Design Portfolio

by Onan Demirel



CONTACT

onan.demirel@strath.ac.uk

Faculty Website

Personal Website

Google Scholar Profile

Department of Design, Manufacturing and Engineering Management (DMEM)
University of Strathclyde
James Weir Building | 75 Montrose Street | Office JW704d
Glasgow, United Kingdom

DESIGN RESEARCH

R.1 INTRODUCTION pg. 1

R.2 DIGITAL HUMAN MODELING pg. 2

R.3 DESIGN FRAMEWORK pg. 3

R.4 DATA INTEGRATION pg. 4

R.5 SHOWCASE pg. 5

DESIGN WORKS

Design Science

W.1 ARTIFICIAL INTELLIGENCE pg. 6

W.2 DIGITAL TWIN pg. 7

W.3 USER EXPERIENCE pg. 8

W.4 HUMAN VARIABILITY pg. 9

W.5 CO-DESIGN pg. 10

W.6 URBAN PLANNING pg. 11

W.7 OCCUPANT PACKAGING pg. 12

Design Art

W.8 SUSTAINABILITY pg. 13

W.9 BIOMIMICRY pg. 14

W.10 DIGITAL ART pg. 15

2025

►The top 20 research and development spenders in the U.S. spend an estimated $142 billion each year, yet 40-45% of that money and immense amounts of resources (e.g., material, energy, human capital) are invested in user-centric products that never make it to the market and end up as pollutants, scrap, or waste (Christie et al., 2012).

►Vulnerabilities that are embedded in the system, in the form of design deficiencies and poor human factors, lead to breakdowns, and increases in the number physical injuries, work absence, environmental disasters, and hazards which lead to significant financial, reputational and organizational losses (Norman, 2013).

►....sustainability, health, security, and the joy of living are under a stringent threat (National Academy of Engineering, 2017).

►44,000 to 98,000, preventable deaths occur annually due to medical errors in U.S. hospitals (Corrigan et al., 2000).

►Modern products are plagued with design flaws that lead to product recalls, errors, obsolescence, safety risk, and market failures (Pahl, 2007).

►Workplace accidents and injuries costs over $150 billion per year (National Safety Council, 2021).

►Lack of human factors engineering competency is widely acknowledged as contributing to the abovementioned problems—harming people and overstretching the planet's resources—leading to the deterioration of well-being (Dul et al., 2012).

*There is an **urgent need** to inject human factors into design to achieve compatibility in designing environmentally, economically, and socially sustainable products.*

*Not meeting the above needs represents a **critical problem** because, if not changed, inadequately designed products and systems will continue to be built, and attaining well-being at the people-planet frontier will not be possible.*

Change is necessary from a short-sighted, resource-hungry, customer-centered mindset to a people-planet well-being focused design thinking approach.



Human-Centered



Systems-Oriented



Creative



Transdisciplinary



Scientific



Societally-Relevant



Well-Being Focused



Collaborative



Inclusive



Sustainable

to err is human; to transform, design.

transformative design towards **people-planet well-being**

DESIGN RESEARCH

R.1 INTRODUCTION pg. 1

R.2 DIGITAL HUMAN MODELING pg. 2

R.3 DESIGN FRAMEWORK pg. 3

R.4 DATA INTEGRATION pg. 4

R.5 SHOWCASE pg. 5

ABOUT MY RESEARCH

My research addresses the increased demands on human-centered design innovation by devising theories, methods, principles, and technologies at the merger of **design**, **human factors**, and **systems engineering.**

OBJECTIVES

My long-term goal is to become an independent teacher-scholar who focuses on:

- **formulating** design theories and methods that explore inter-dependencies and co-evolution humans in engineering, natural, and social systems.
- **educating** designers who can put human factors principles at the core of design efforts that support people-planet well-being.

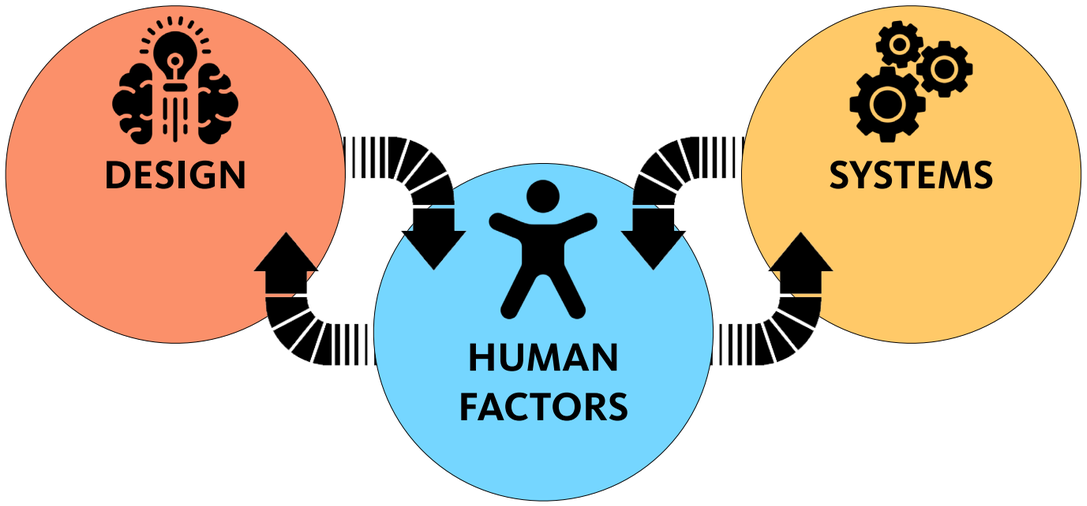
INTERESTS

My research group's primary interest has been developing design frameworks that support **human-centered**, **transdisciplinary** theory and methods that seeks to create desirable and sustainable changes and solutions for product, process, and service conceptualization.

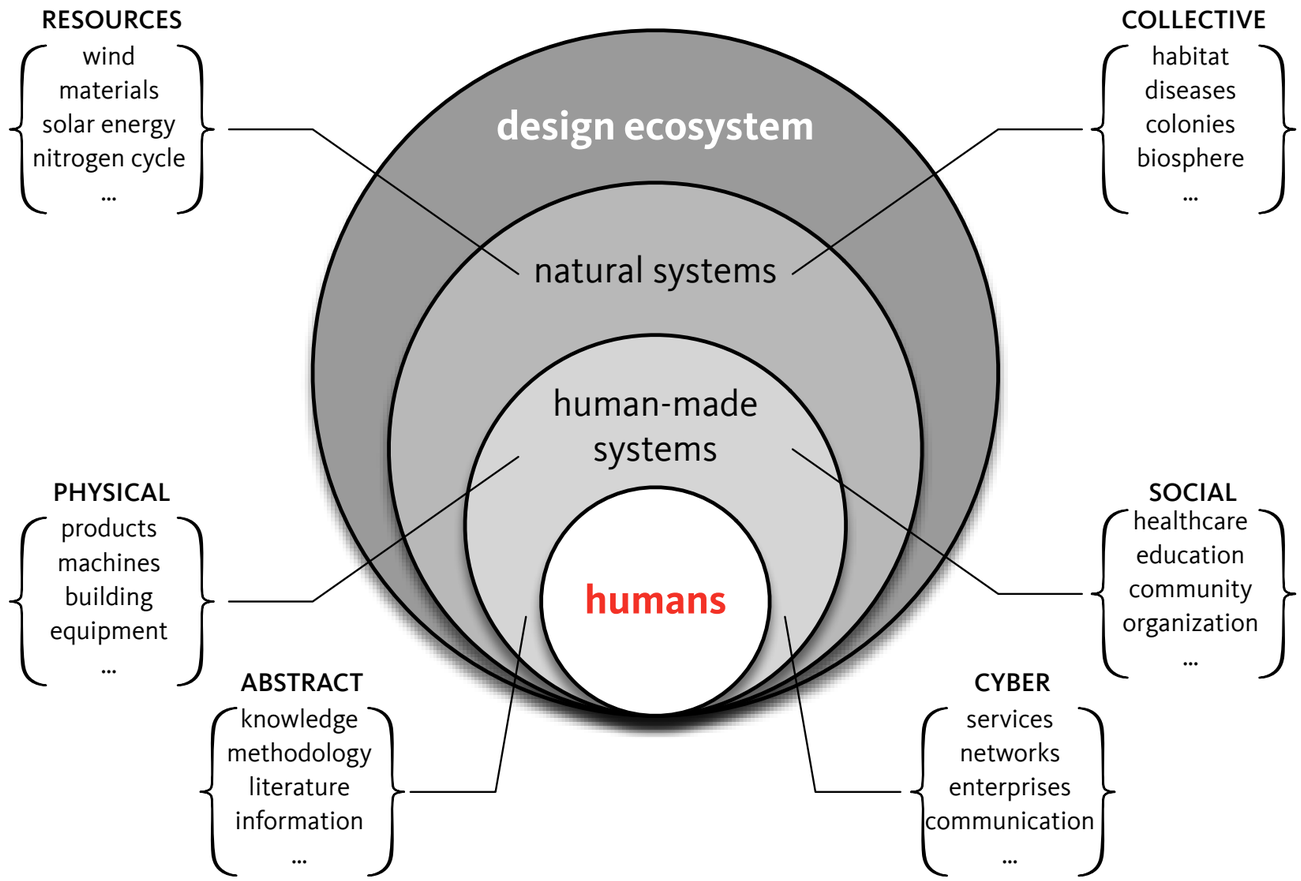
TECHNICAL AREAS OF EXPERTISE

I conduct **research** activities and **teach** in the following technical areas:

- Human factors engineering
- Digital human modeling
- Design theory and methods
- Human-centered design
- Systems engineering
- Safety engineering
- Prototyping
- Product development
- Industrial design



