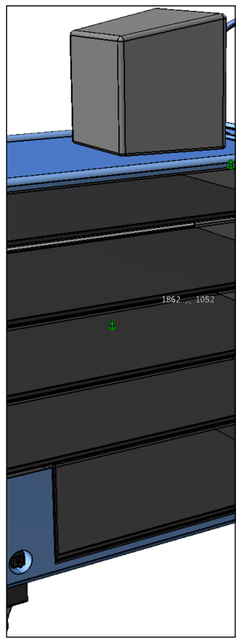
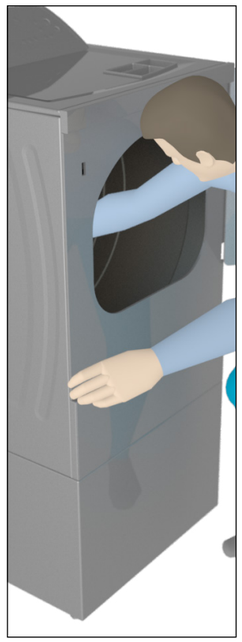
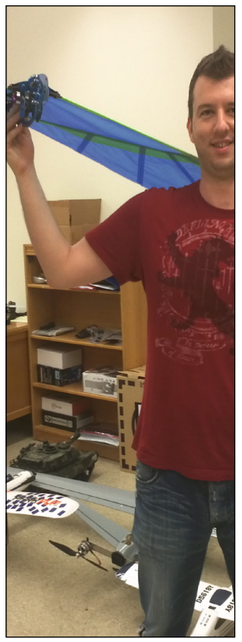
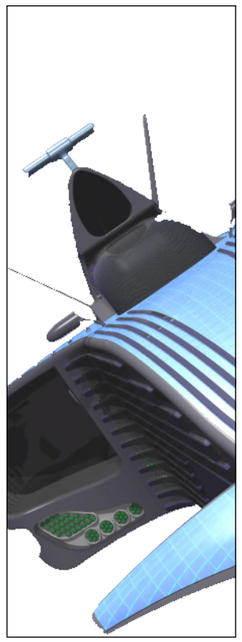
Design Portfolio

by Onan Demirel

CREATION

CONCEPTION

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DESIGN RESEARCH

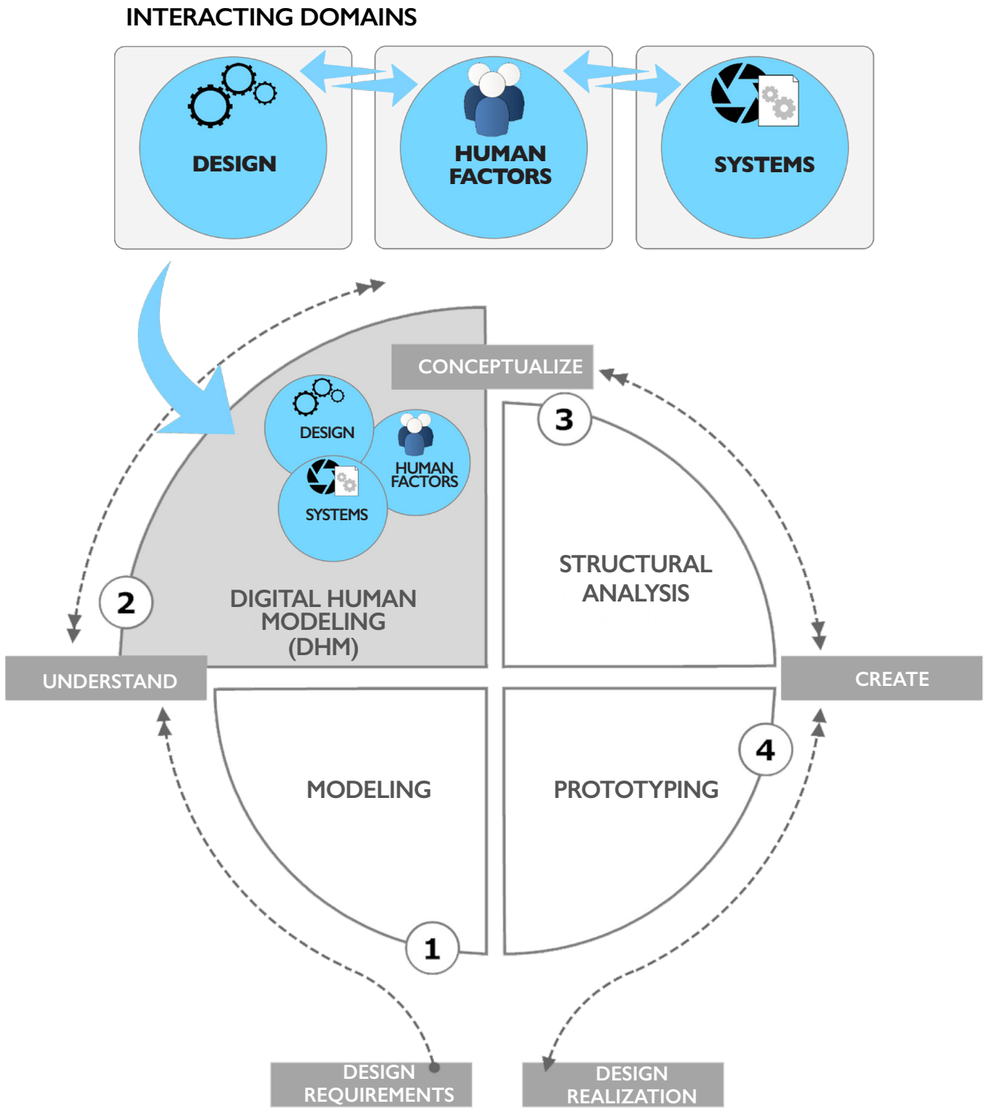
DESIGN APPLICATIONS

HUMAN-IN-THE-LOOP DESIGN FRAMEWORK BASED ON DIGITAL HUMAN MODELING

HUMAN-IN-THE-LOOP DESIGN FRAMEWORK

Objective: I proposed a novel **product design** framework, which utilizes **Digital Human Modeling (DHM)** as a middle-ware to form a seamless integration between; **Design**, **Human Factors Engineering** and **Systems Engineering** [1].

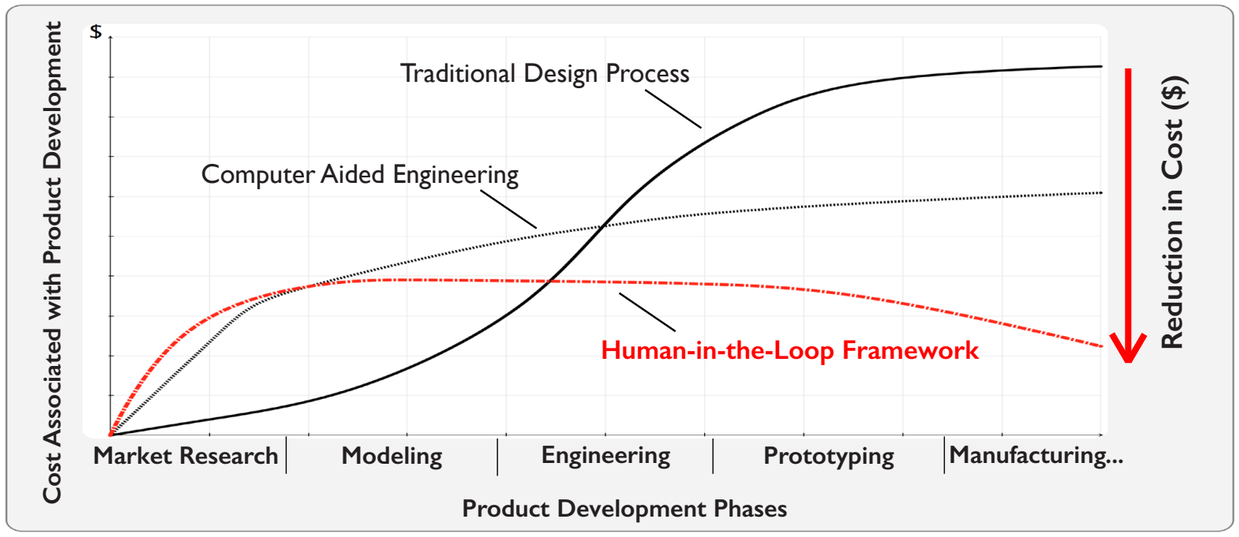
Goal: To consider **human needs, abilities** and **limitations** during **early** stages of product design in a **systematic** way [1,4,5].



WHY IS THIS FRAMEWORK IMPORTANT?

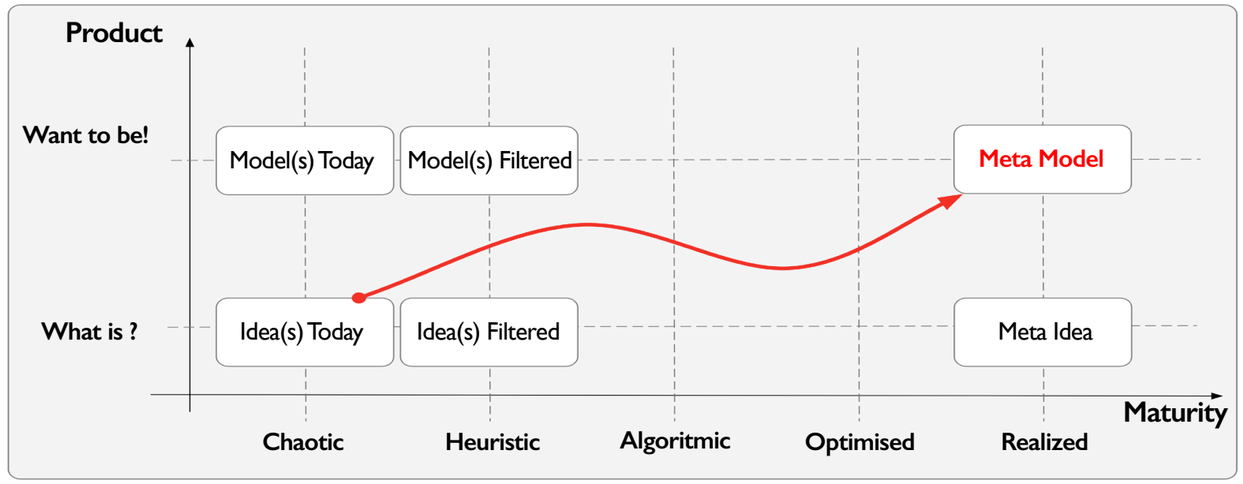
A) Cost Savings and Reduction in Design Iterations

- Introduces **human aspects** of the design **early** in product development **[1,5,6].**
- **Reduces** design iterations, lead-time to market, and development costs **[1,5,6].**
- Offers a design flow from **conception** to **creation** of products **[1,5,6]**.



B) Ability to Capture a Potential Meta Model from Idea Today

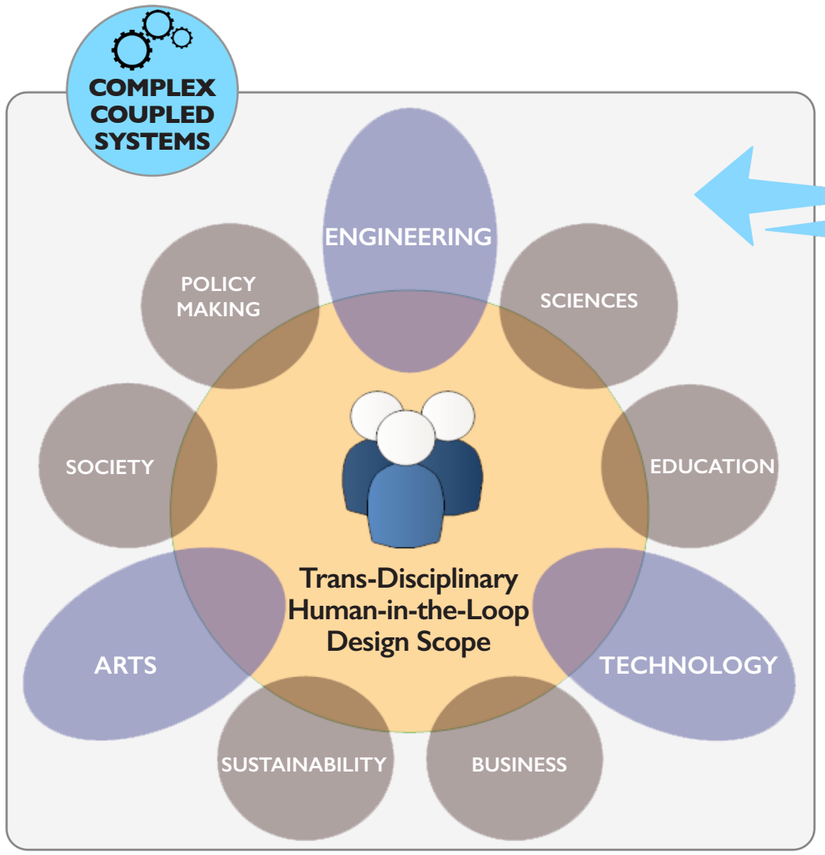
- Provides a **seamless integration** with **engineering** and **design techniques [1,3].**
- Creates a modular platform to allow integration of new **technologies [1,3].**
- Enables **strategic thinking** through systematic refinement of ideas **[1,3].**

