

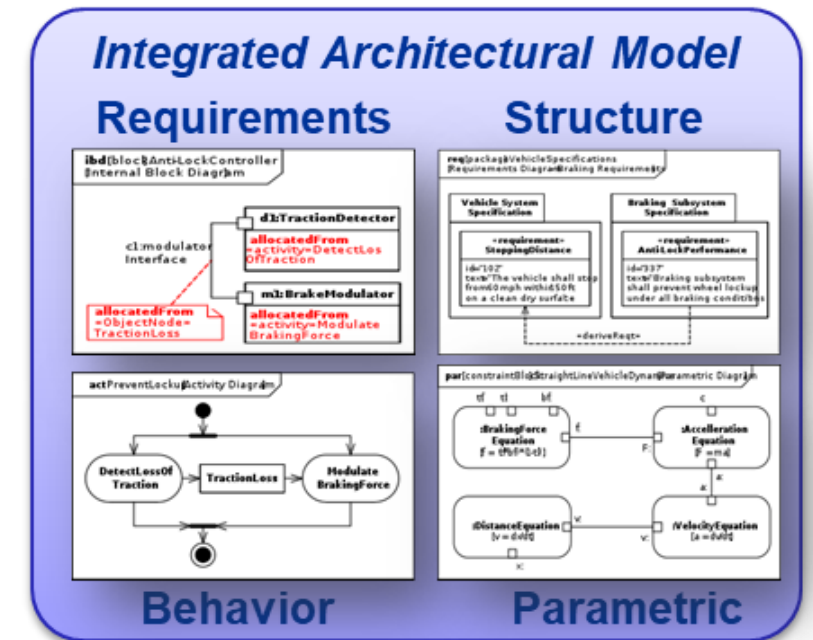
Digital Twin and Industry 4.0 in support of Heliostat Technology Advancement

Tietronix Software
HelioCon Project

July 12th, 2023

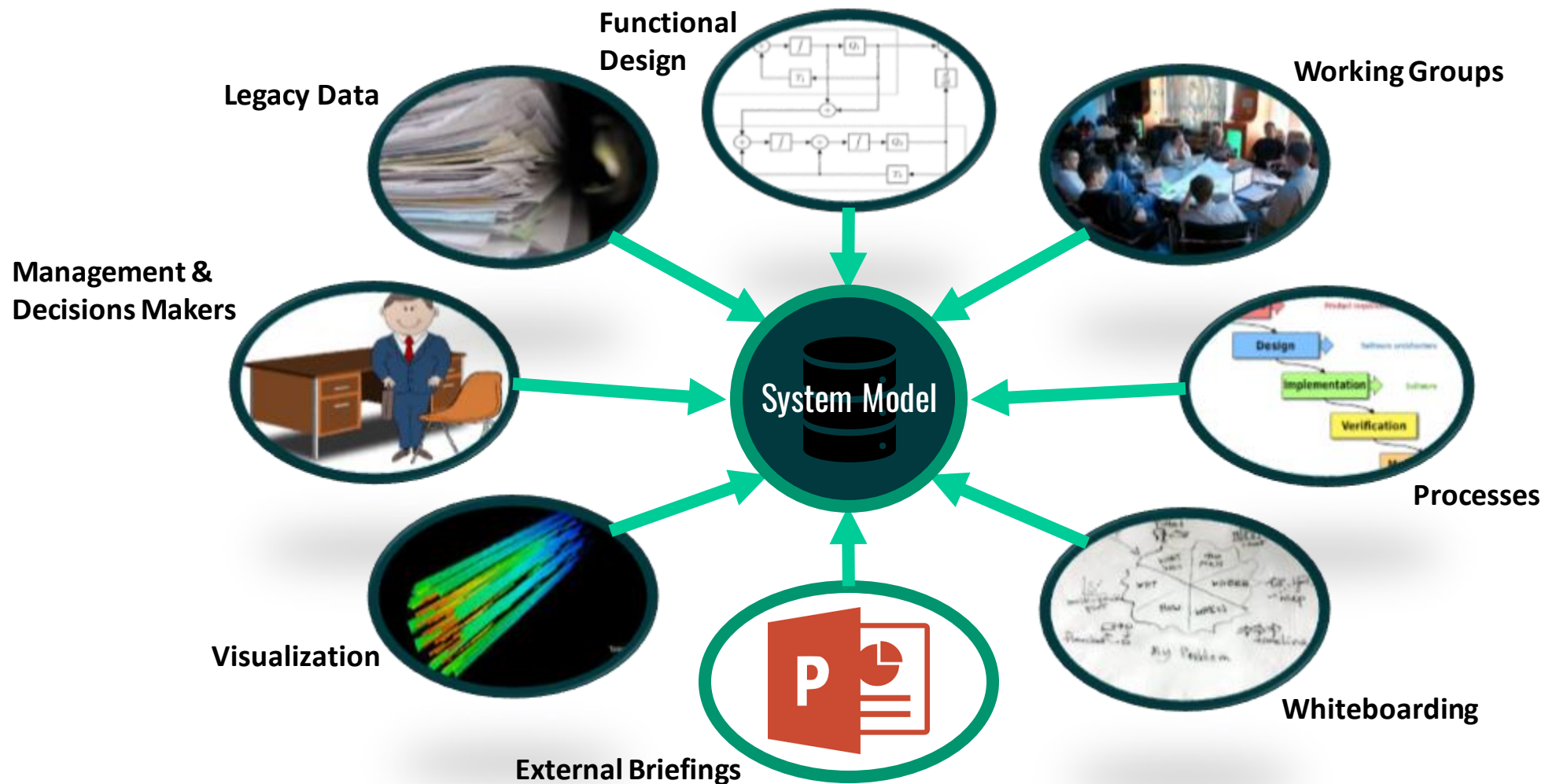
- Project aims to apply multiple technologies from the Industry 4.0 to the heliostat design, manufacturing, deployment and operations in order to realize the cost reduction seen by other industries which have adopted these technologies.
- Industry 4.0 technologies:
 - *Model Based System Engineering (MBSE)*
 - *Digital Twins*
 - *Machine Learning*
 - *Industrial Internet of Things (IIoT)*
 - *Virtual and Augmented Reality*