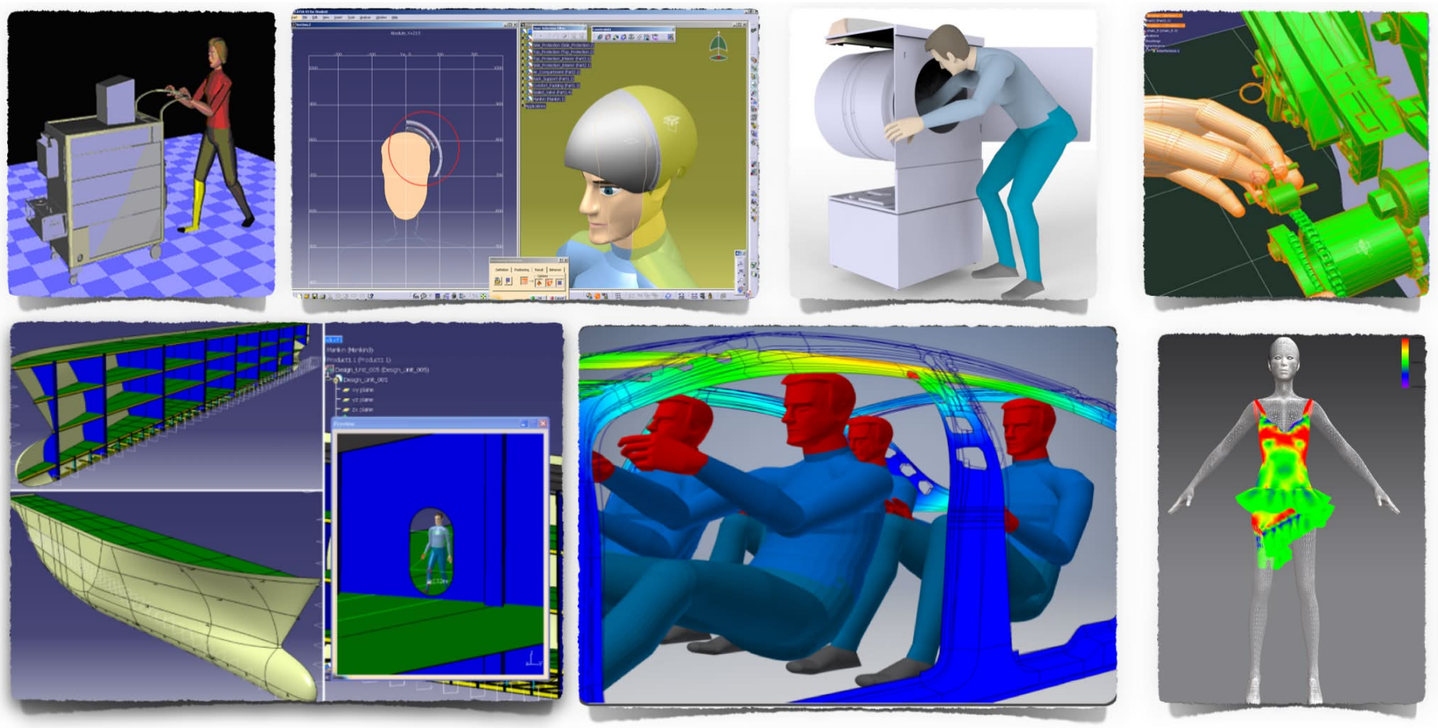
Transformative Design: Merging design and technology in engineering design, human factors, and systems to create desirable and sustainable changes and solutions in addressing people-planet well-being.



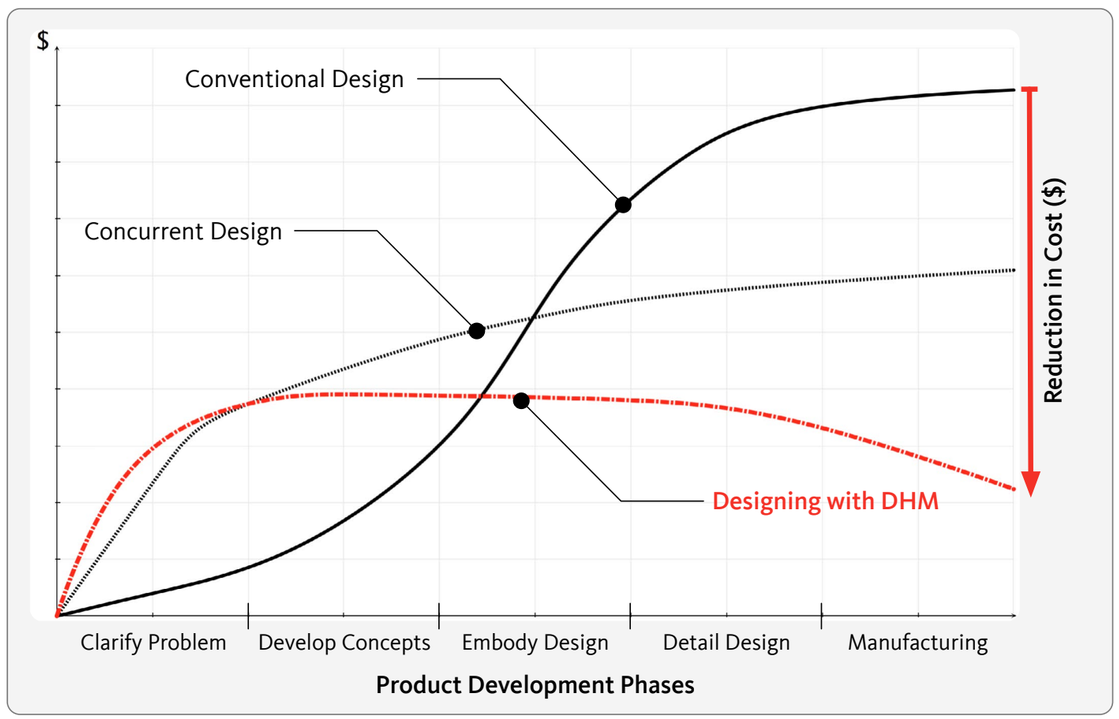
Life-Centered Design (LCD) Thinking Model: The design ecosystem comprises smaller intertwined sub-systems, where humans and human-made systems co-exist and evolve within natural systems.

DIGITAL HUMAN MODELING (DHM)

- Uses manikins as representations of people inserted into a simulation environment.
- Provides visualizations of human with math science in the background.
- Enables designers to simulate physical and cognitive human performance.
- Facilitates the prediction of performance and safety.



Transdiciplinary Connections: DHM enables designer to look beyond traditional disciplines.



More effective early-phase design: Cost savings associated with designing with DHM.

Goals:
- Inject human factors into the early phase design
- Optimize human-system performance
- Improve human well-being
- Enable tools for people-planet well-being

Application Areas:
- Architecture
- Healthcare
- Occupational ergonomics
- Task and work design
- Assembly and manufacturing
- Consumer goods
- Transportation and vehicle design
- Apperal design
- Human performance analysis
- Aerospace and aviation
- Industrial design
- Media, games, and entertainment

DHM

Artistic
- **Animation**
  - Computer Graphics
  - Movies and Games
- **Visualization**
  - Textile/Fashion
  - Industrial Design
- **Information**
  - Instruction
  - Training

Scientific
- **Physical**
  - **Anthropometric**
    - Population Libraries
    - Specific Populations
  - **Empirical and Computational**
    - Ergonomics and Biomechanics
      - Product / Process Design
      - Safety and Comfort
      - Finite Element Analysis
      - Crashtesting and Impact
- **Cognitive**
  - Situational Awareness
  - Workload and Stress

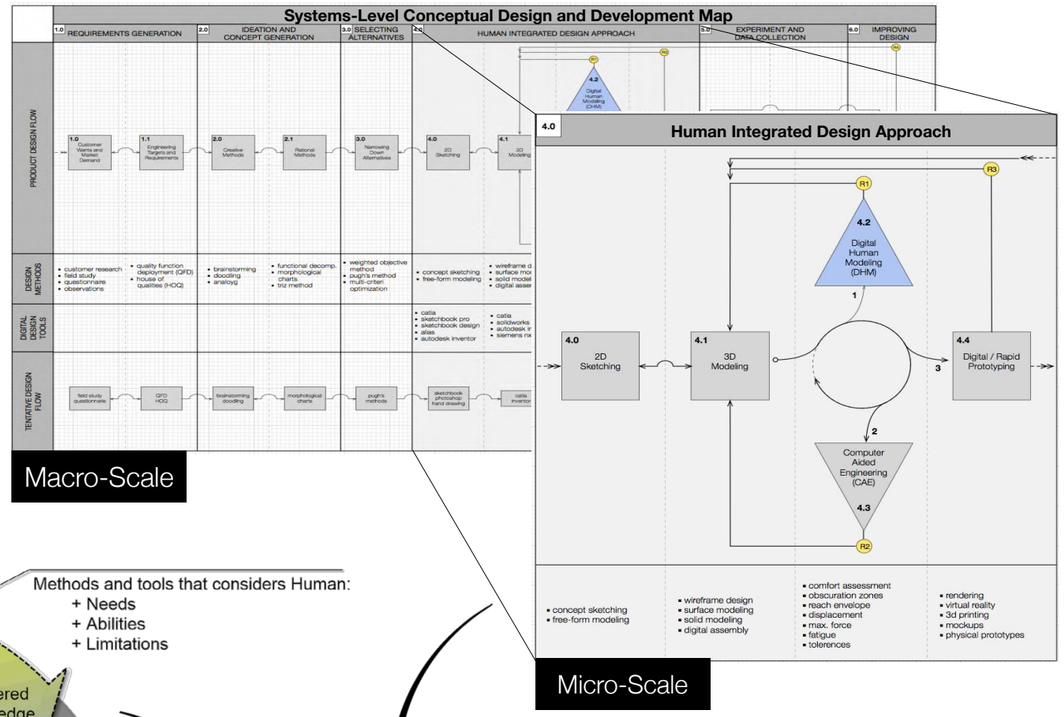
Designing with DHM:
- Cost and time savings
- Reduced design and protoyping iterations
- Conception to creation with humans-in-the-loop
- Seamless integration with computational design
- Augment design thinking efforts