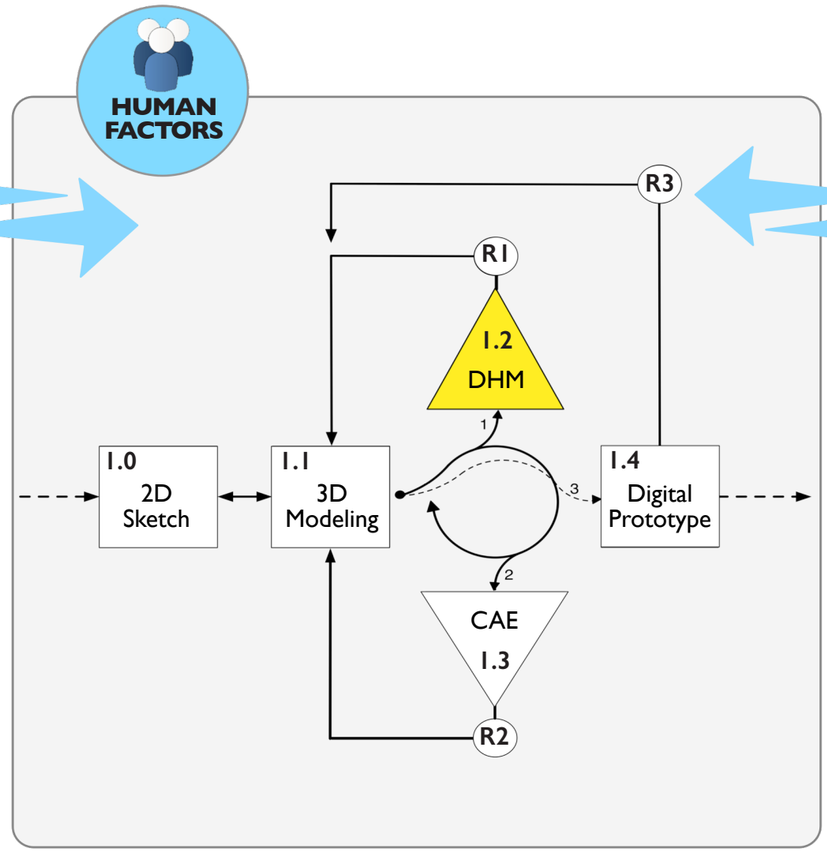


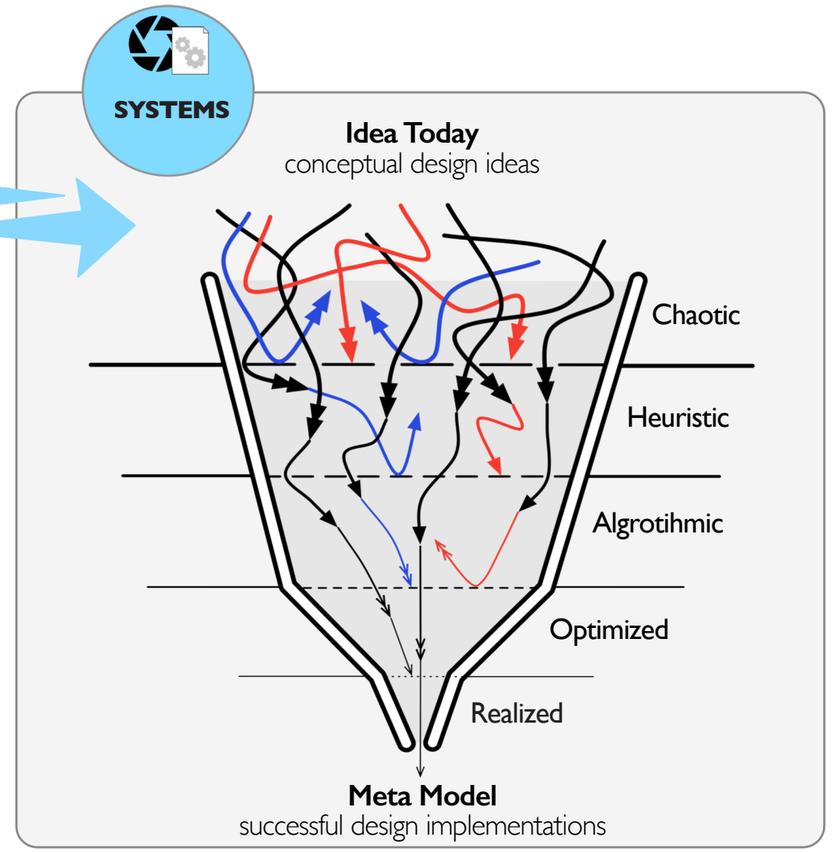
PUBLICATIONS

1. Demirel, H. O., Zhang, L., Duffy, V. G. (2014) Opportunities for Meeting Sustainability Objectives. *International Journal of Industrial Ergonomics* (In Press).
2. Demirel, H. O., & Duffy, V. G. (2013). A Sustainable Human Centered Design Framework Based on Human Factors. In *Lecture Notes in Computer Science / Digital Human Modeling and Applications in Health, Safety, Ergonomics, and Risk Management. Healthcare and Safety of the Environment and Transport*, 8025, 307-315.
3. Demirel, H. O., Duffy, V. (2012). Bhattacharya, A., & McGlothlin, J. D. (Ed.) Ergonomics Software Sources. In *Occupational Ergonomics: Theory and Applications* (pp.1245–1248). Second Ed.
4. Demirel, H. O., & Duffy, V. G. (2009). Impact of Force Feedback on Computer Aided Ergonomic Analyses. In *Lecture Notes in Computer Science / Digital Human Modeling*, 5620, 608-613
5. Demirel, H. O. (2008). User Manual and Examples: Tecnomatix Jack 5.0. In *The Handbook of Digital Human Modeling: Research for Applied Ergonomics and Human Factors Engineering*, Boca Raton, FL: CRC Press. Retrieved: http://www.crcpress.com/product/catno/ER564X.
6. Demirel, H. O., & Duffy, V. G. (2007). Applications of Digital Human Modeling in Industry. In *Lecture Notes in Computer Science / Digital Human Modeling* Volume, 4561, 824-832.
7. Demirel, H. O., & Duffy, V. G. (2007). Digital Human Modeling for Product Lifecycle Management. In *Lecture Notes in Computer Science / Digital Human Modeling*, 4561, 372-381.

R.2 PROPOSED DESIGN FRAMEWORK DOMAIN INTERACTIONS & DESIGN FLOW







DIGITAL HUMAN MODELING (DHM) [1,5,6]

- Provides visualizations of human with **math & science** in the background.
- Uses manikins as representations of workers inserted into a simulation or virtual environment to facilitate the prediction of **performance and safety.**
- Can have potential to represent and simulate complex human functions, including both **physical and cognitive performance** during design process.

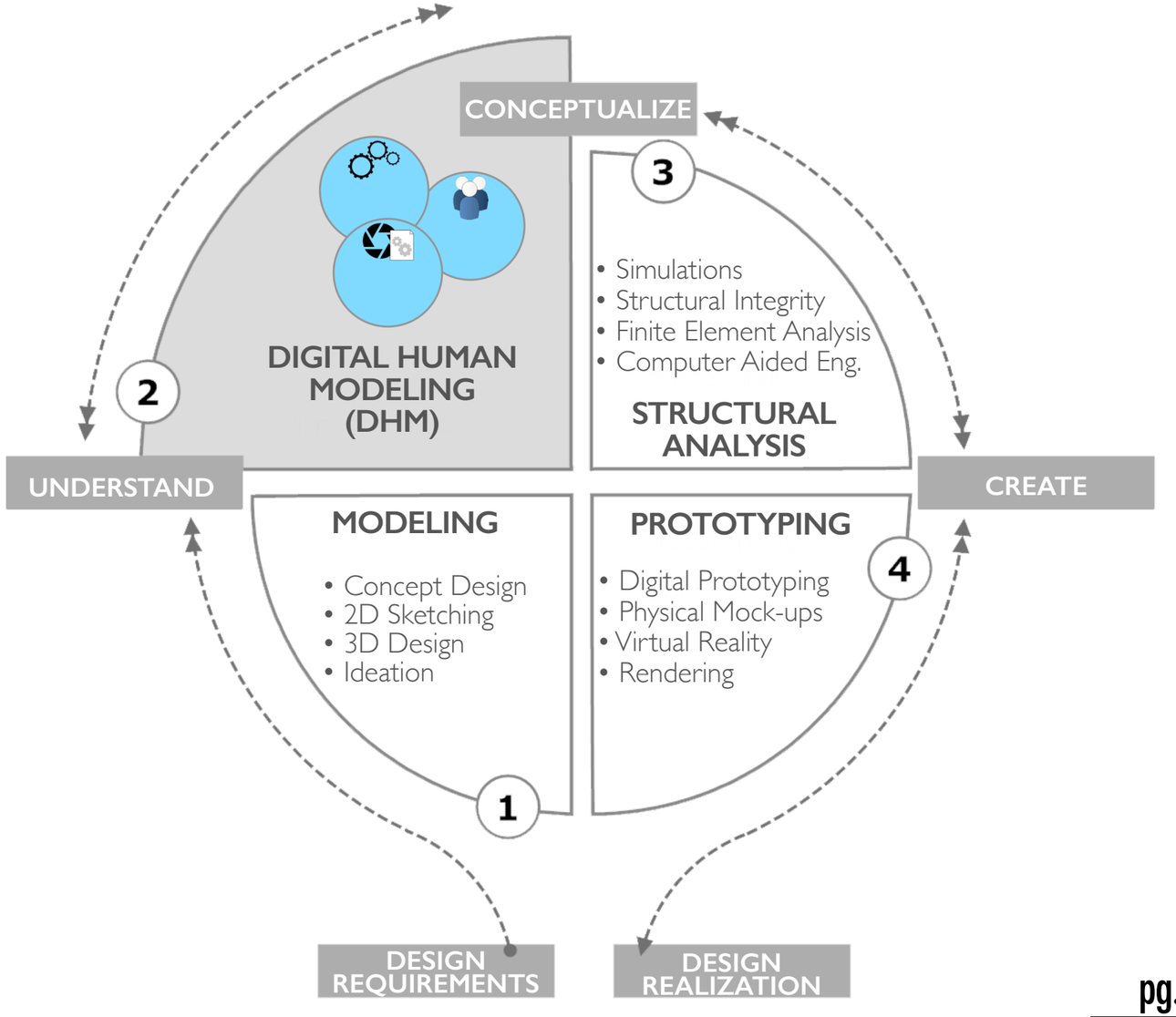
DESIGN FLOW IN FRAMEWORK

1→2 **UNDERSTAND** : Product development starts with identifying and understanding consumer requirements, which leads to concept idea generation through matching design requirements with engineering requirements and production of low-fidelity 2D/3D models.

2→3 **CONCEPTUALIZE** : Design requirements and concept ideas are linked with human modeling knowledge-base. Alternative models are created and further analyzed to capture best fit for human use/interaction through Digital Human Modeling (DHM) tools.

3→4 **CREATE** :Best model(s) from a pool of alternatives are selected, and high-fidelity models are refined by using structural simulations to create initial digital prototype(s).

4→ **DESIGN REALIZATION** : concept model(s) go in digital, and physical tests for further refinement. A concept product is selected and final prototype for beta-model is realized.

