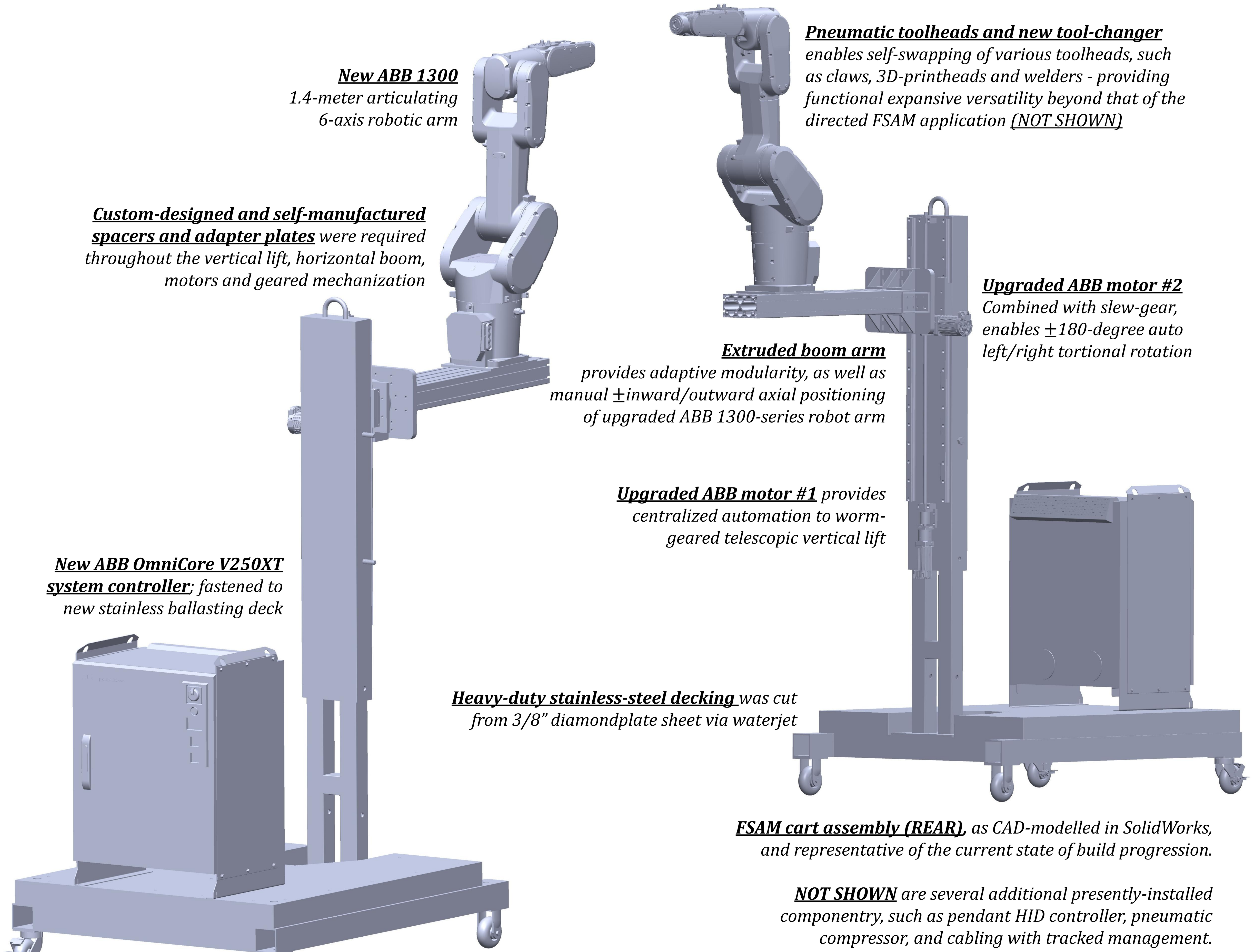
The stated objective for utilizing a 6-axis robotic arm for 3D-printing metals via the implementation of friction-stir additive manufacturing (FSAM) is the fabricative repair of military vehicle systems. The unit was designed to meet a multitude of specifications for various applications, such as aircraft, watercraft and mechanized armored systems.

These requirements include the capability of self-support in reaching repairs up to 9ft high, the agility and clearances necessary to negotiate winged craft, and the ability to perform all tasks at a ±7 degree positive or negative incline while remaining solidly balanced, mobile, and maneuverable by individual human operator.