DIGITAL HUMAN-IN-THE-LOOP (DHIL) FRAMEWORK

INTEGRATED

SYSTEMS

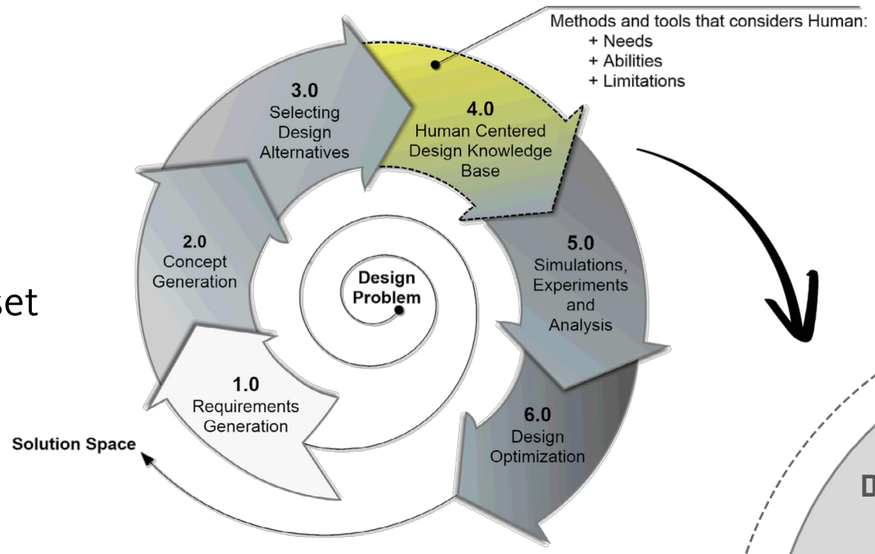
- Understanding of the **interactions** among humans and other elements of a system
- Optimizing **human well-being** and overall **system performance**
- Enabling design decision-making at **macro-** (e.g., human-product interaction) and **micro-scale** (e.g., muscloskeletal)



HUMAN-CENTERED

HUMAN FACTORS

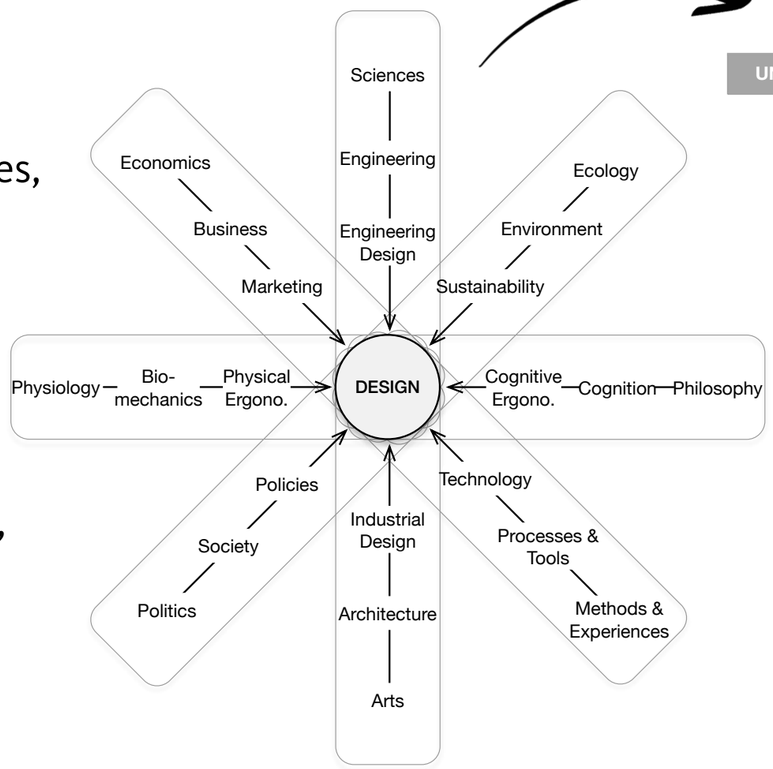
- Incorporating human **needs**, **abilitites**, and **limitations**
- Fostering **design thinking** mindset
- Keeping people **in the loop** throughout the design cycle
- Injecting **human factors** design principles early in the design

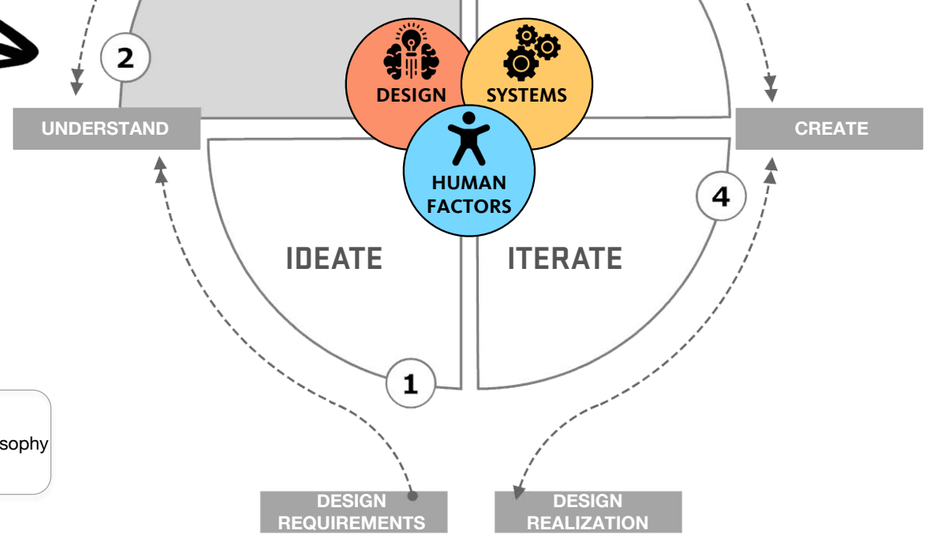


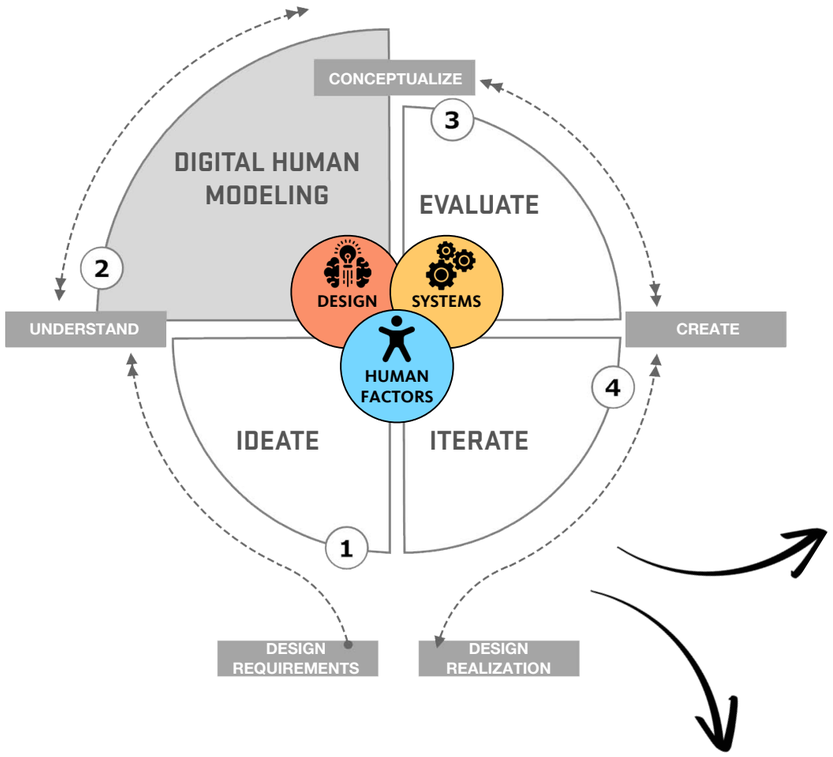
TRANSDISCIPLINARY

DESIGN

- Embracing theories, principles, and methods from a **broad range** of disciplines
- Bringing a **holistic** lens on modern product design
- Catering **future-focused**, **sustainable** design mindset
- Promoting **environmentally**, **economically**, and **socially** councious design activities