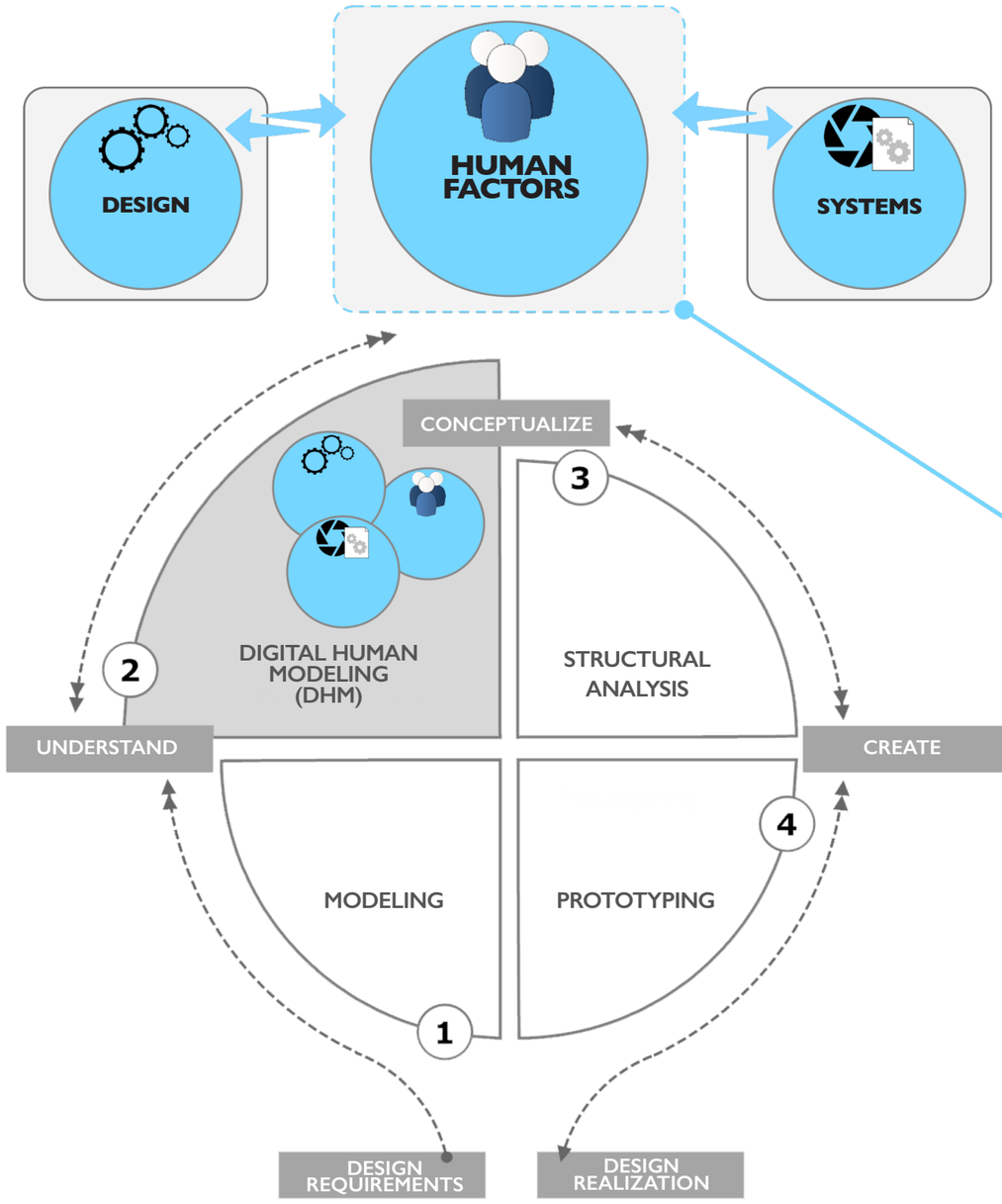


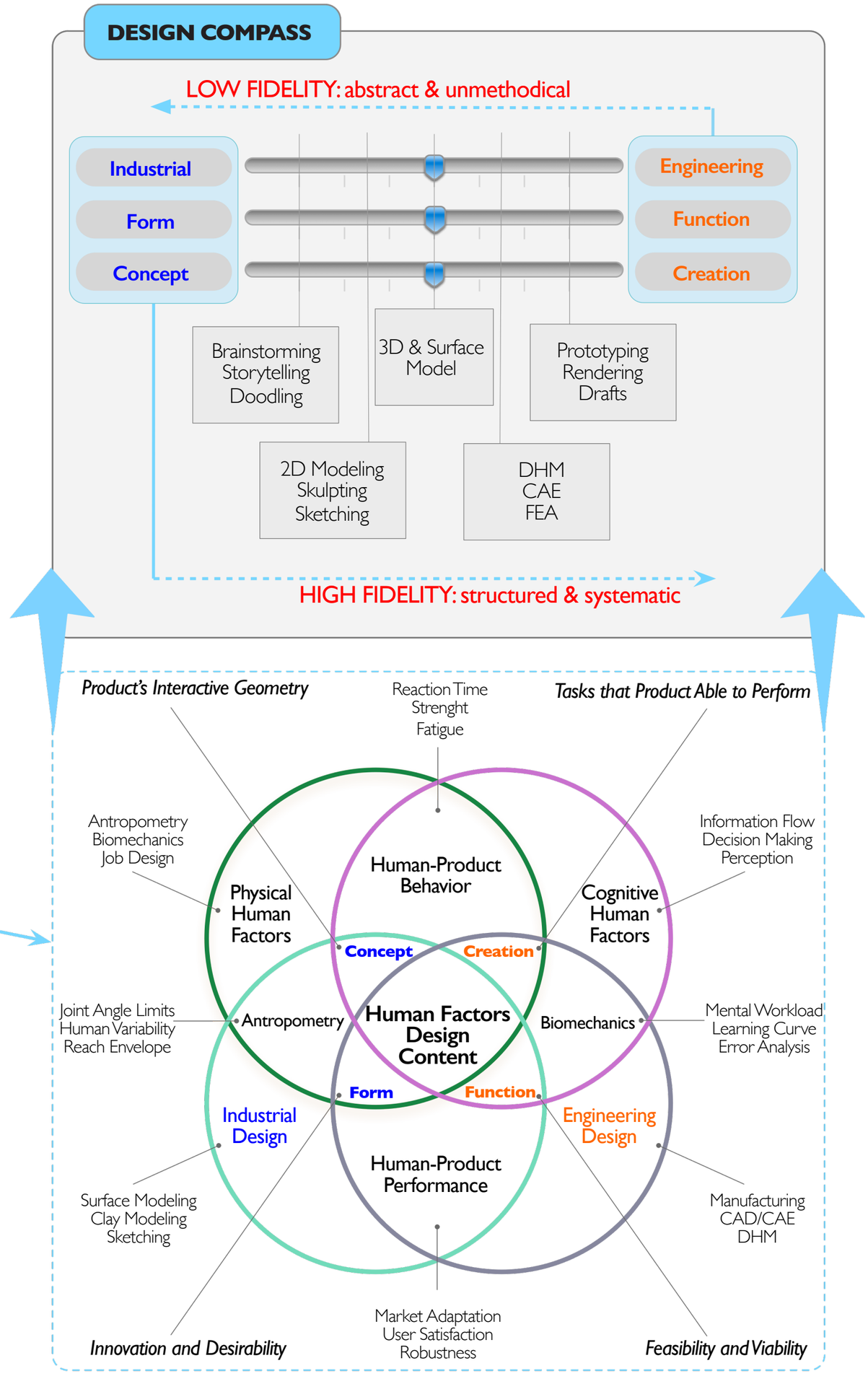
DESIGN COMPASS

About: I proposed a design compass as a visual guide to represent the interactions between design content and the fidelity of the design applications that are rendered within Human-in-The-Loop framework. It presents design extremities and design content contribution in product design development based on Human Factors domain knowledge and expertise.

Current Use : It provides a systematic visual representation of the design interactions between abstraction (arts, form) and structure (engineering, function), and offers a visual assistance in design realization of a high fidelity model (proof) from a low fidelity idea (concept) within Human-in-The-Loop design framework.

Future Work: My aim is to convert this visual compass tool to a mathematical axiom, which quantifies design content and provides a much systematic control of the design process. This would assist artists and engineers in harmonizing abstract and structural nature of design, monitoring contribution needed from different design domains and managing resources such as material, time, human effort to render a desirable, feasible and viable products.





HOW TO INTEGRATE THE COCKPIT DESIGN WITHIN CONCEPT FORMULA-1 DEVELOPMENT?

A) Design Flow for Cockpit Design

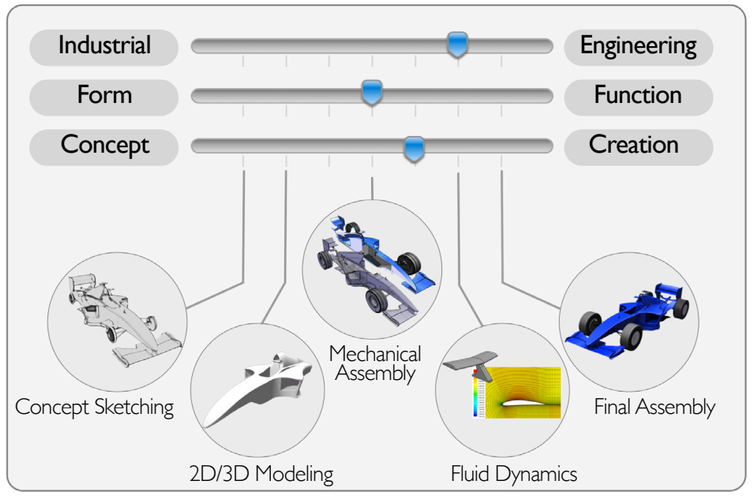
1→2 **UNDERSTAND** : The design starts with 2D digitalized sketching (based on design requirements derived previously), then 3D models are generated to establish initial design parameters.

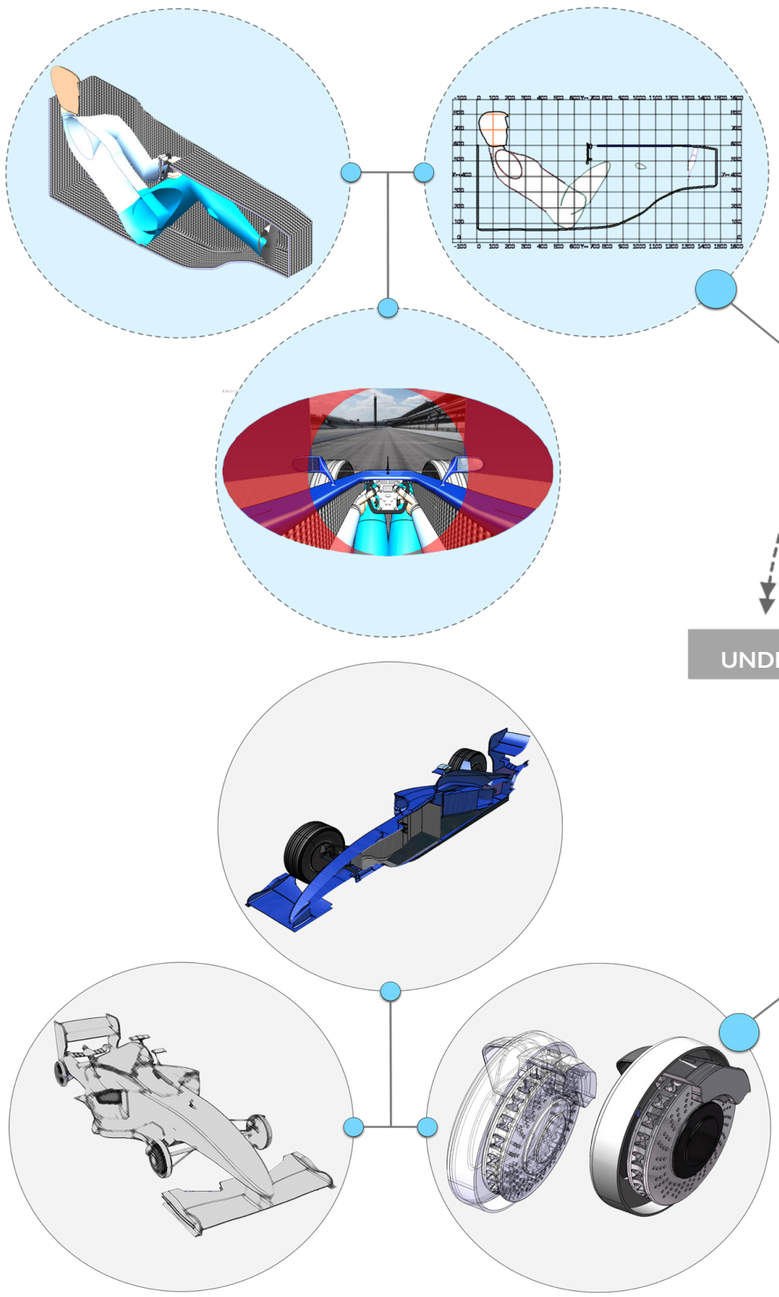
2→3 **CONCEPTUALIZE** : DHM tools are utilized to check driver's posture (data coming from motion capture and anthropometric library) and biomechanics assessments are run to optimize it.

3→4 **CREATE** : After defining the right cockpit geometry and driver posture, FEA and Kinematics were applied to check structural integrity of the cockpit and chassis as well as control systems.

4→ **DESIGN REALIZATION** : Finally a high fidelity digital prototype is developed,which is subject to change through further design optimization until reaching to optimum (ready to build) model.

B) Design Compass for Cockpit Design





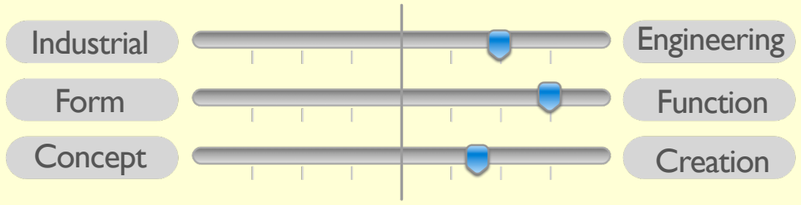
Focus: To incorporate Digital Human Modeling (DHM) early stages of the vehicle development and to improve driver posture comfort (in terms of joint angles and vision) without sacrificing structural integrity.

Methodology: Consist of using my Human-in-The-Loop design framework for modeling and simulation, and utilize Virtual Reality (VR) tools to extend the advance visualization techniques during design process.

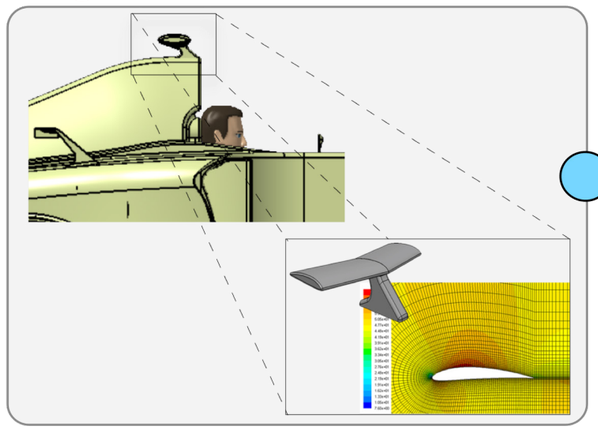
Results: Joint angle discomfort were improved while maintaining the aerodynamics and structural integrity of the vehicle. Center of gravity was further lowered.