Improvements

Designed and manufactured parts to adapt, upgrade, and install numerous off-the-shelf components, as well as negotiated their strategic placement based on intended application in accordance with ABB installation guidelines :

- **Conducted applicable stress simulations**, and calculated the forces being exerted system-wide, to ensure proper metallurgy and material margins of safety to design and accompanying 10.9 metric hardware. Subsequently **manufactured said steel adapter plate** to accommodate addition of larger 1300-series ABB robotic arm; secured plate and installed new arm.
- **Created mounting solutions** to enable the upgrading of motors from original mismatched Teknic models to a directly compatible centrally-controllable model made by ABB; manufacture them and install with new motors.
- **Designed and installed decking** to provide mounting surface and additional ballast.
- **Determined cable track needs** and relevant routing; connected operative data and power.
- **Built a 480V 50ft power cable** to enable extended workspace and enhance expeditionary versatility.
- **Designed and manufactured conversion plate** to provide adaptive compatibility to upsized pneumatic tool changer; successfully installed tool changer.
- **Installed air compressor** to provide air to system.
- **Reconfigured mounting orientation** for ABB OmniCore V250XT system; installed new auxiliary motors controller.



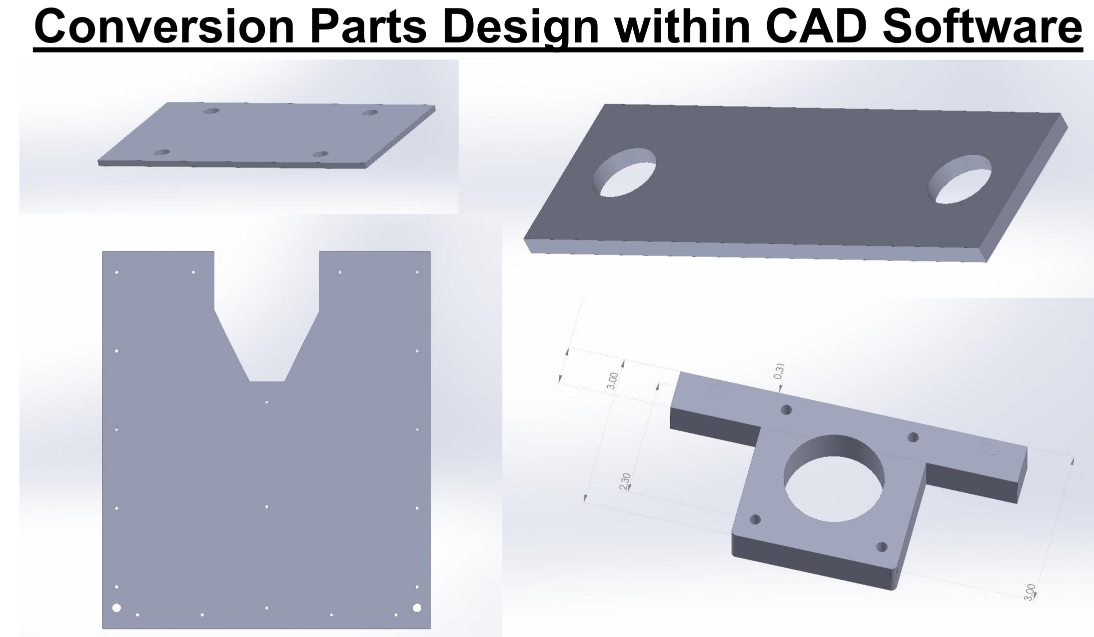
FSAM cart assembly (FRONT)

FSAM cart assembly (REAR), *as CAD-modelled in SolidWorks, and representative of the current state of build progression.*

NOT SHOWN *are several additional presently-installed componentry, such as pendant HID controller, pneumatic compressor, and cabling with tracked management.*