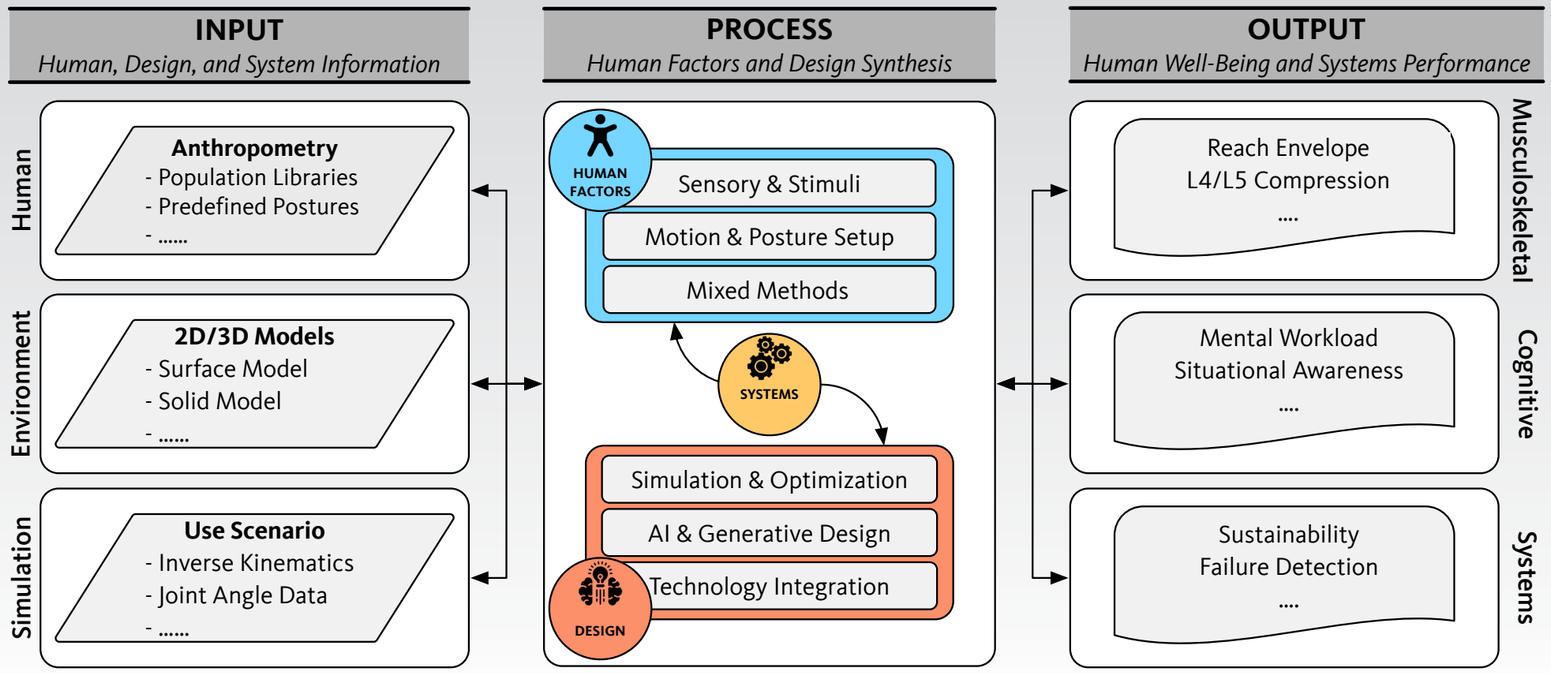






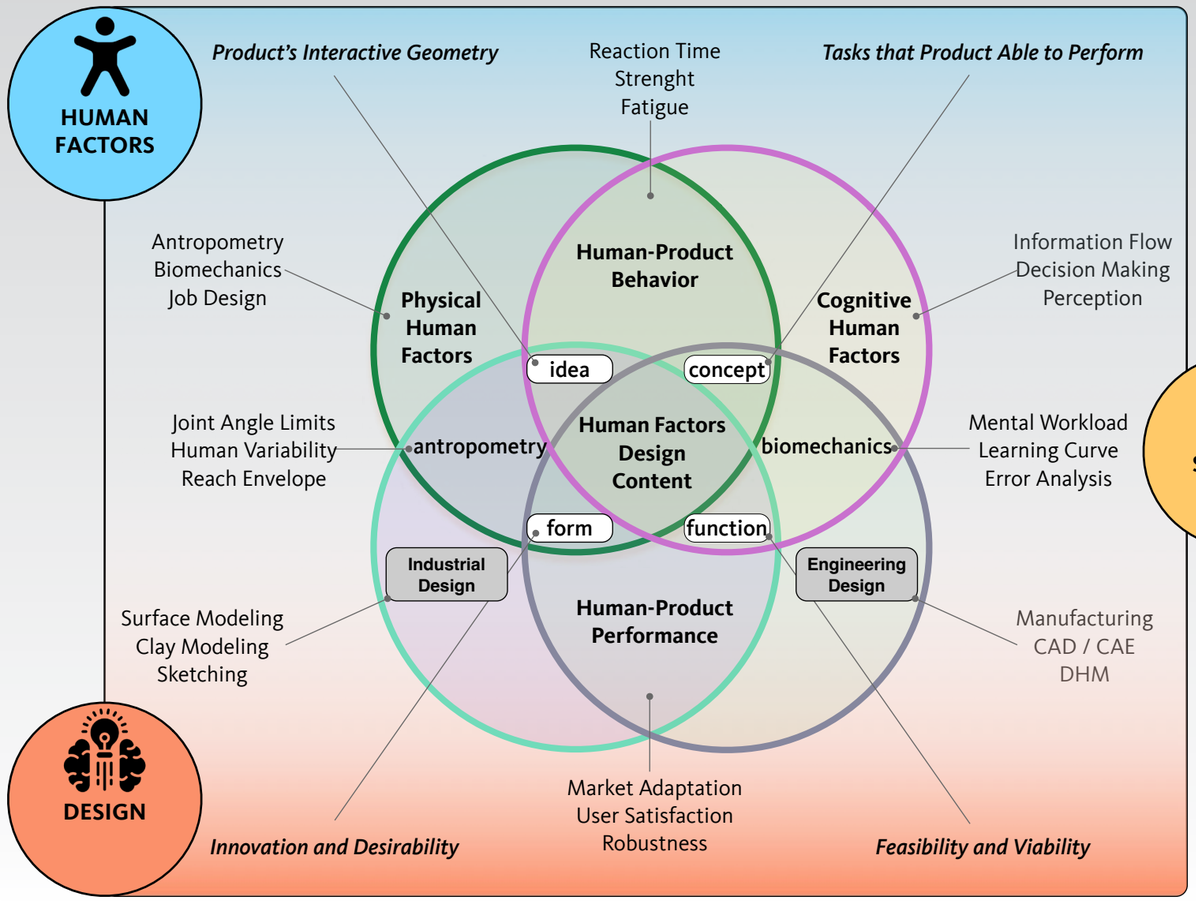
Data Flow within D-HIL Framework

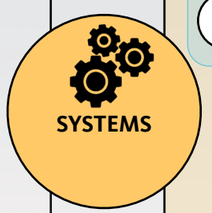
Integrating Human, Design, and Systems Knowledge

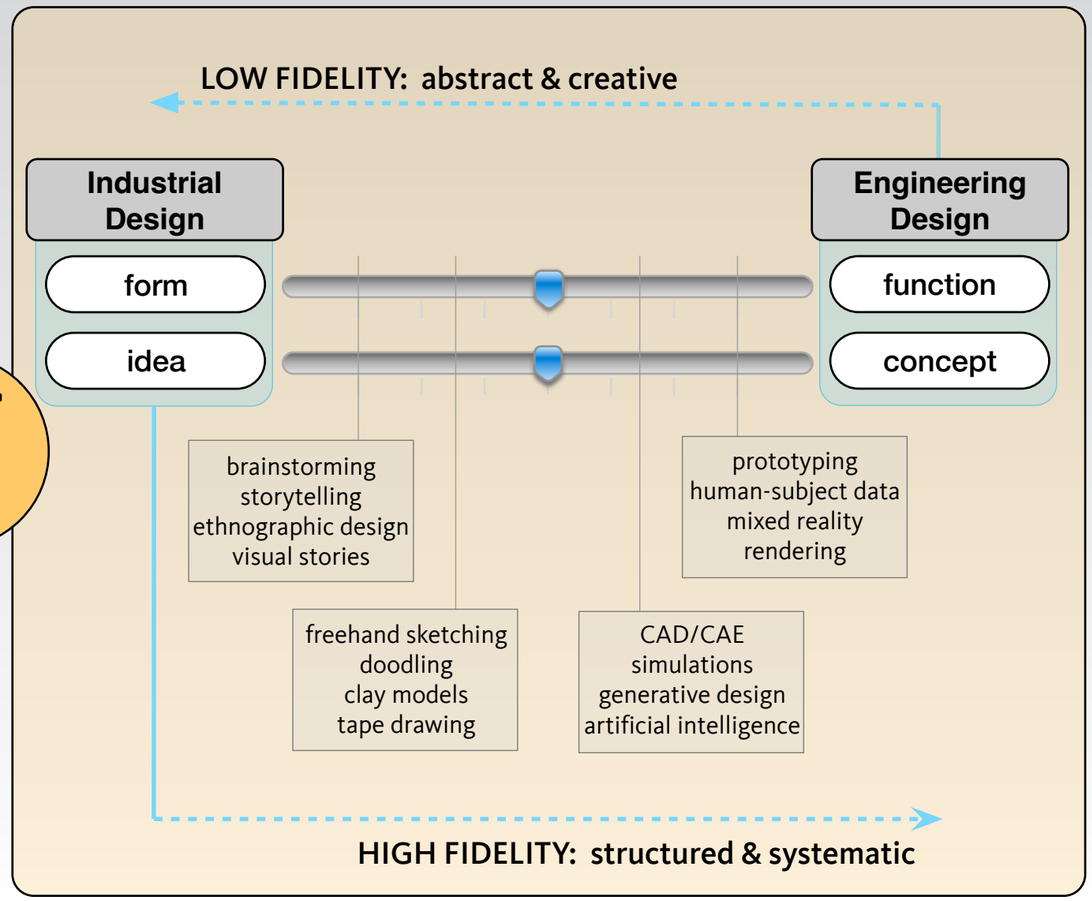


Human Factors Design Content

Integrating Scientific Methods and Creative Approaches for Modern Human-Centered Design

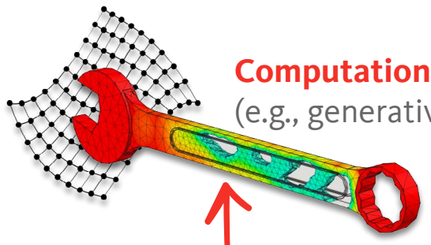






D-HIL - Turning Challanges into Opportunities

- Integration with **emergent**, **computational** design tools to enable modern design practice that meets life-centered design (LCD) goals.
  - Proactive human factors engineering workflow by bringing the digital representation of humans into the **early-phase** design.
- Establishes transdisciplinary design integration to help design **environmentally**, **economically**, and **socially** sustainable products.