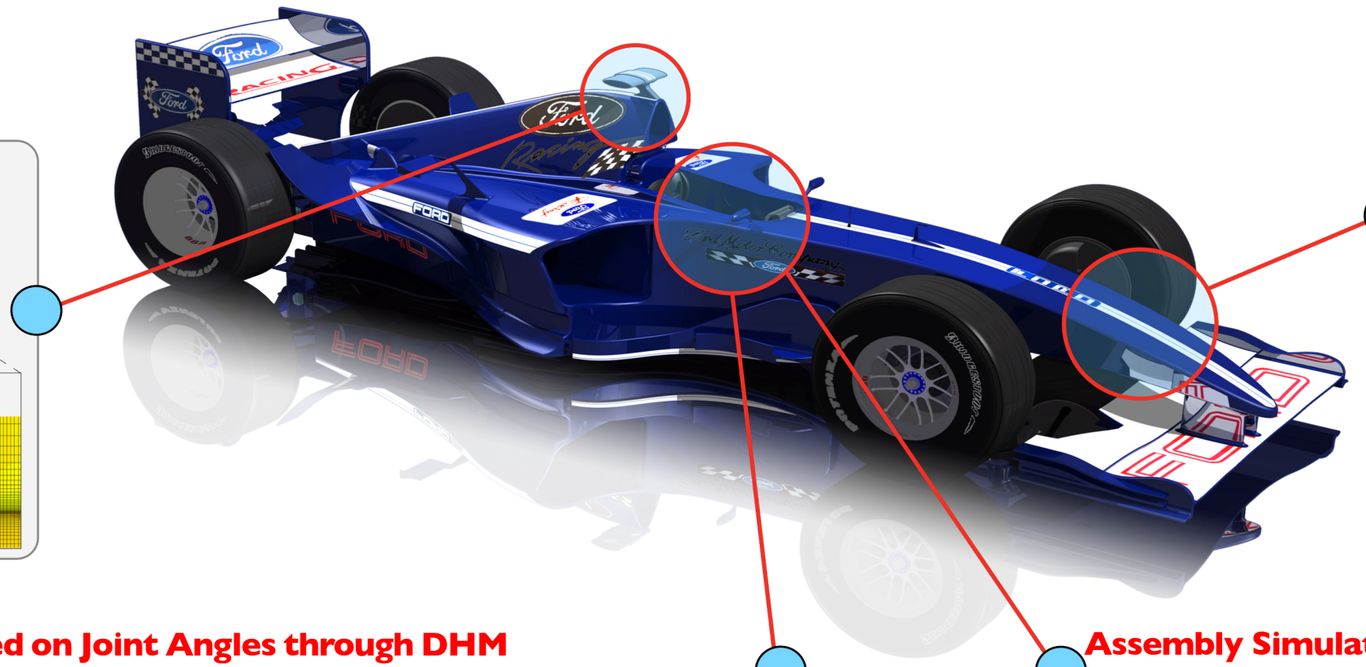
Future Work: Includes a total-vehicle integration design study, which aims to form a high fidelity digital vehicle design system that manages and monitors engine simulation, steering controls, suspensions with DHM.

About: This study was held as an integrated concept vehicle development research project at European Ford Design Studios. I was asked to demonstrate an integration showcase of Digital Human Modeling (DHM) and Virtual Reality (VR) for a concept vehicle development.

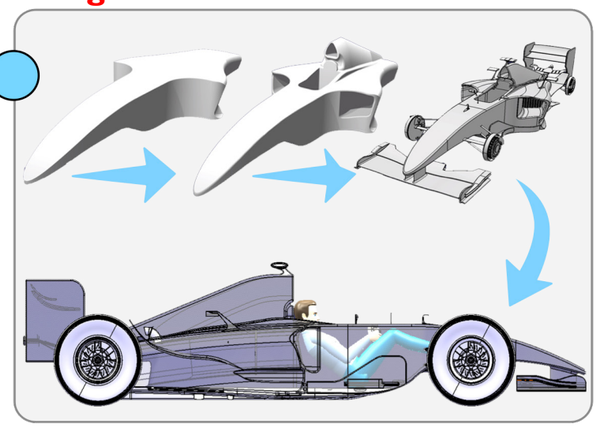


Integrated CFD with DHM

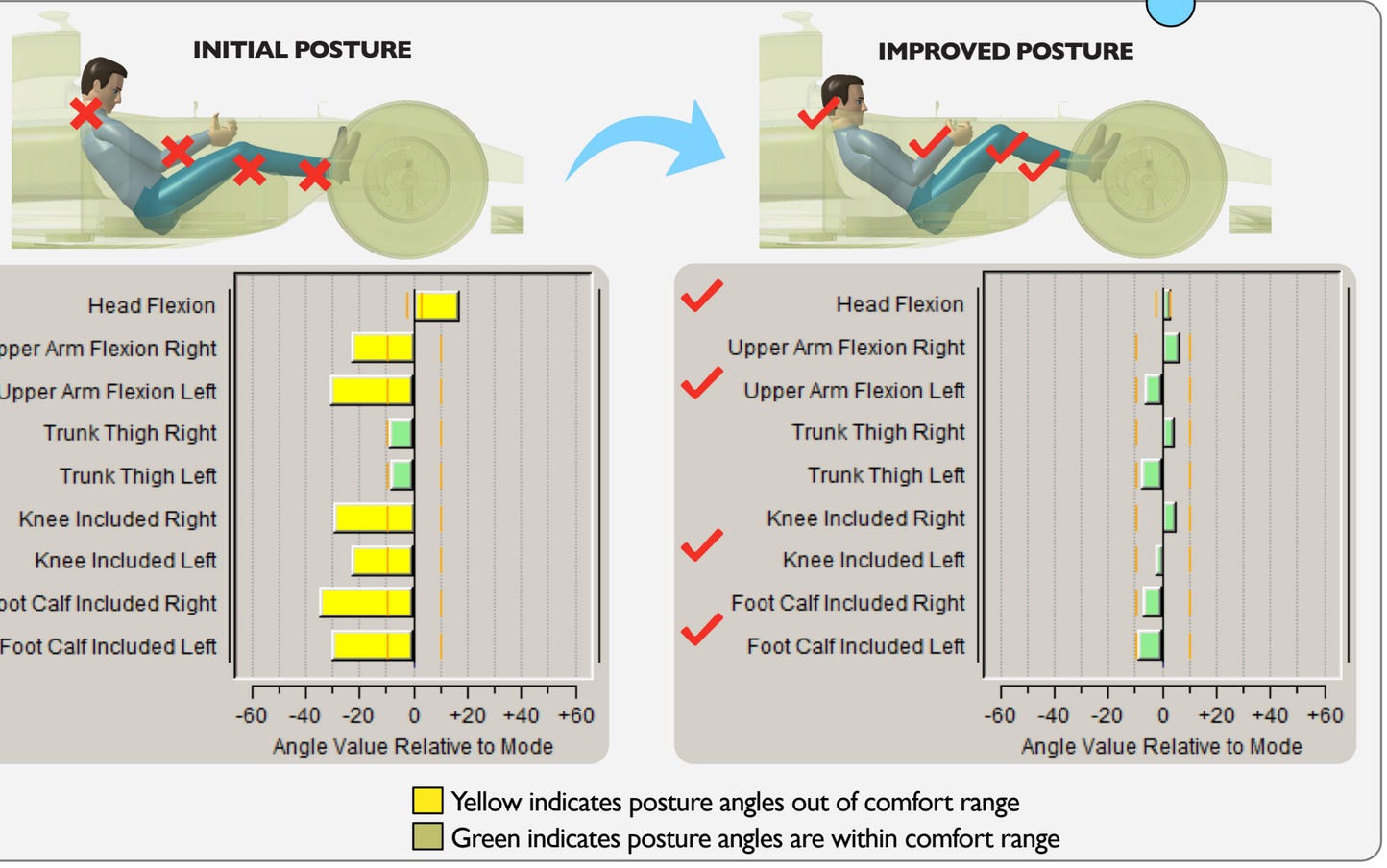




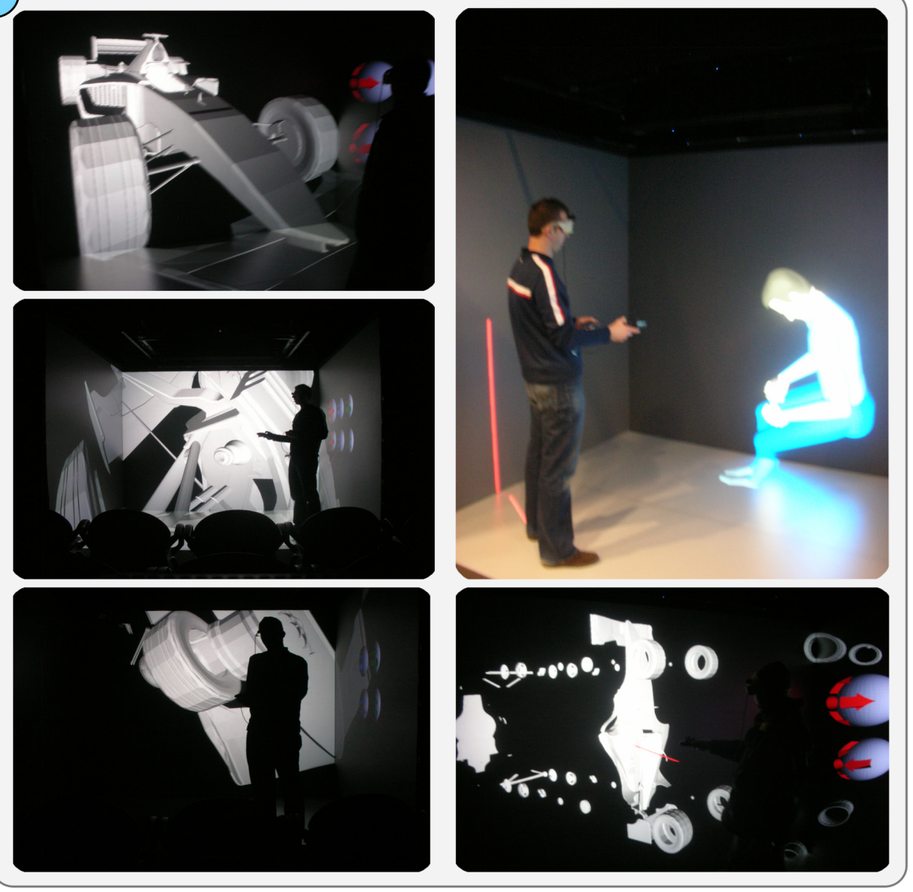
Integrated CAD Model with DHM



Posture Improvement Study Based on Joint Angles through DHM



Assembly Simulation in Virtual Reality with CAVE



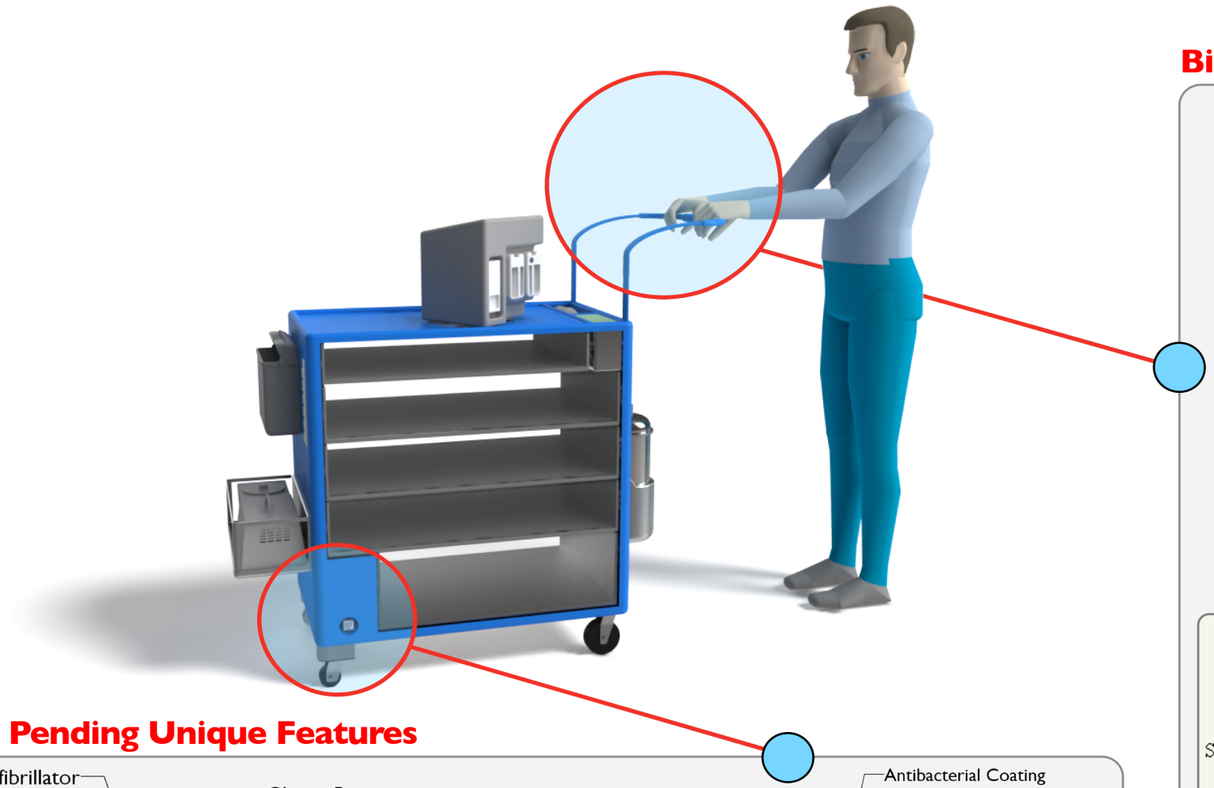
Focus: To create a user-friendly, light-weight, easy to use and a safe code cart to accommodate needs and limitations of nurses coming from different anthropometric backgrounds.