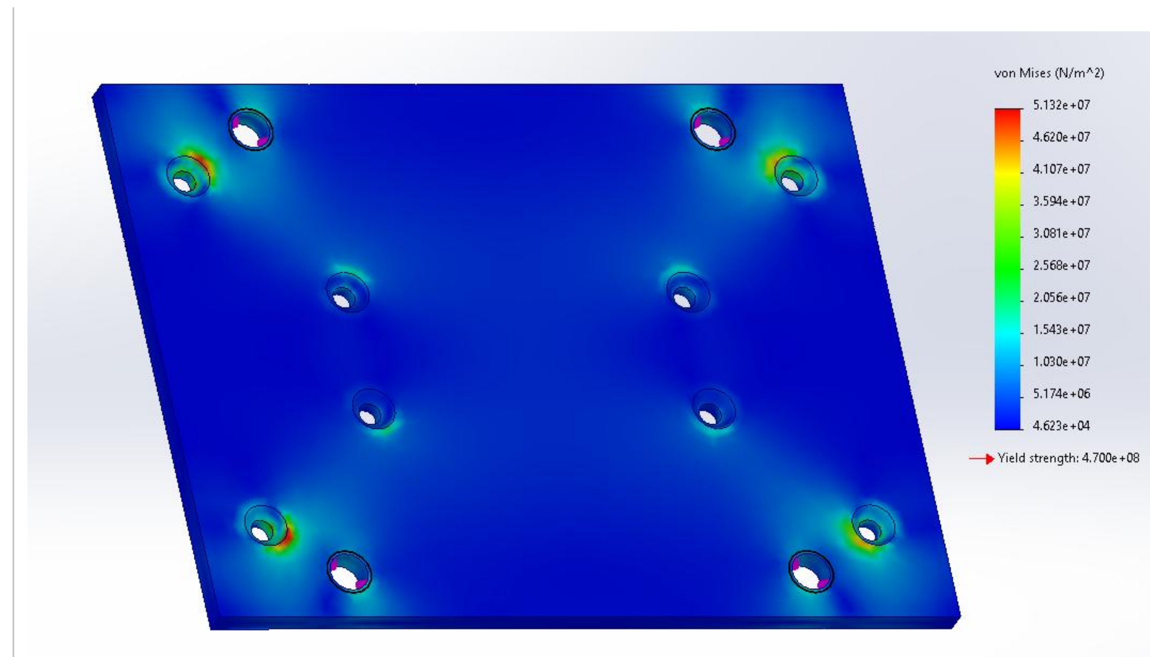
Parts Manufactured

Conversion Parts Design within CAD Software



Prior to manufacture, *2D & 3D models are created via computer-aided design (CAD). Shown are representations of the various CAD parts files that were designed to adapt the upgraded components.* ***Clockwise from top left,*** *1.) guide rail spacer , 2.) spacer for worm gears, 3.) multi-function upper deck ballast plate and mounting surface, and 4.) adapter spacer for mounting of new ABB motor.*

Modelled Stress Test of 3/8"Steel Adapter Plate



Modeled physical stress tests were conducted *within SolidWorks CAD software, applying correlative material tolerances to establish a solid mounting surface with appropriate margins of safety.*

Conclusions

Efforts culminated in having successfully mounted the larger ABB 1300 robotic arm to the original chassis in place of the smaller 120 unit that was originally featured. Ultimately, the project progressed significantly in the six weeks provided. However, given the short timeframe dictated by limited tenure, the project has not reached completion – albeit in a good position to be handed-off to the next team.

Future planned upgrades include the requirement for self-propulsion, featuring a motorized 4-wheel-driven zero-turn drivetrain. Additional cable management, a "shopping cart" type push handle, a "garden hose"-style power cord hanger, the 3D-FSAM spindle, further optional quick-detachable tooling, rotational vertical base, and slew-gear safety lockout.

Acknowledgements

TEAM MINI-ABB would like to thank the John Olson Advanced Manufacturing Center, as well as the students, faculty, and interns involved in the friction-stir (FSAM) research project.

We also wish to thank Dr. John Roth (Olson Center), Dr. Stephen Hale (UNH), Dr. Sadie Stimmell (MCC), as well as our project advisors Cordelia Norris and Owen Mahanes.

Funding provided in-part
by the ReGen Valley Tech Hub grant,
as administered by Manchester Community College,
Manchester, New Hampshire.

NH-LIFT is a project funded by the National Science Foundation (NSF award #2412054).

Special thanks are offered to
the National Science Foundation and its EPSCoR Track 2 grant (NSF award #2218063) for providing support for this research.

Contact: *Jesse Mertz, MCC Student:*
jmertz058@students.ccsnh.edu