Computational Design
(e.g., generative design and topology optimization)

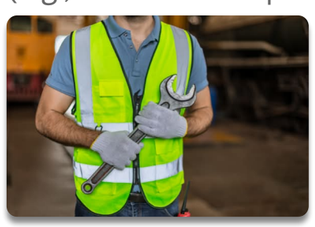
Compensation Cost
(e.g., workforce loss and absence)



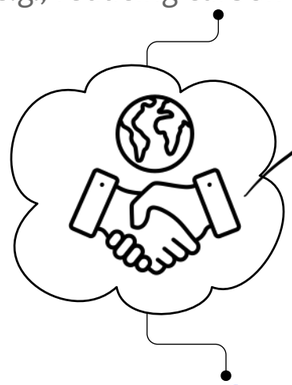
Repetitive Motion & Injury
(e.g., carpal tunnel syndrome)



Labor Law
(e.g., workers' compensation)



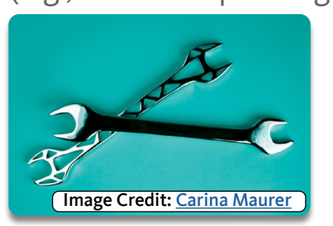
Environmental Sustainability
(e.g., reducing carbon footprint)



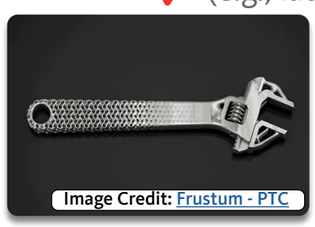
Opportunities for people-planet well-being

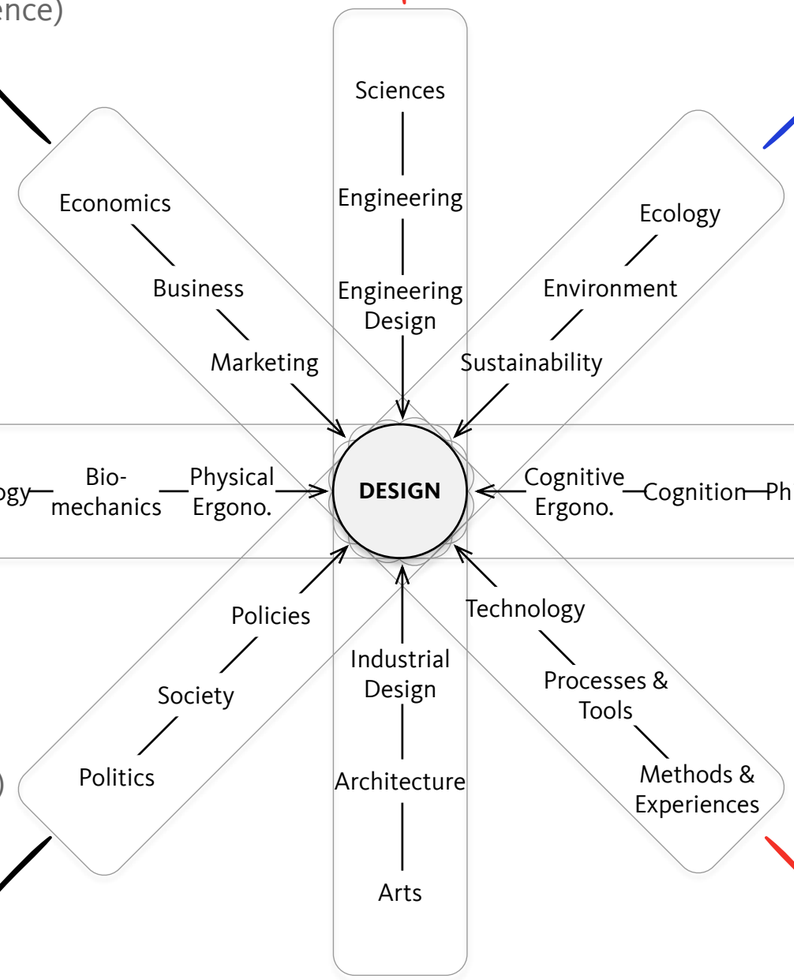
Ease of Use
(e.g., designing for the elderly)

Additive Manufacturing
(e.g., 3D metal printing)



Aesthetic Design
(e.g., lattice structure design)





Challanges
Theories, Methods, and Technologies
Solutions

Designing for People-Planet Well-Being: The D-HIL framework can enable designers to blend creative (e.g., aesthetics) approaches and scientific methods (e.g., generative design) to generate and evaluate inclusive concept variants positively impact people and the planet.



DESIGN WORKS

Design Science

W.1 ARTIFICIAL INTELLIGENCE pg. 6

W.2 DIGITAL TWINS pg. 7

W.3 USER EXPERIENCE pg. 8

W.4 HUMAN VARIABILITY pg. 9

W.5 CO-DESIGN pg. 10

W.6 URBAN PLANNING pg. 11

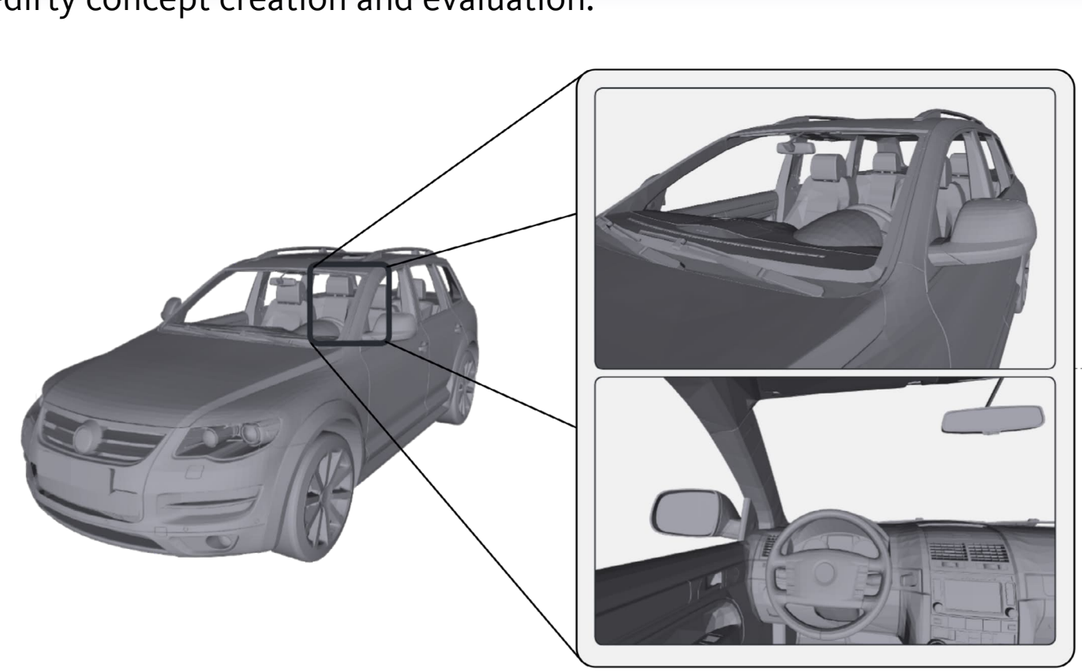
W.7 OCCUPANT PACKAGING pg. 12

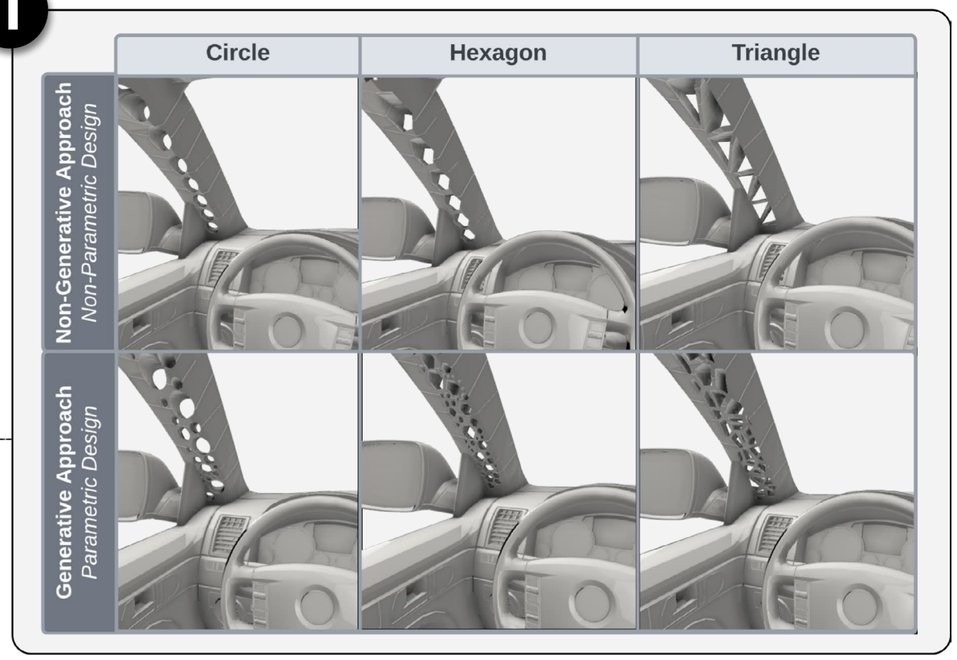
ABOUT

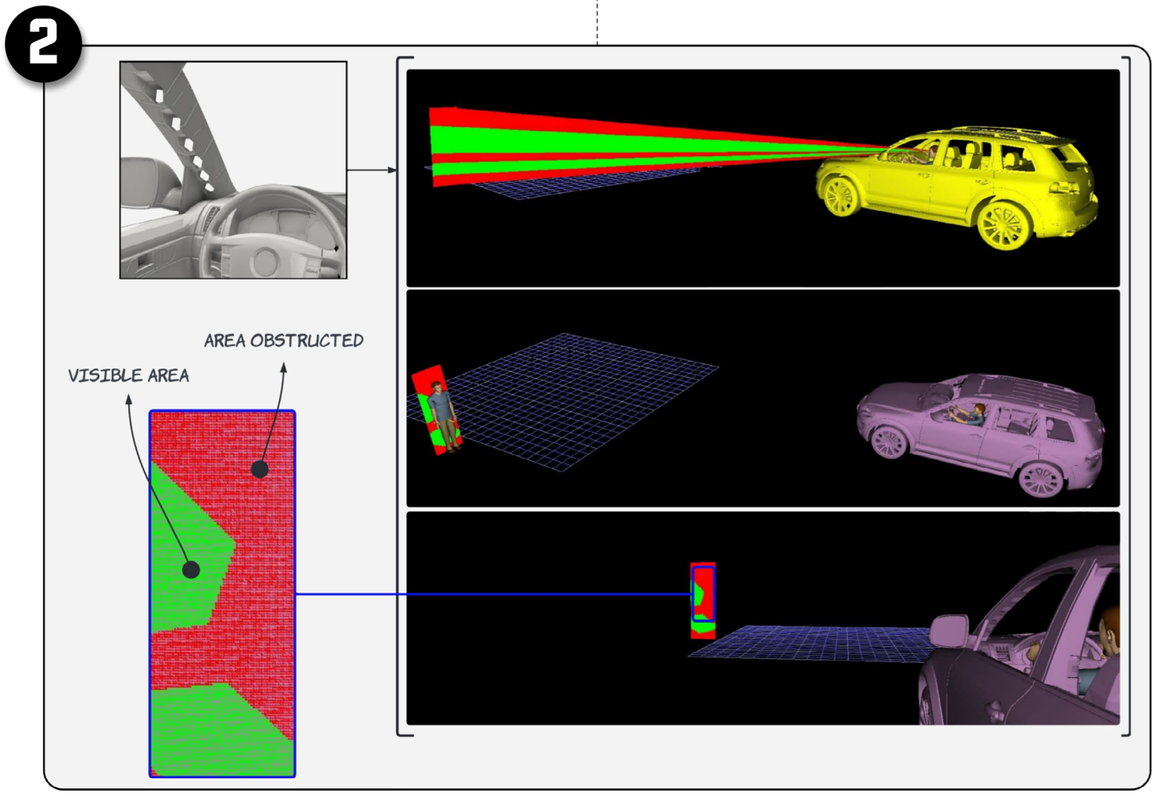
Current generative design tools lack the integration of human factors, which diminishes the efforts to understand a broad set of human capabilities, limitations, and potential emotional responses for future human-centered product innovation. This research formulates a human-centered generative design framework that injects human factors early in the design for quick-and-dirty concept creation and evaluation.