Methodology: Creating human-machine-interaction simulations for patent pending unique features (such as bi-directional drawers, adjustable handles...etc.) through my Human-in-The-Loop design framework.

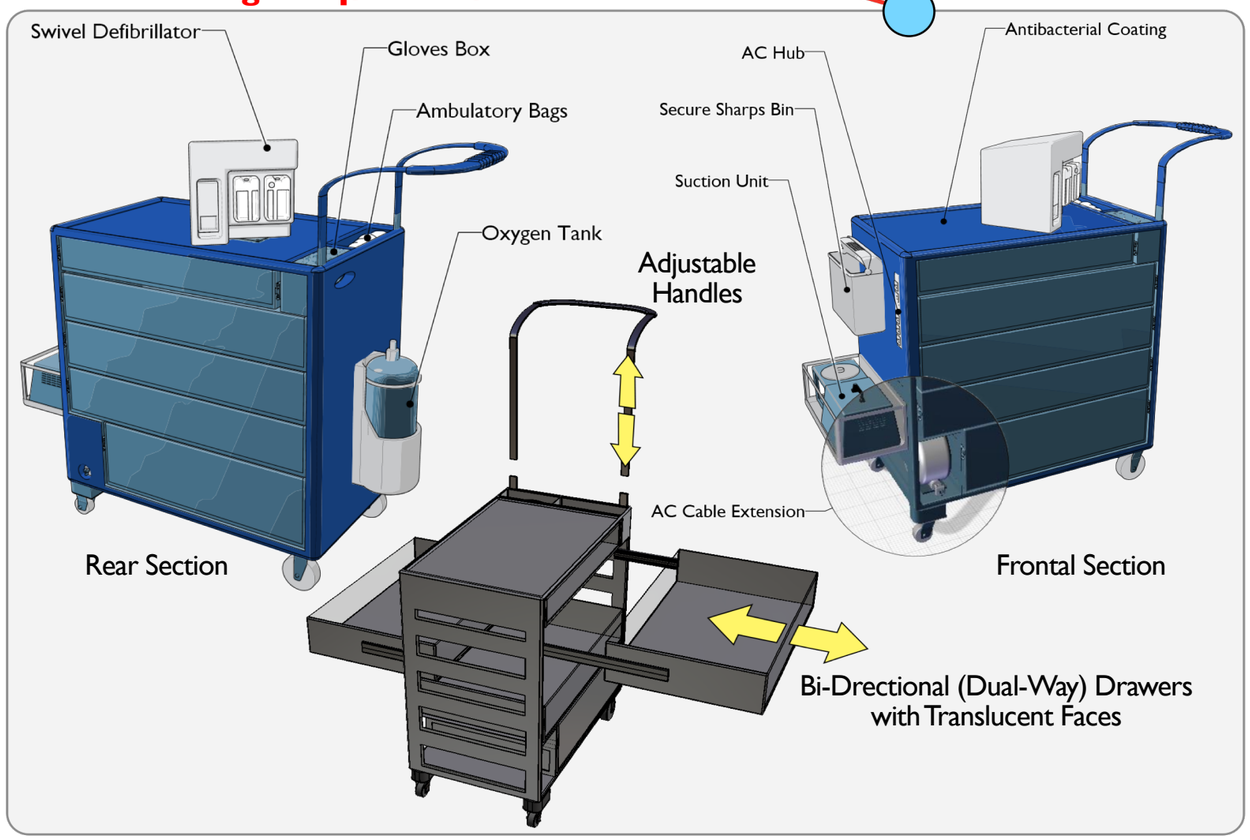
Results: Percent capable summary of upper and lower limbs were improved and visual obscuration (cluttler) zones were cleared. Proposed cart model accomodates a wide range of nurses comparing to current models.

Future Work: Finalizing patent application, developing marketing/sales plans and creating manufacturing drafts for a possible large scale production opportunity.

About: This study was a collaboration between Purdue University and Franciscan St. Elizabeth. I was asked to design a user-friendly, safe, lightweight and versatile code cart, which replaces current cart models, and would accommodate nurses coming from different anthropometric backgrounds.



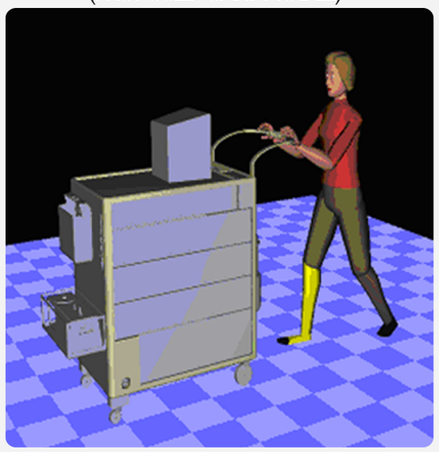
Patent Pending Unique Features

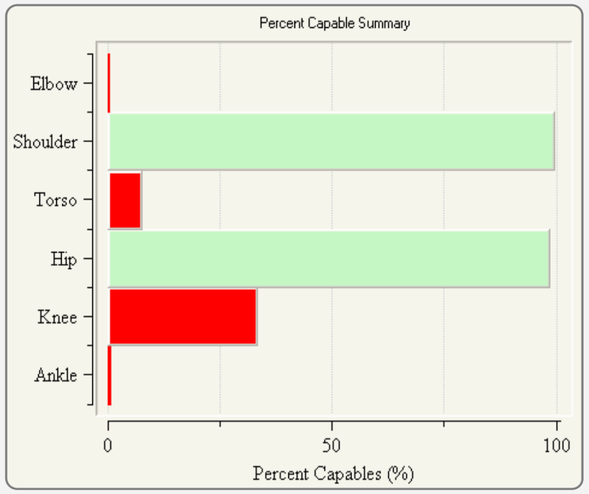


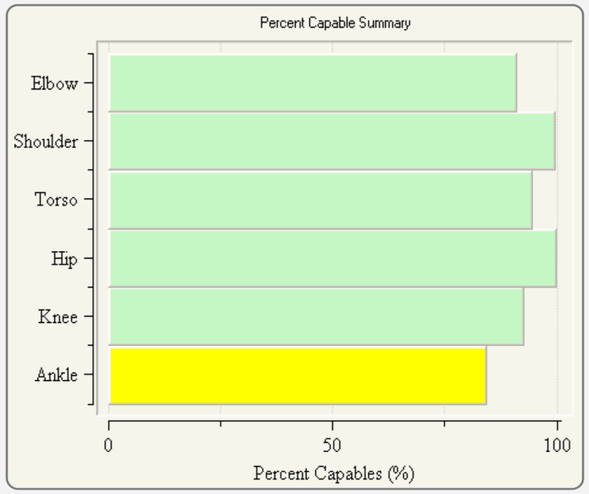
Biomechanical Simulation of Push-Pull Movement (Strain Forces & Vision)

INITIAL PUSH POSTURE
(CURRENT CART MODEL)

IMPROVED PUSH POSTURE
(PROPOSED CART MODEL)







- Poor Static Strenght results (high strain forces applied on body corresponding segments)
- Nominal Static Strenght results (average strain forces applied on body corresponding segments)
- Good Static Strenght results (low strain forces applied on body corresponding segments)

Current cart model creates cluttered vision

Proposed cart model eleminates cluttering problem

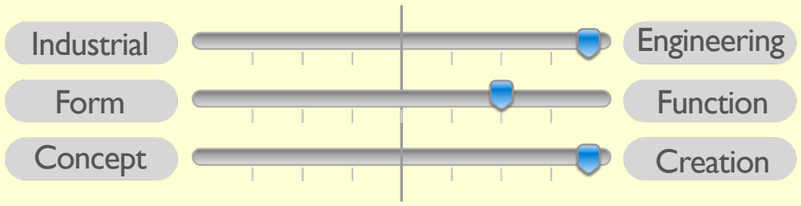
Focus: To improve posture when loading-unloading of clothes of user groups coming from a wide-range of anthropometric population by utilizing Digital Human Modeling (DHM) during product development cycle.

Methodology: To generate digital postures based on user study (data collection) and develop human-machine simulations by using Human-in-the-Loop design framework to find optimized geometry.

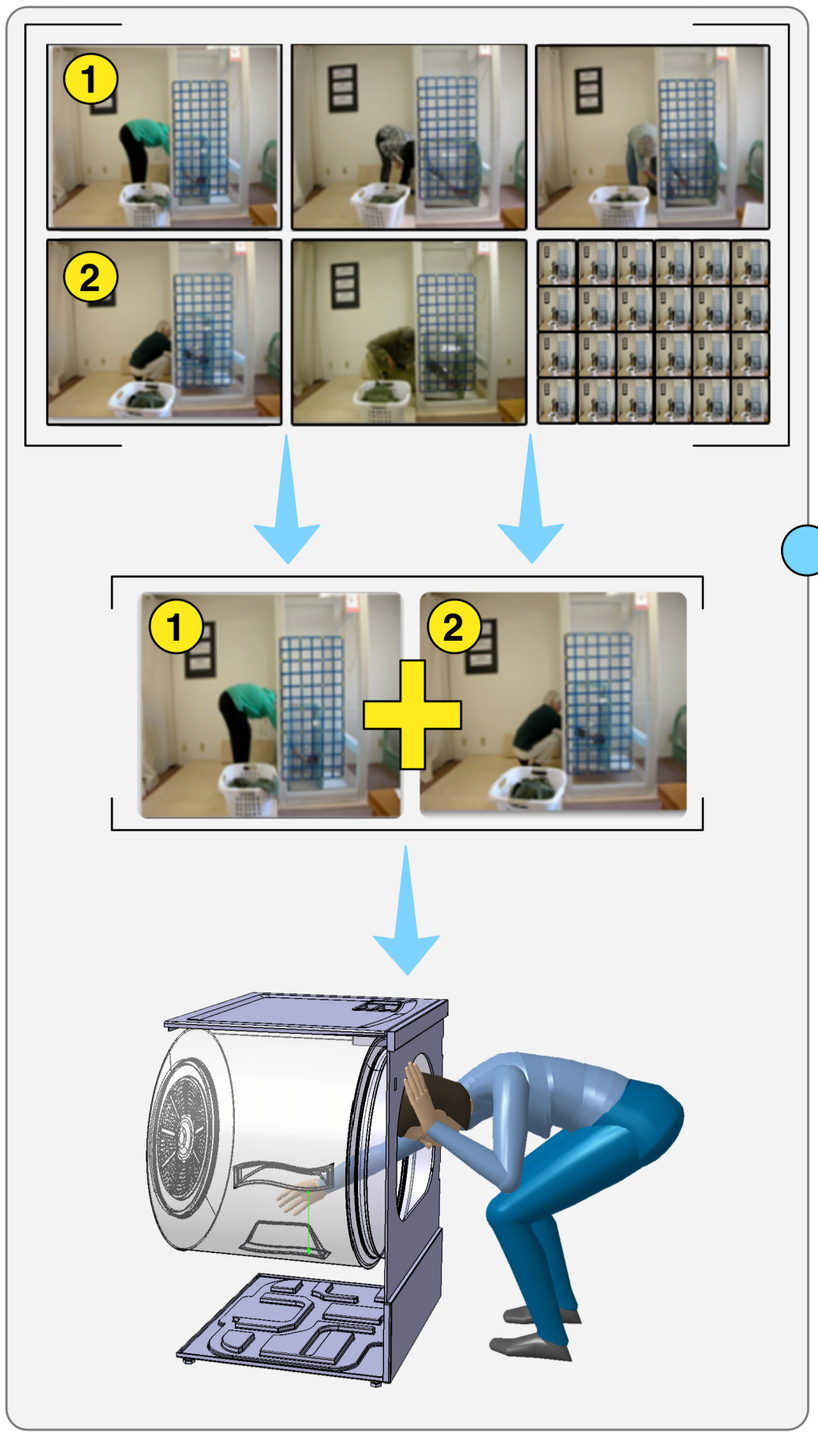
Results: Door inlet size was increased for ease of access, pedestal height was optimized for different users, and overall dimensions of the wash-machine was finalized.

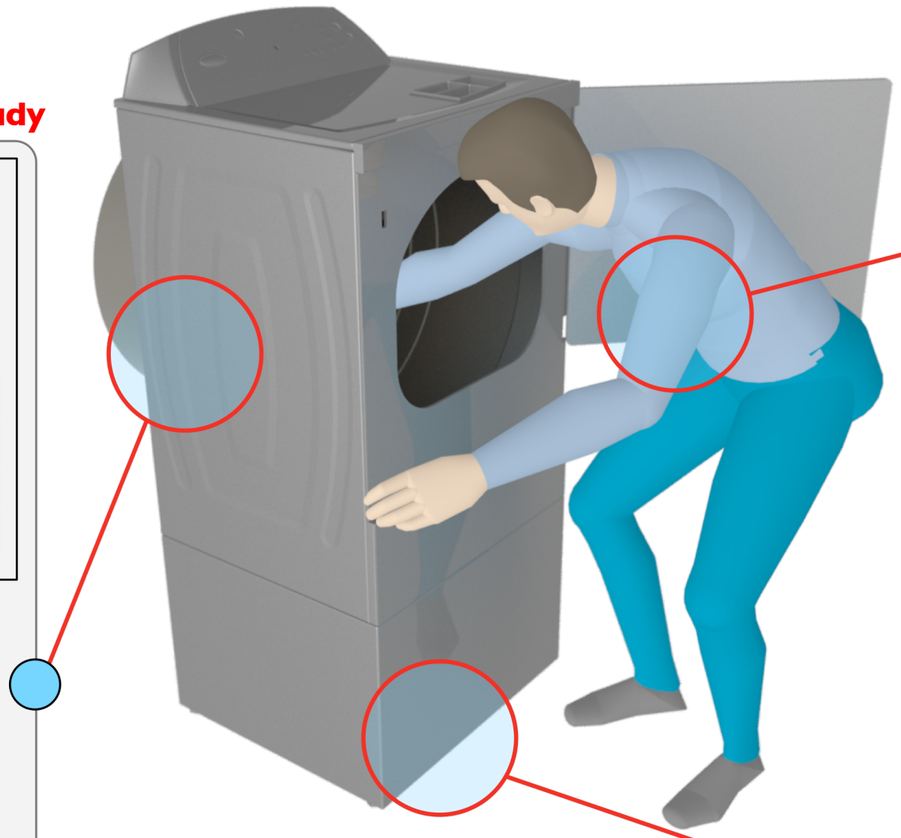
Future Work: To develop future wash-machines that accommodate different needs and offer comforting features for users.