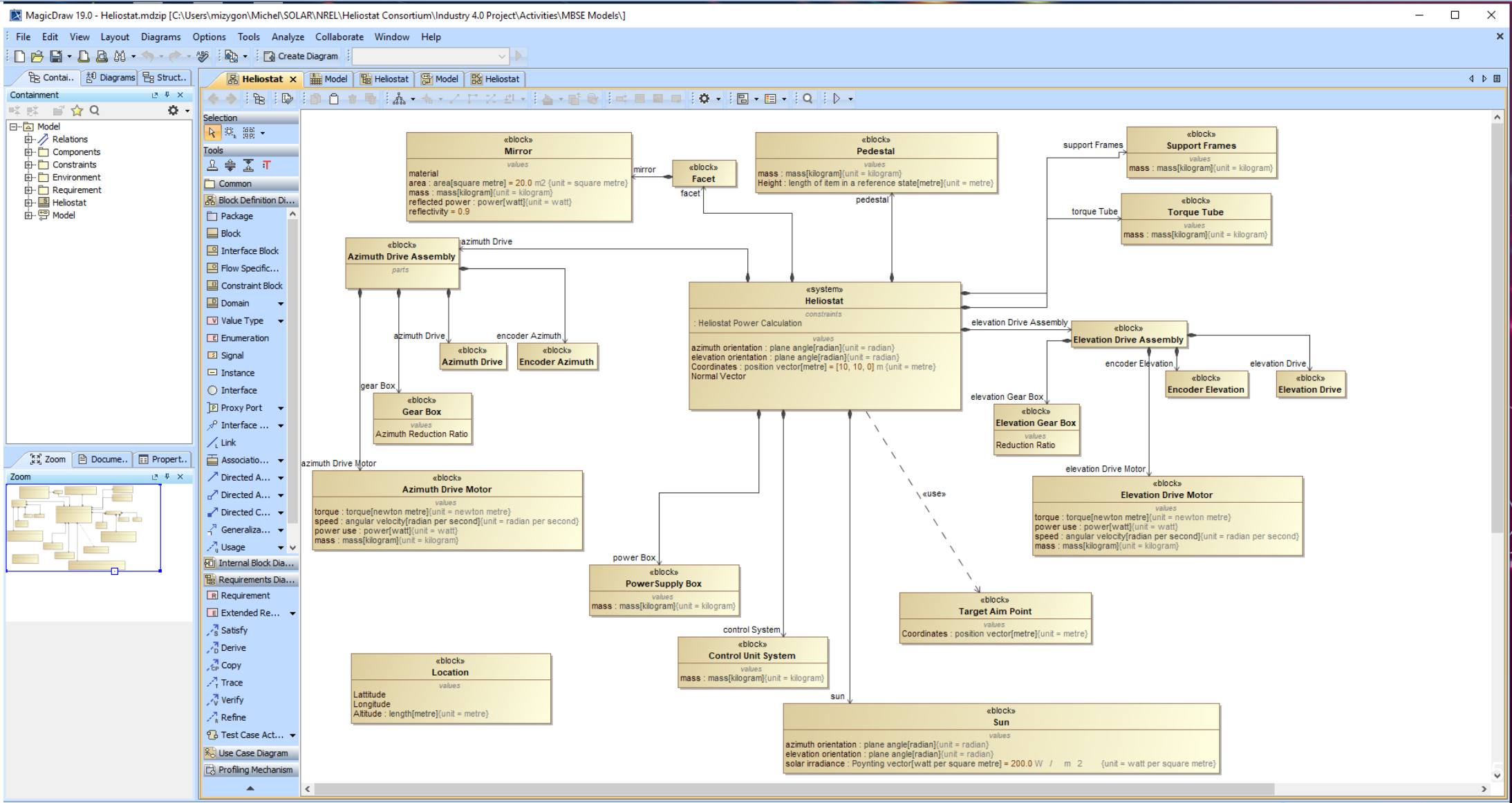
- Models use common data sets
 - *Provides a consistent view of the architecture*
 - *Can lead directly to system specifications & test plans*
 - *Reduces systems integration and testing risks*
 - *Promotes traceability*
 - *Makes it possible to identify gaps and overlaps*
 - *Facilitates model reuse and integration*
- Uses a standards-based modeling language
 - *Defines architectures that can be simulated with standard tools*
 - *Models can be used with many standards compliant automation tools*
- Automation tools are used to generate artifacts
 - *Less labor intensive to generate & update*