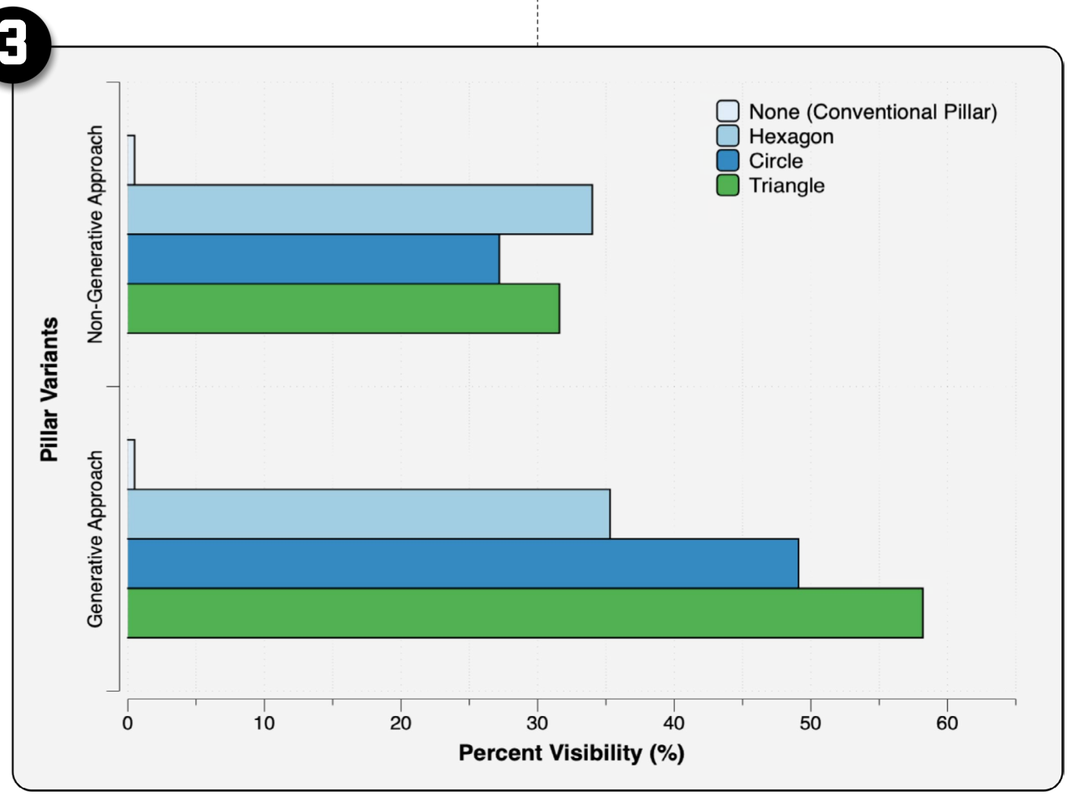
DESIGN ACTIVITIES

1. Generate Variants — concept pillar models
2. Simulation — obstruction simulation setup
3. Analysis — comparion between pillar variants











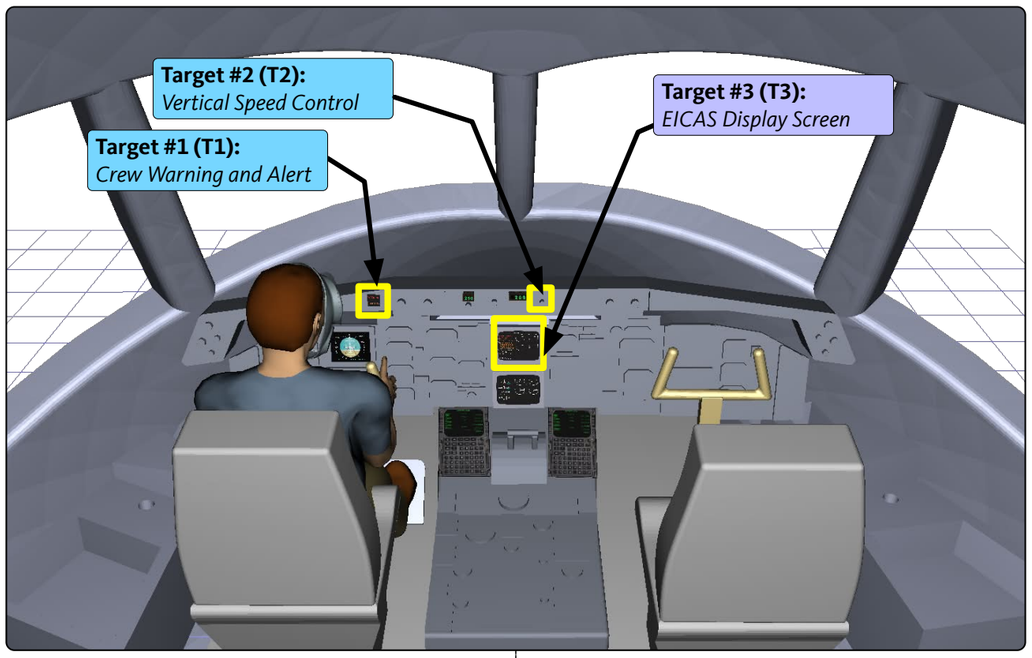
Demirel, H.O, Goldstein, M. H., Li, X, and Sha, Z. “Human-centered generative design framework: An early design framework to support concept creation and evaluation,” International Journal of Human–Computer Interaction, vol. 40, no. 4, pp. 933–944, 2024.
doi 10.1080/10447318.2023.2171489

ABOUT

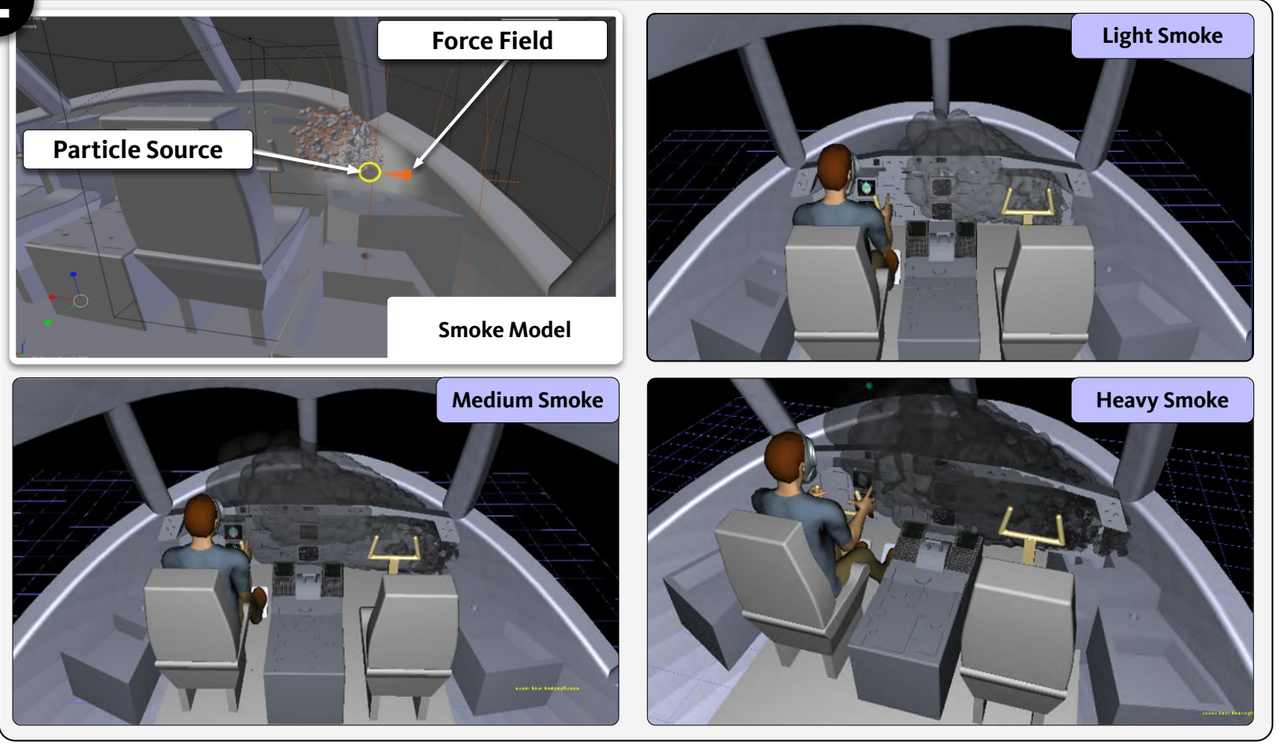
This research introduces a digital human modeling (DHM) based early design approach to automate task analysis during emergencies. It provides a proof-of-concept demonstration of the automation framework within the context of the cockpit fire and smoke case study.