About: This consumer product design study was a collaboration between Whirlpool Corporation and Purdue University. I was asked to design a "wash-machine for all" around the requirements generated from consumer studies and technology integration.

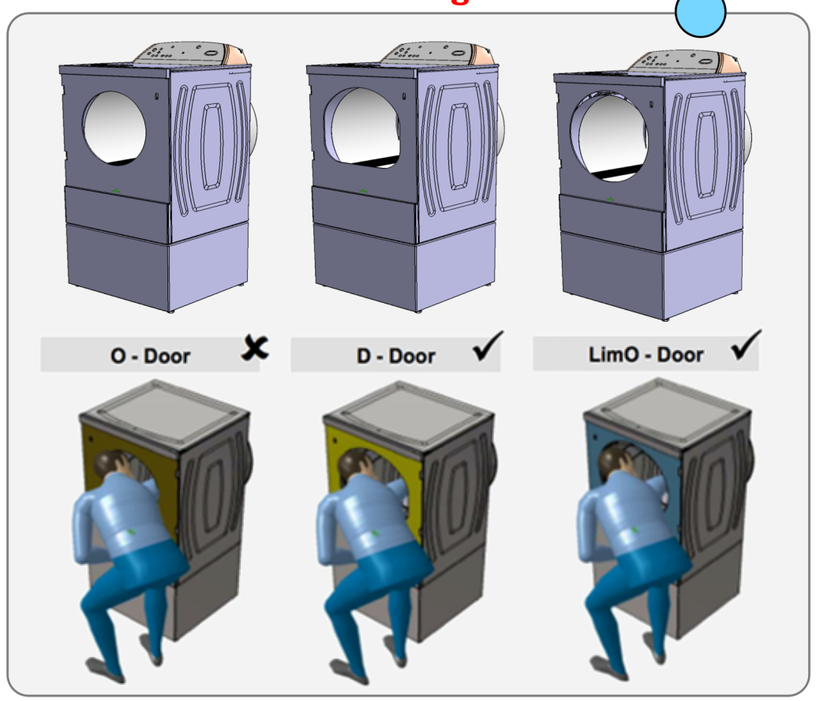


Digital Posture Construction from Usability Study

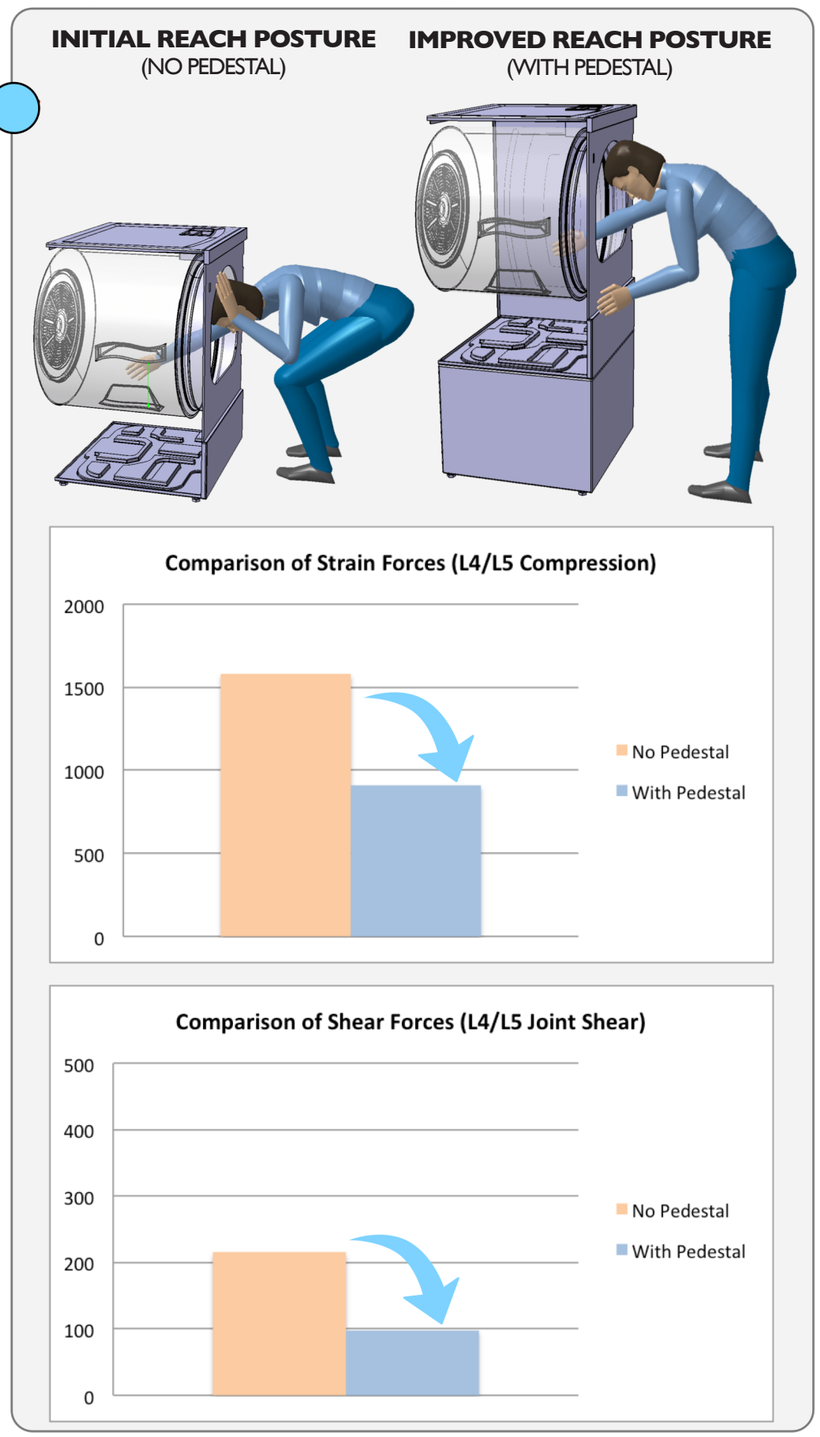




Inlet Door Validation through DHM



Comparison between Design Alternatives



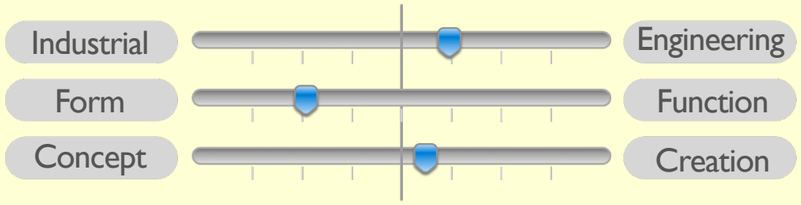
Focus: To develop a aesthetically pleasing, simple, versatile and a sustainable bottle design study which demonstrates sketch-to-prototype product development showcase.

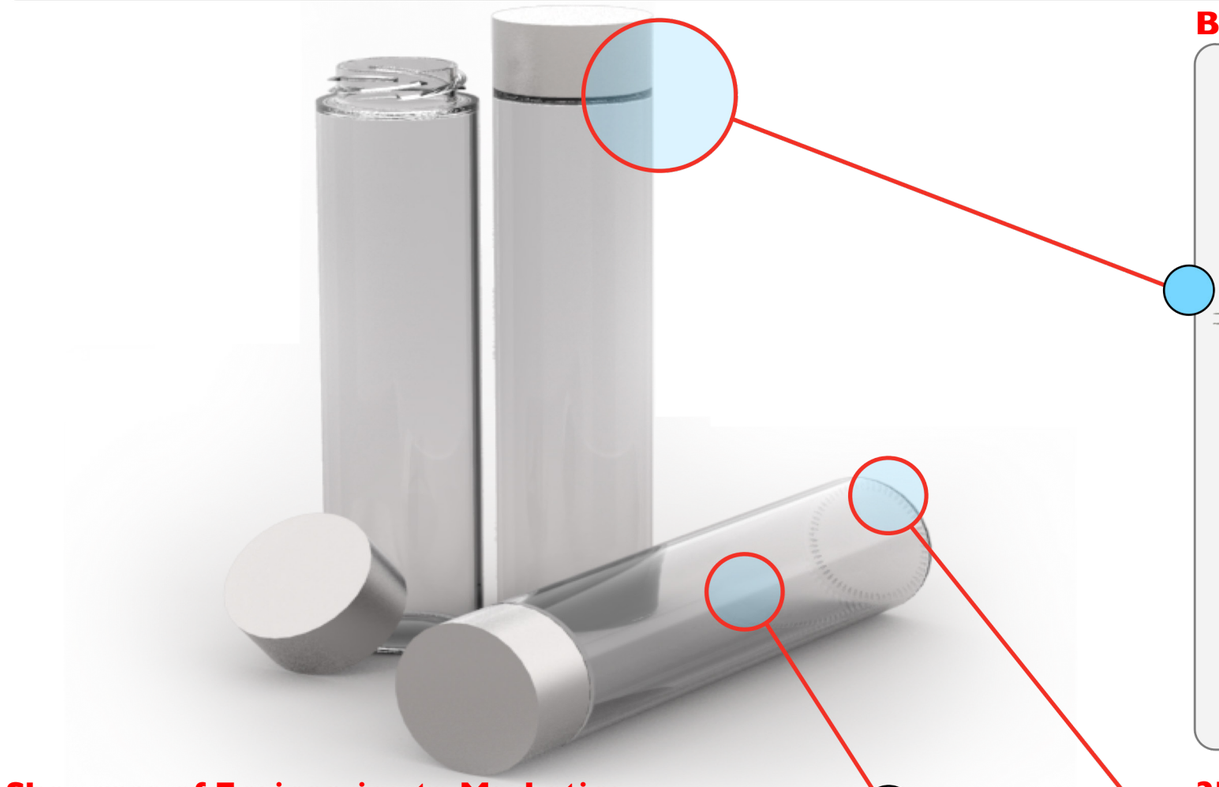
Methodology: To start design showcase with sketching and ideation, then transferring sketches to 3D and mechanical modeling, finally producing a high-quality renders for marketing.

Results: A link between sketching to prototyping was formed and steps required in product development were demonstrated.

Future Work: To develop different showcase and design scenarios where ideation, engineering and marketing are linked with human aspects of the design.

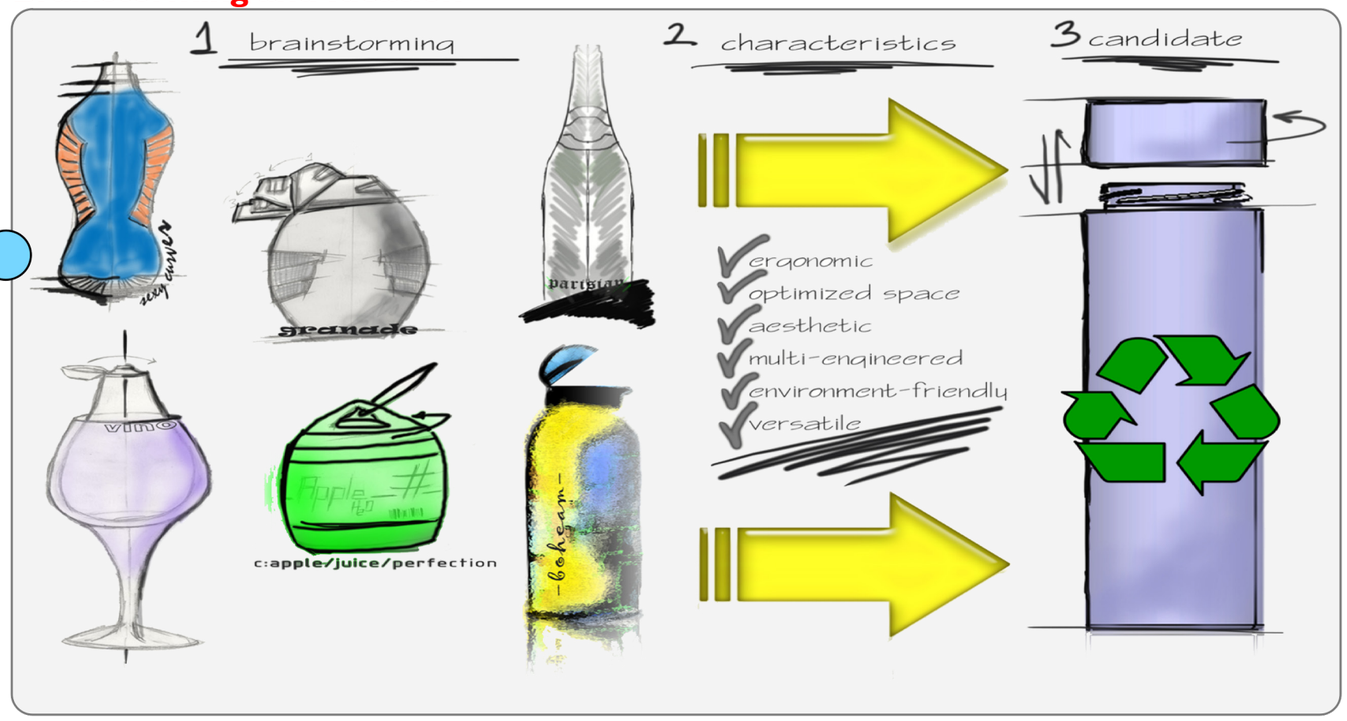
About: The sustainable bottle design study is a demonstration of sketch-to-prototype product development cycle, which features sketching techniques, design, parametric modeling, engineering analysis, rendering and marketing.



