TBD

Digital Engineering Design Center (DEDC) Modelling an ISRU System

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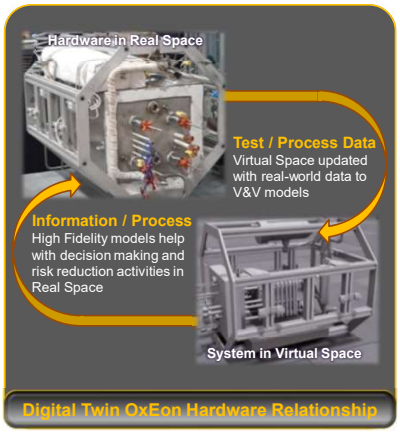
EXECUTIVE SUMMARY

- The Digital Engineering Design Center (DEDC), partnered with JSC and operated by the University of Texas at El Paso's (UTEP) Aerospace Center, hires interns from universities local to Houston & located onsite in Building 56.

- The DEDC provides immersive project-based learning on digital engineering toolsets and processes supporting NASA's digital transformation goals:
  - Digital Engineering uses authoritative sources of systems' data and models as a continuum across disciplines to support integrated digital approach life cycle activities from concept through disposal.
  - The digital environment provided includes the state-of-the-art digital engineering suite, Siemens Xcelerator.
- The pilot project is developing an end-to-end integrated model of an In-Situ Resource Utilization (ISRU) system for commodities production:
  - ISRU uses local resources to provide mission consumables to enable a sustainable Moon or Mars surface presence.
  - The final digital twin product will include a methanation reactor, condenser, and electrolyzer subsystem.

INNOVATION

- The primary objective of the DEDC is to provide a pipeline for the next-generation aerospace workforce, equipped with transformational DE skills
- This goal is achieved by developing ISRU system digital twins and providing 'hands-on' experience with DE tools & methodology
- The models and methodologies can be infused into NASA projects and initiatives to enable rapid model-analyze-build technology development.



COLLABORATION

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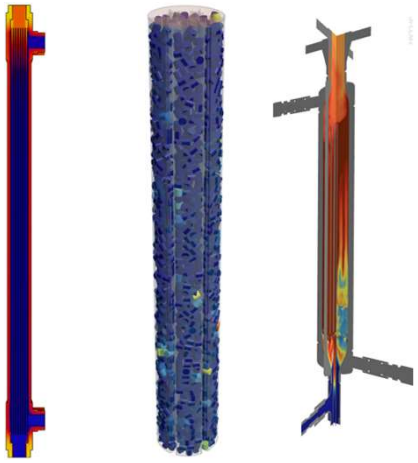
University of Texas at El Paso (UTEP)
- Develop students and faculty with relevant NASA projects
- Operate remote DEDC

Propulsion & Power Division (EP)
- Serve as pathfinder providing ISRU hardware and projects
- Provide ISRU subject matter & experts (SME)

OxEon Energy
- Provide hardware & test data
- Provide development support of prior models

Other Supporting Engineering Divisions:
- Crew and Thermal Systems Division (EC)
- Software, Robotics, & Simulation Div. (ER)
- Project Mgmt. & System Eng. Div. (EX)

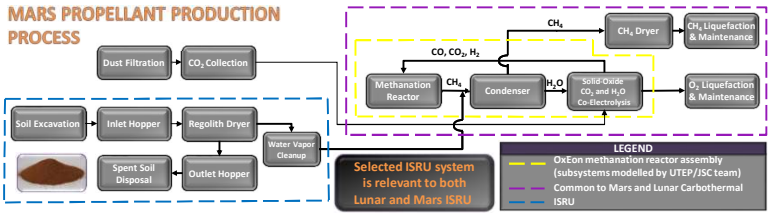


Condenser temperature profile (left); DEM catalyst particles (center); low fidelity reactor methane flow (right)

OUTCOMES & INFUSION

The DEDC's vision is to provide a DE capability that can be infused into NASA JSC-led projects and initiatives.

1. The project develops a Digital Twin for the key subsystems of the integrated system (Methanation Reactor and Condenser), which are common elements to both the Lunar and Mars ISRU architecture.
2. Each of the subsystems is modeled in Siemens StarCCM+. Each of the models achieves the fidelity to simulate the inputs to the outputs test cases at the subsystem level.
3. Methanation Reactor Modeling–The Methanation reactor is modeled as a porous media flow and the methanation reactions are modeled as appropriate surface chemistry.
4. Condenser Modeling -The condenser is modeled as multiphase fluid film modeling.
5. Catalyst Bed Reactor Modeling – DEM is used to generate catalyst particles in the reactor bed.
6. Promotion/Outreach – presented DEDC work and DE capabilities to the 2023 Thermal & Fluid Analysis Workshop and universities (including UTEP & Rice University).
7. Prepare the current (NASA workforce) and provide a pipeline for the next-generation (student-interns) aerospace workforce with transformational digital engineering skills.



FUTURE WORK

Describe planned future work, pursuits and next steps

1. Anchor the subsystem models under the Siemens Teamcenter toolbox to develop a system model that will incorporate the requirement linkage between subsystems and Interface Control Documents (ICD).
2. Model Scalability – increase fidelity of models using additional test data and make models scalable to different environments (lunar, Mars, etc.).
3. VR Capability – enable models to be viewed & interacted in 3D space.
4. Enhanced collaboration – include other universities, NASA centers, industry partners.

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