DESIGN ACTIVITIES

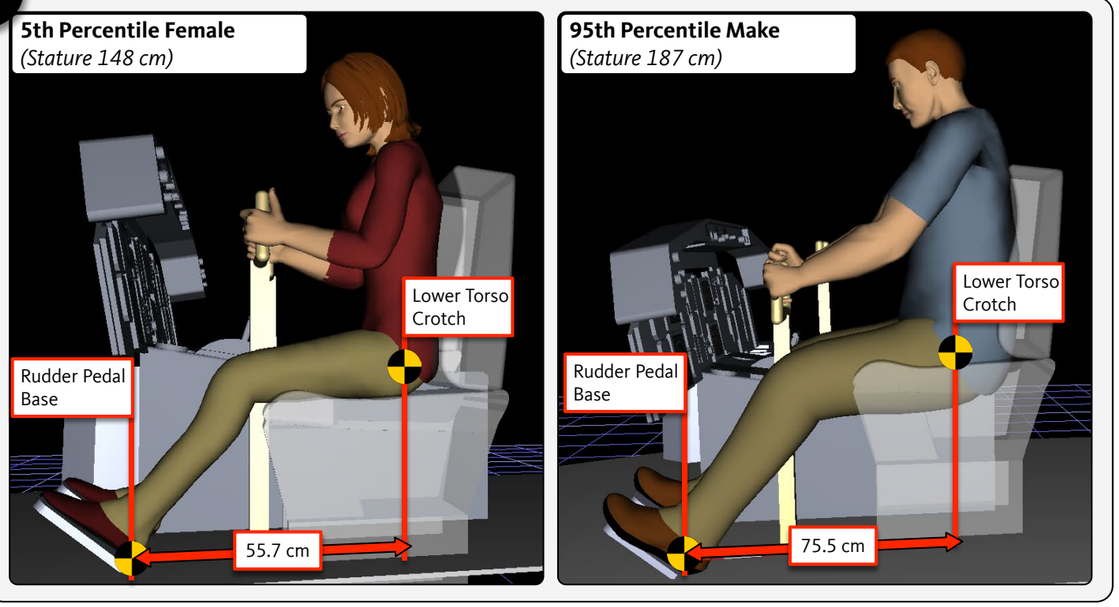
1. Modeling — cockpit setup and manikin construction
2. Simulation — smoke particle modeling
3. Validation — human-in-the-loop virtual reality (VR) study



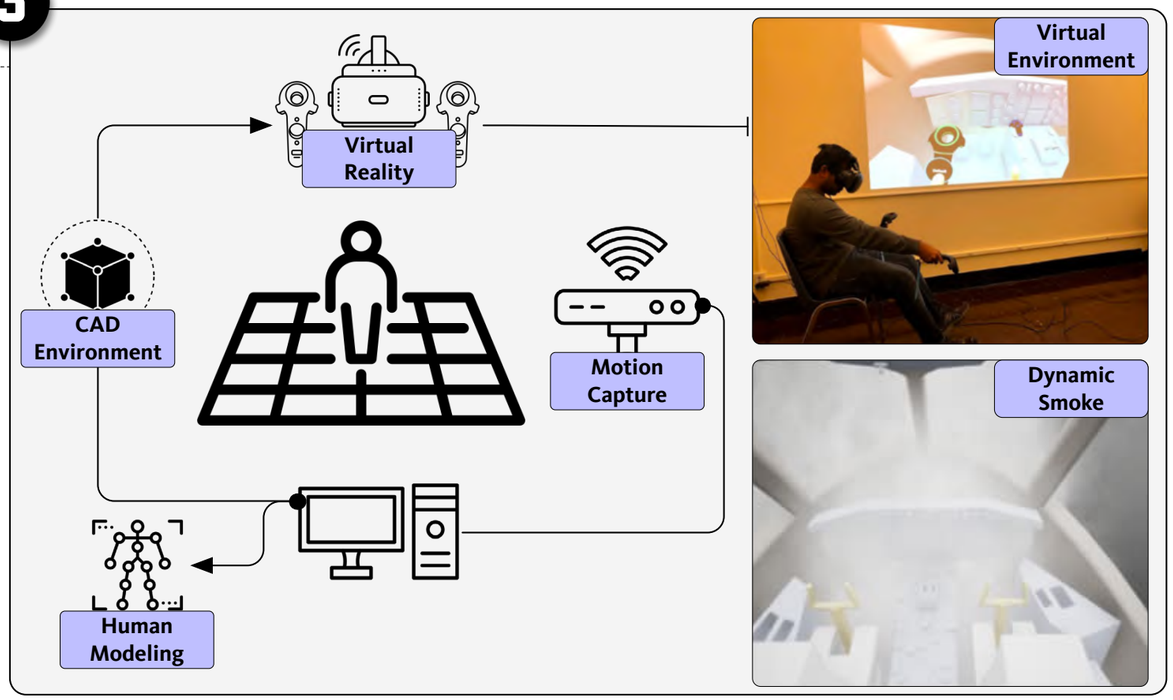
2

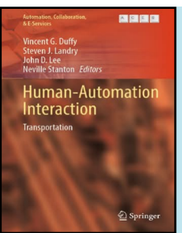


1



3





Gawand, M. S., & **Demirel, H. O.** (2022). Task Simulation Automation via Digital Human Models: A Case Study on Cockpit Fire and Smoke Emergencies. In Human-Automation Interaction: Transportation (pp. 345-362). Cham: Springer International.
doi 10.1007/978-3-031-10784-9_21

UNDERSTANDING USER NEEDS — ACCESSIBLE WASCHING MACHINE

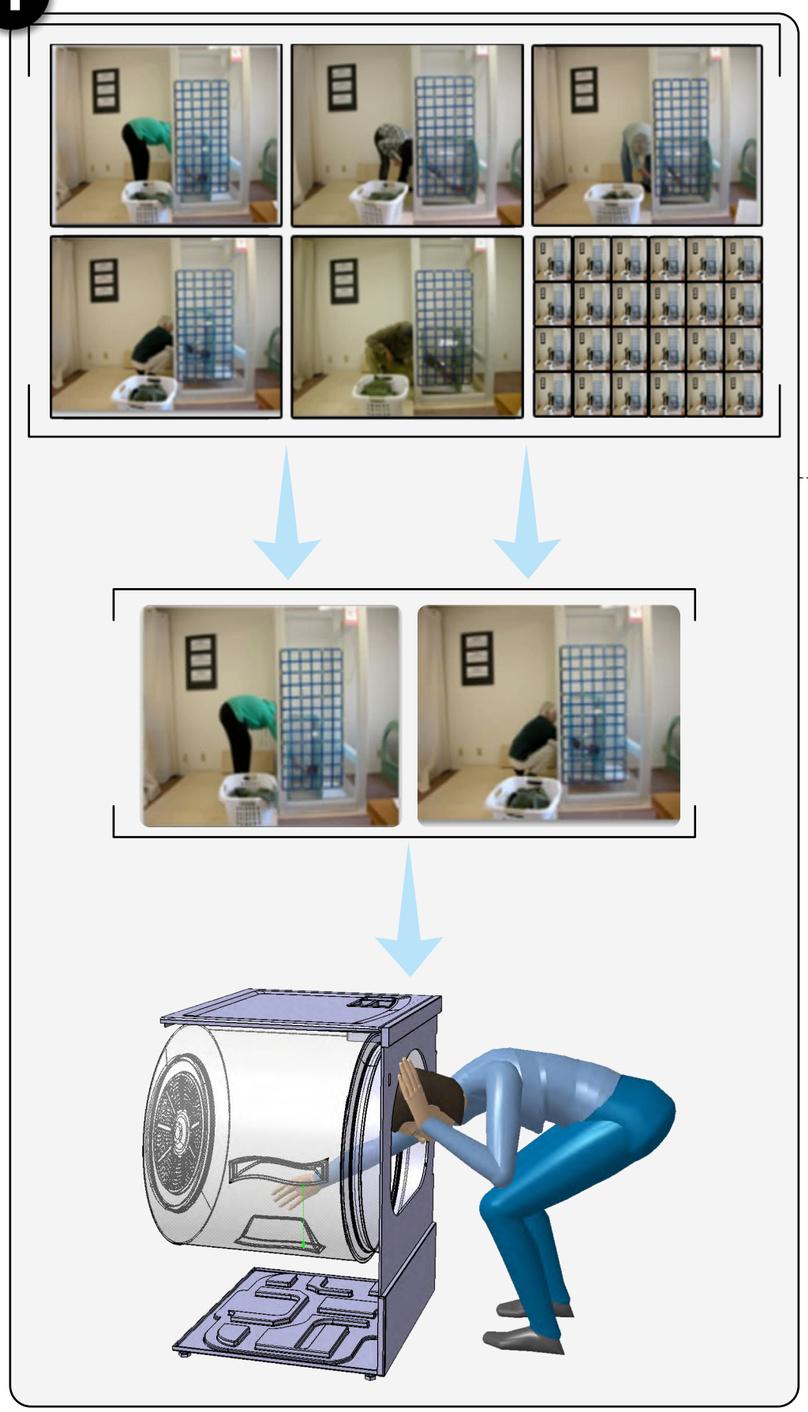
ABOUT

This study demonstrates how digital human modeling (DHM) bridges engineering and business decision-making. It illustrates the ergonomics benefits, such as reduced L4/L5 compression and shear, of adding a pedestal to a washing machine from both engineering and industrial design perspectives, enabling more robust decision-making using digital twin approach.