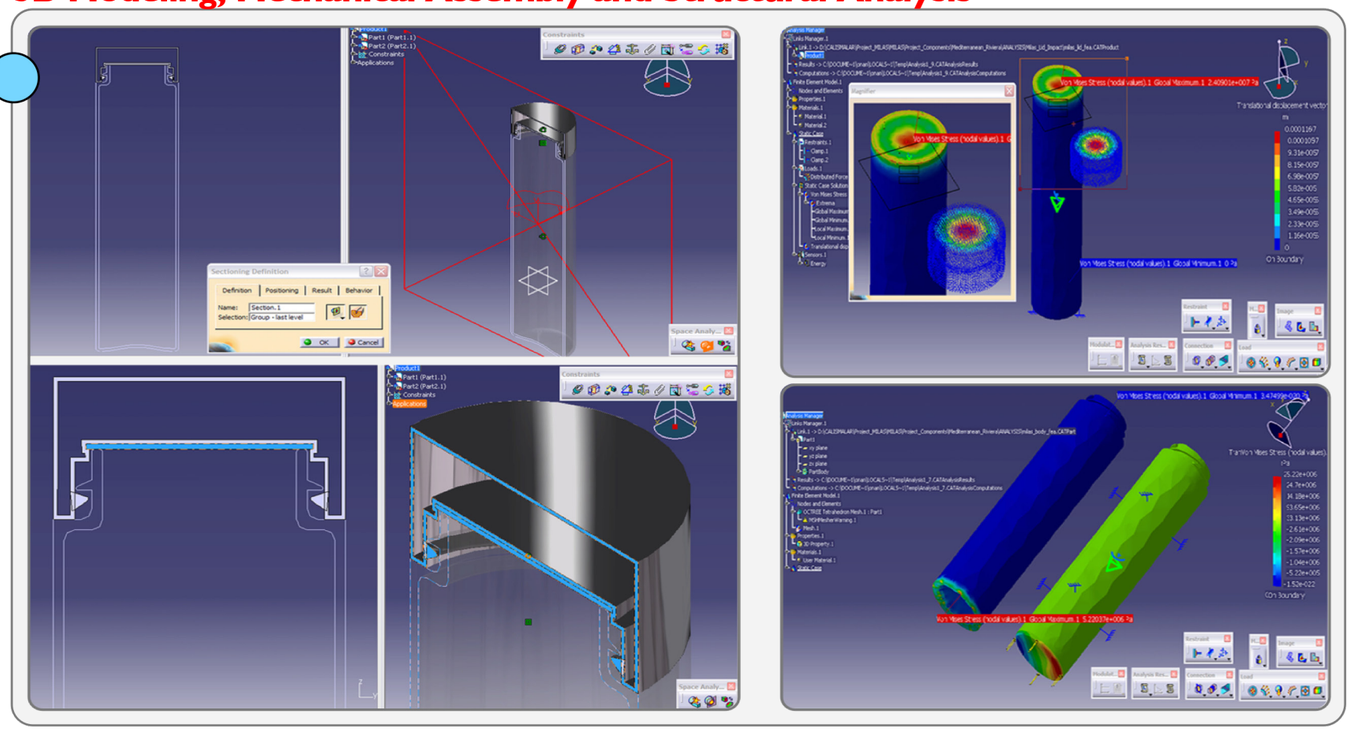


Showcase of Engineering to Marketing

Brainstorming and Ideation



3D Modeling, Mechanical Assembly and Structural Analysis



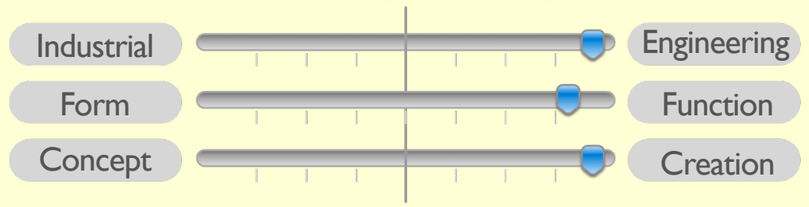
Focus: To design, test and prototype a remote controlled flapping-wing bird robot (ornithopter), which continiously captures and processes image on a flight pattern.

Methodology: To capture, process and differentiate predefined geometric objects laying on a random flight pattern. This includes remotely controlling the robotic bird and gliding over the flight pattern.

Results: Flapping bird was able to capture predefined geometry on a flight pattern and differentiate each object during image processing.

Future Work: To enhance the flight and image processing capabilities of the flying bird and form an integration with wireless devices.

About: This study was part of a PhD. level course project collaborated with Industrial Engineering and Mechanical Engineering at Purdue University, and focuses on developing an flapping-wing robot (ornithopher) integrated via a smart-device for advance image processing.



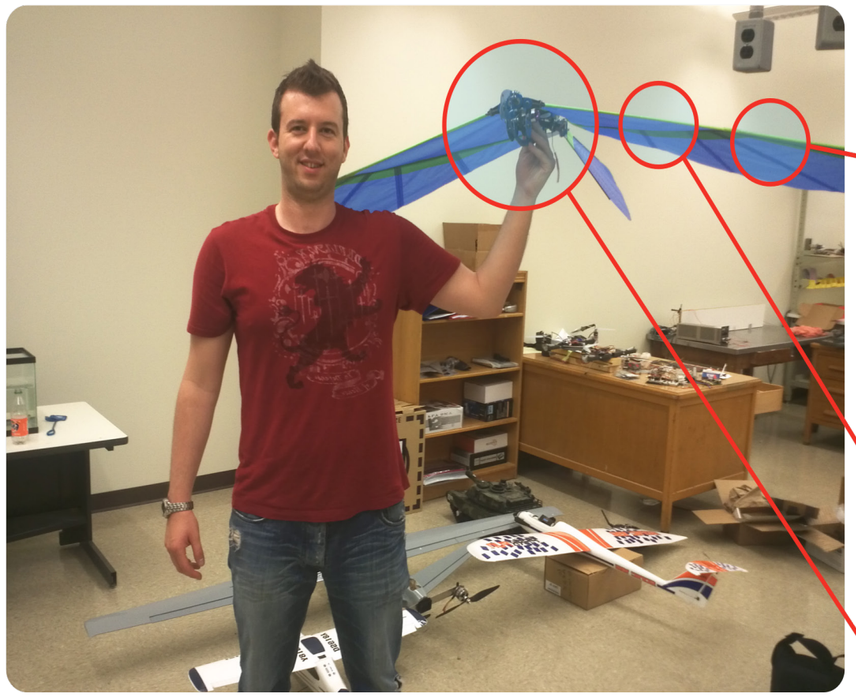
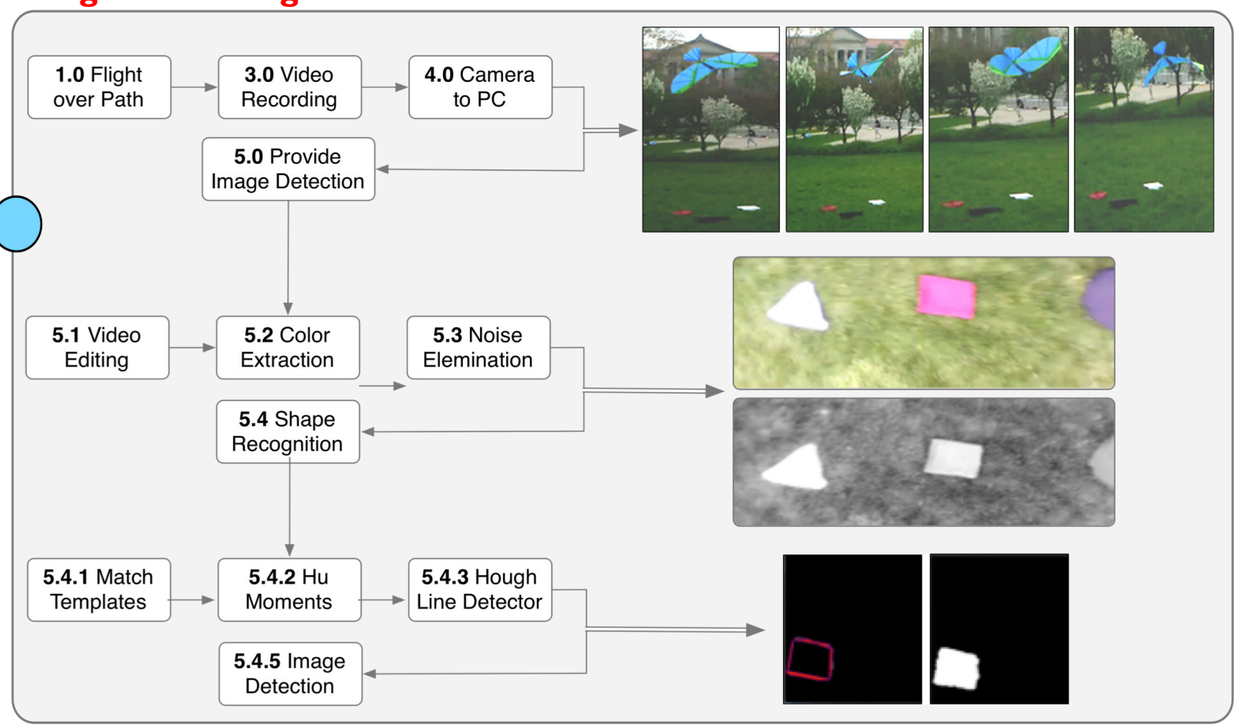
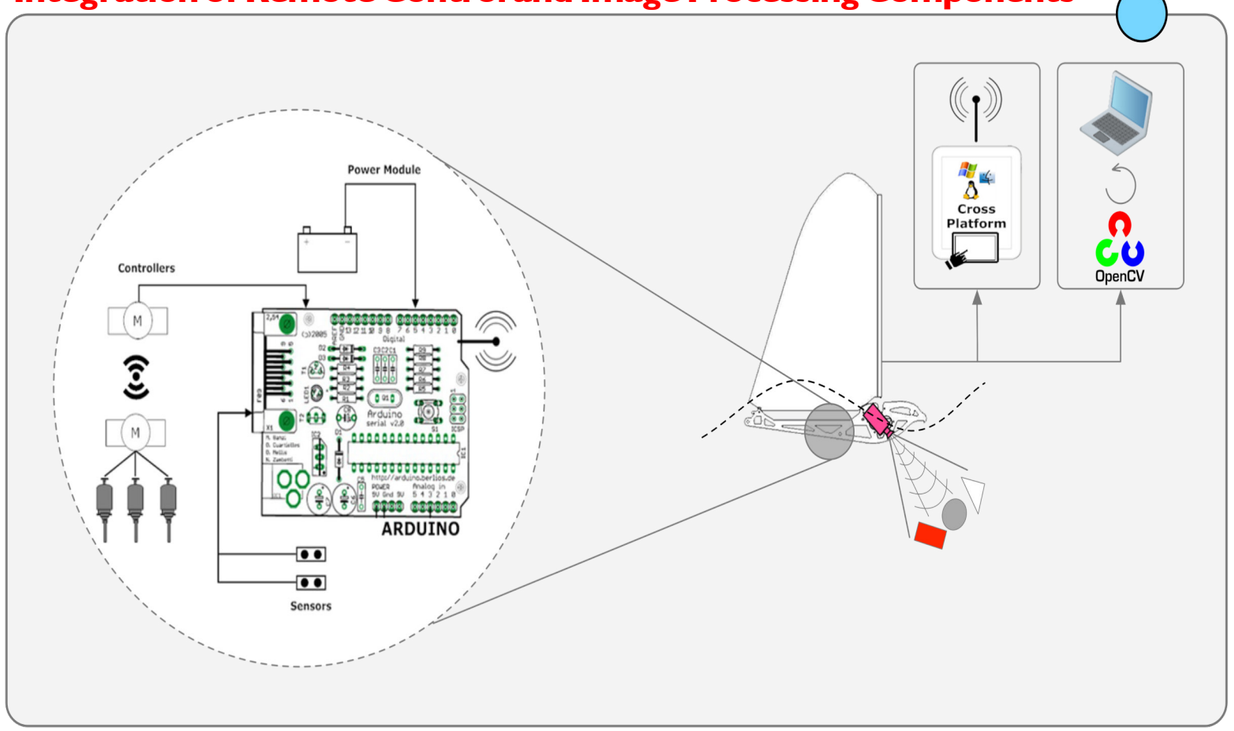