Data as a single source of truth

Inputs from multiple streams





DT is a virtual model, designed to accurately reflect a physical system that enables better understanding, prediction and collaboration of the physical system throughout all phases of the lifecycle

● Tenets of a DT:

- *An immersive environment that allows stakeholders to collaborate through a common visualization and interaction platform throughout the system lifecycle*
- *Connect IoT sensory data to the virtual model to gain insights, to generate possible improvement in the design and to apply back to the actual system during design*
- *Connect systems telemetry and commands to the virtual simulation model to perform “what-if” scenarios and design trade studies to assess margins, impacts during operations*
- *Access system data (schematics, 3D CAD, simulations, procedures, FMECA, fault trees, Anomaly Reports, IFI history) to support design trade studies, analysis and predict anomalies and real-time decision making.*
- *Collect and ingest operational archive data to update/train the virtual model with data mining and machine learning technologies.*
- *DT is used for VR/AR Training and AR for operational procedures development verification*

Initial Digital Twin prototype

The screenshot displays the NVIDIA Omniverse interface for a digital twin prototype. The main viewport shows a 3D scene of a heliostat field in a desert environment. The heliostats are large, rectangular mirrors reflecting the sky and clouds. The scene is rendered in a realistic style with shadows and a clear blue sky.

The interface includes a top menu bar with options: File, Edit, Create, Window, Layout, Tools, Help. The top right corner shows "LIVE" and "CACHE: ON". The left sidebar contains navigation tools and a "Stage Lights" button. The right sidebar shows a "Stage" panel with a search bar and a list of objects:

Name (Old to New)	Type
World (defaultPrim)	Xform
SR00_9000_00	Xform
Heliostat_NSTTF	Xform
Heliostat_Tonopah	Xform
fieldTerrain	Xform
Measure	Xform
Environment	Xform

The bottom panel shows the "Content" browser with a search bar and a list of assets. The "NREL DT" folder is selected, showing a file named "HeliostatsExample.usd". The file's metadata is displayed:

Name	Date	Size
SolarDynamics	06/02/2023 09:05AM	
HeliostatsExample.usd	06/05/2023 08:10AM	4.44 KB

The "NREL DT" folder details are also shown:

Property	Value
Date Modified	06/02/2023 09:04AM
Created by	mzambetti
Modified by	mzambetti
File size	0.00 KB

Initial Digital Twin prototype

The screenshot displays the NVIDIA Omniverse interface for a digital twin prototype. The main viewport shows a 3D scene of a heliostats field in a desert environment. The scene includes a large heliostat on the left, a smaller one in the center, and a larger one on the right. The sun is visible in the sky, casting shadows on the ground. The interface includes a top menu bar with 'File', 'Edit', 'Create', 'Window', 'Layout', 'Tools', and 'Help'. Below the menu bar is a toolbar with various tools and settings, including 'RTX - Interactive', 'Perspective' view, '17 - 35 mm' focal length, 'Zoom 18.14756', and 'Stage Lights'.

The right sidebar contains a 'Stage' panel with a search bar and a list of objects:

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Below the Stage panel is a 'Property' panel.

The bottom panel shows the 'Content' browser with a search bar and a list of assets:

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SolarDynamics	06/02/2023 09:05AM	
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Additional information for the selected asset:

- NREL DT
- Date Modified: 06/02/2023 09:04AM
- Created by: mzambetti
- Modified by: mzambetti
- File size: 0.00 KB

Checkpoints are also visible in the bottom right corner.