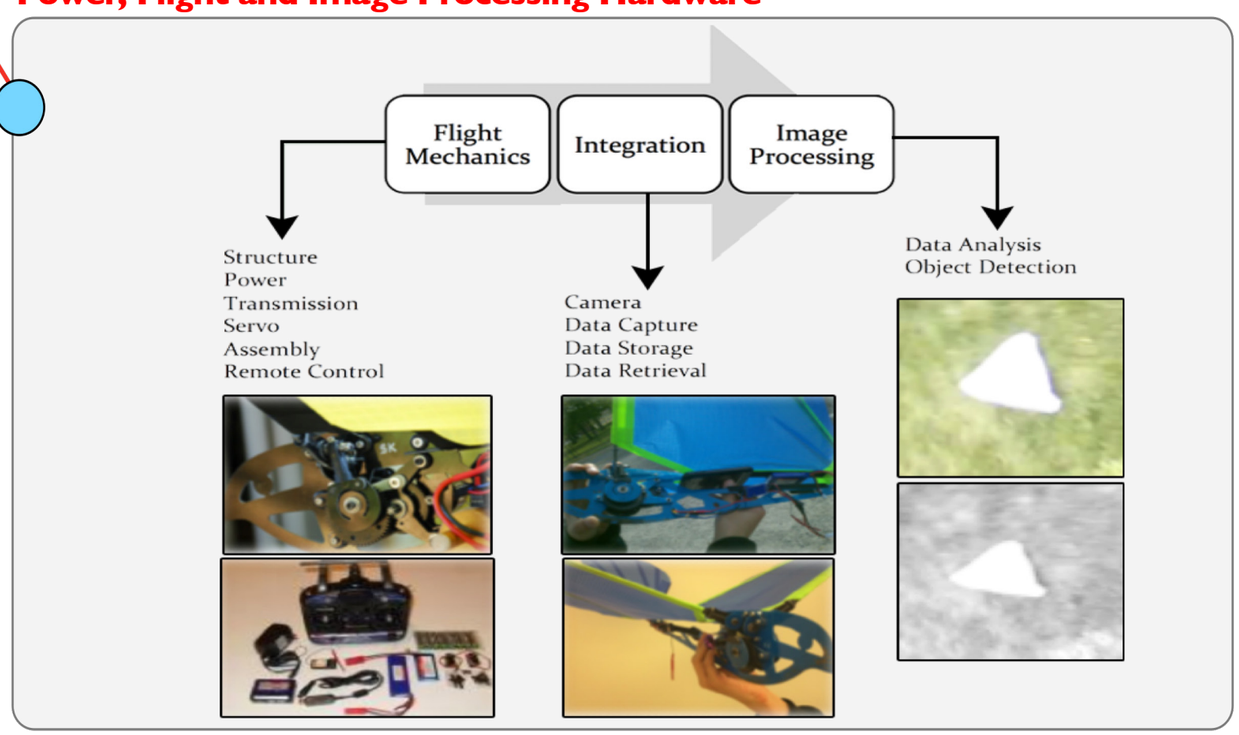
Image Processing Flow



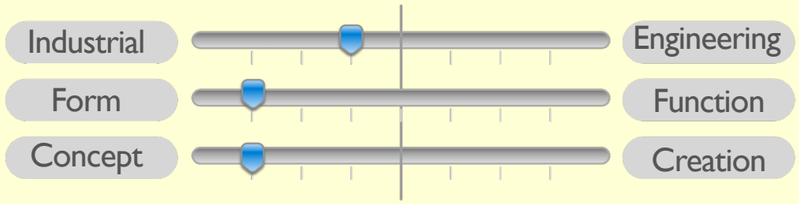
Integration of Remote Control and Image Processing Components

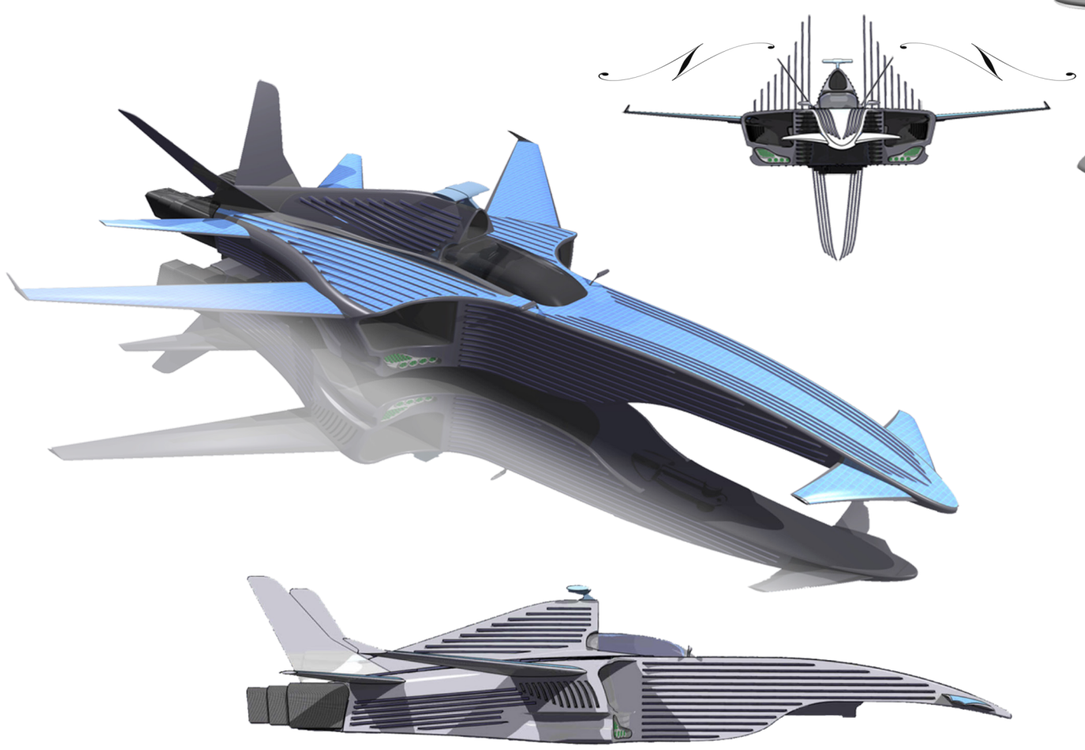


Power, Flight and Image Processing Hardware

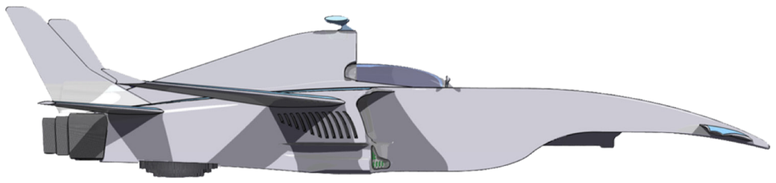


About: This concept vehicle design study demonstrates advance surface modeling, 3D parametric design, rendering and storytelling. This is my attempt to utilize engineering and art tools for conceptual design of a futuristic vehicle.

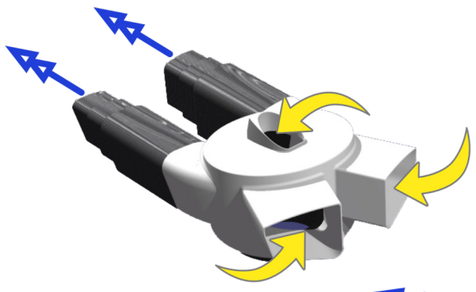


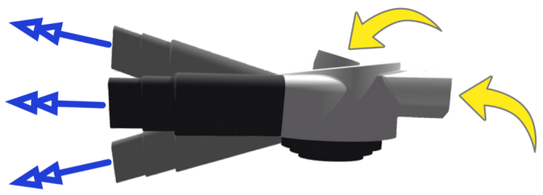


VSTOL nozzle is fully-retracted, solar turbine is shot down, nitro-electrolysis struts are activated and main nozzle is extended in scram mode.

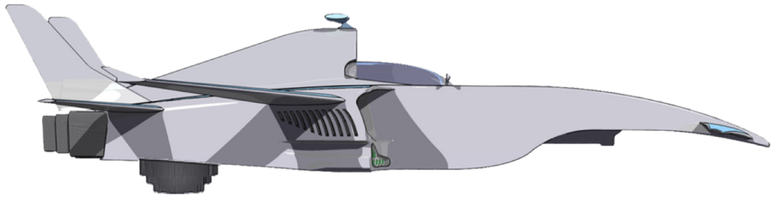


VSTOL nozzle is semi-retracted, solar turbine is in alernative thrust mode.

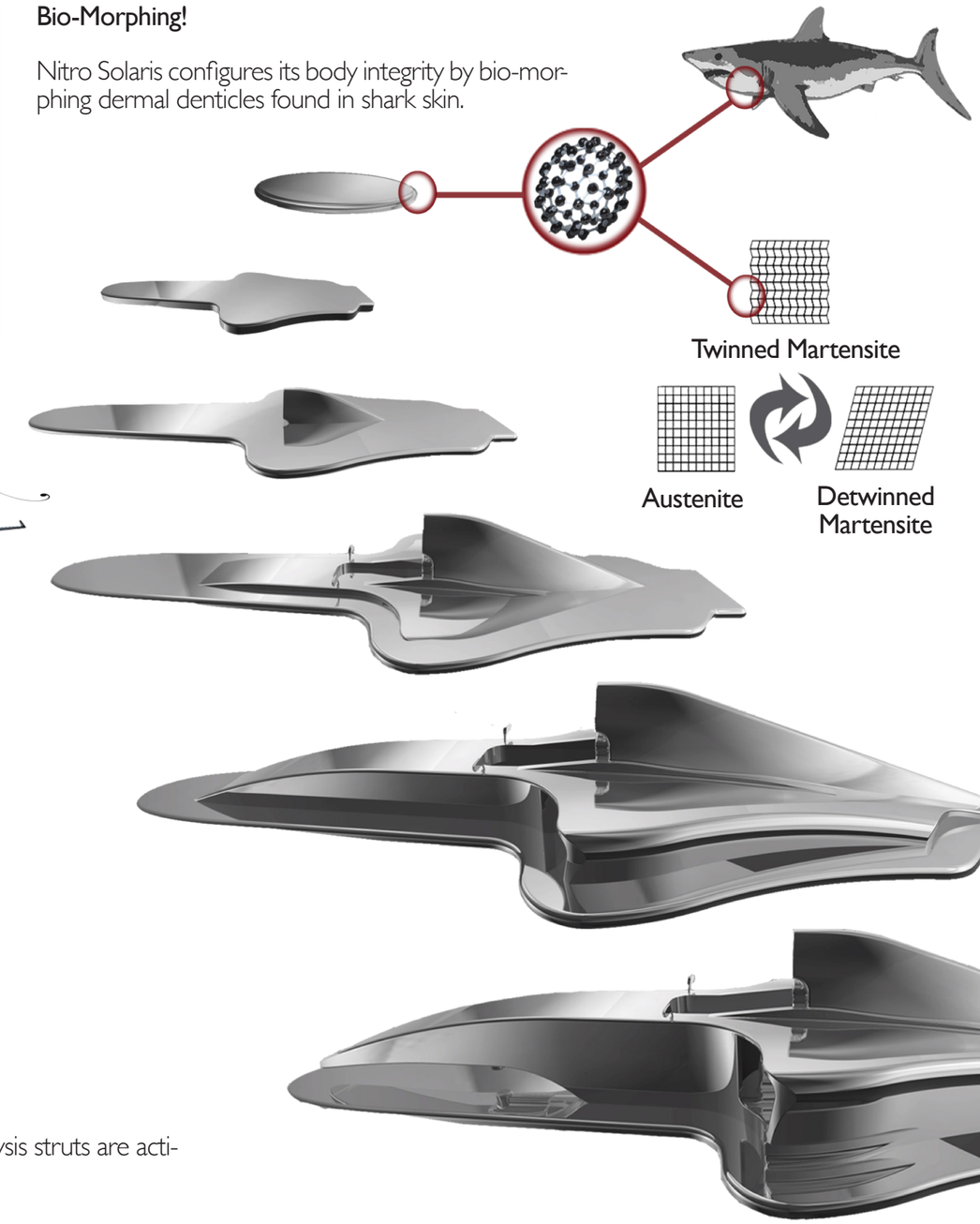




At low speeds, Nitro Solaris's unique jet chamber is powered solely by nano-crystal solar cells. When high speeds are needed, it extracts nitrogen from air through nitro-electrolysis system. Extracted nitrogen runs the scram jet. Thanks to its silent scram jet technology and 3D-vector-thrust capability, Nitro Solaris offers a comfortable journey at extreme speeds.

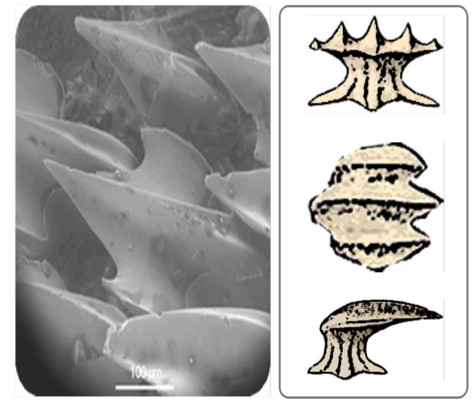


VSTOL nozzle is extended, solar turbine is in full power.



Bio-Morphing!

Nitro Solaris configures its body integrity by bio-morphing dermal denticles found in shark skin.



Dermal Denticles!

>>Built on the same engineering principles of most advanced compounds, dermal denticles provide both rigidity and elasticity without deformation.

>>The perfect hydrofoil form of denticals creates tiny vortices that reduce drag to make sharks swim faster.