DESIGN ACTIVITIES

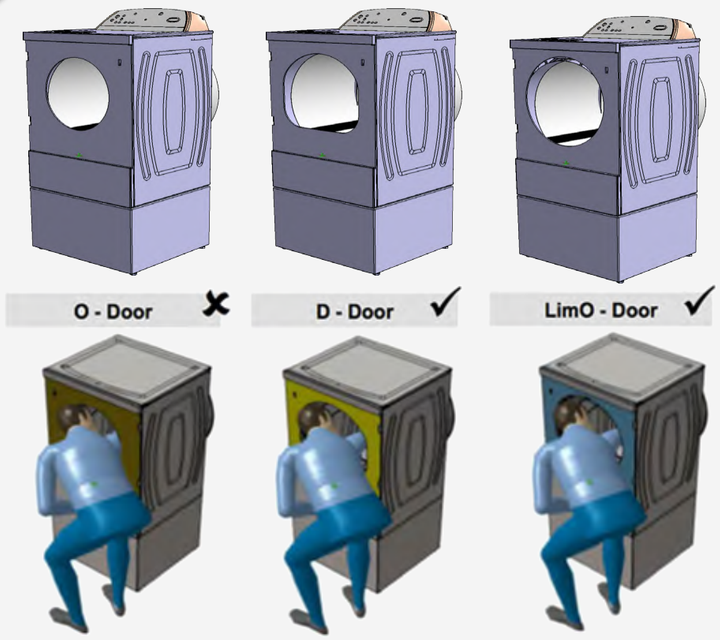
1. User data collection — maniking reconstruction
2. Accessibility analysis — validation of concept variants
3. Biomechanics — differences in compression forces

1

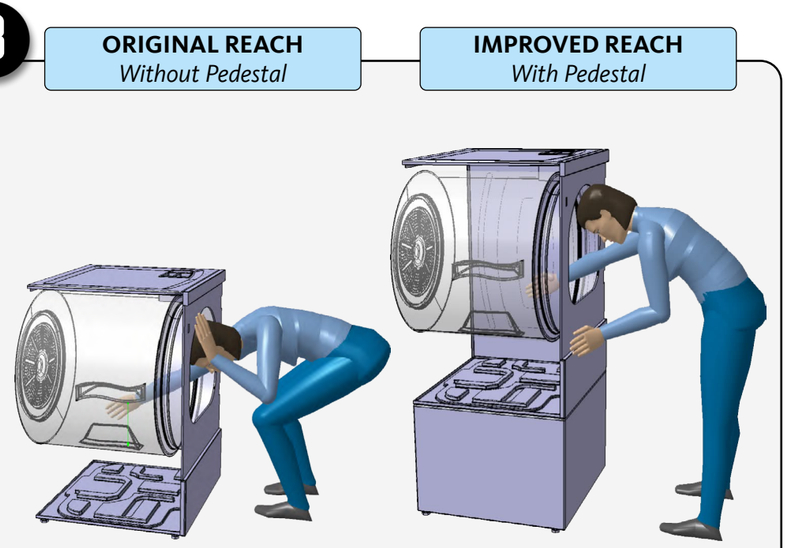


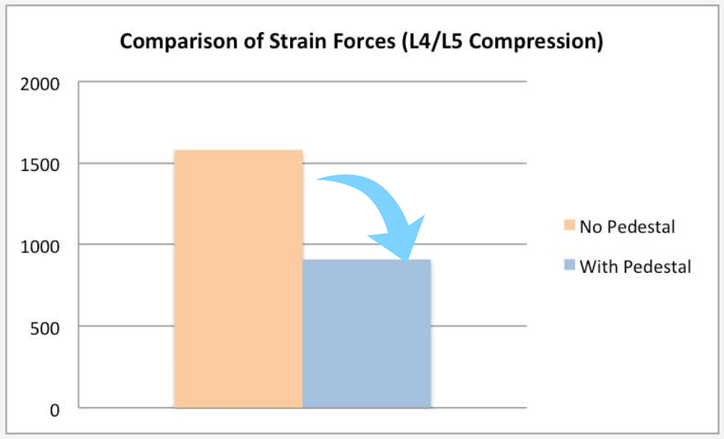


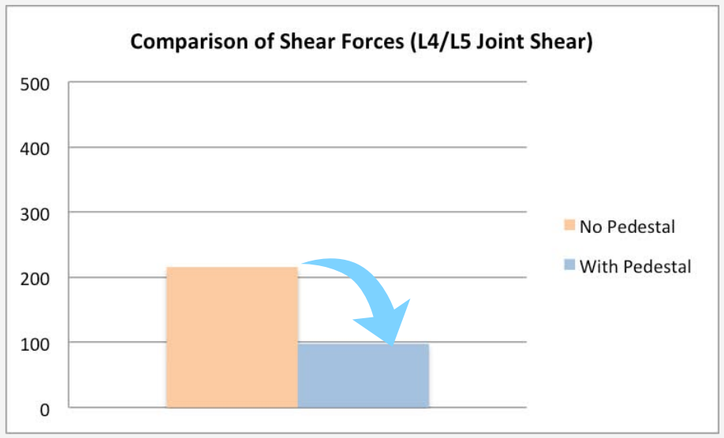
2



3









Demirel, H. O., Irshad, L., Ahmed, S., & Tumer, I. Y. (2021). Digital twin-driven human-centered design frameworks for meeting sustainability objectives. *Journal of Computing and Information Science in Engineering*, 21(3), 031012.
doi 10.1115/1.4050684

ABOUT

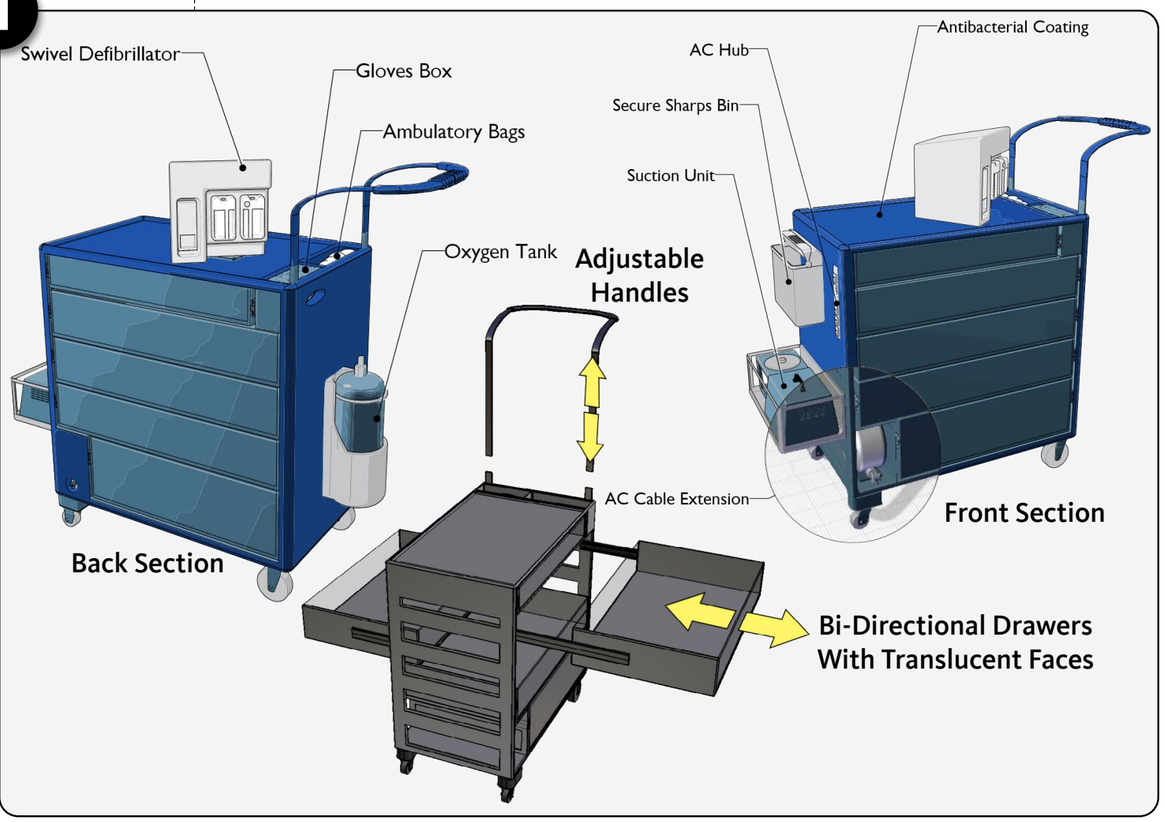
This design study focuses on creating a user-friendly, lightweight code cart that meets the needs and limitations of nurses with diverse anthropometric backgrounds. The percent-capable summary evaluates how easily nurses can push and pull the carts during a code. Similarly, the field-of-view model replicates binocular vision to show how much each code cart variant obscures visibility.

DESIGN ACTIVITIES

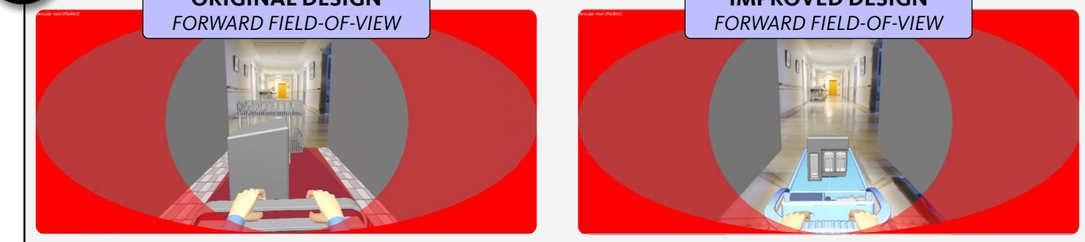
1. Digital design — solid and surface modeling
2. Binocular vision model — forward field-of-view (FoV)
3. Biomechanics — population percent capable summary



1



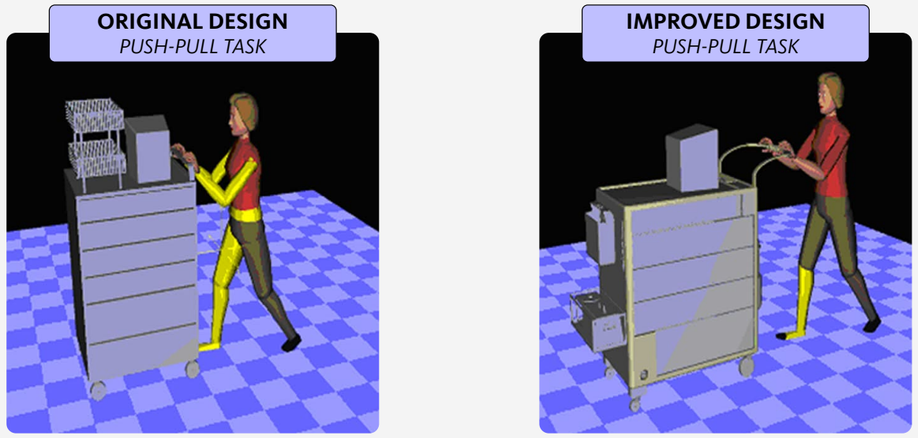
2

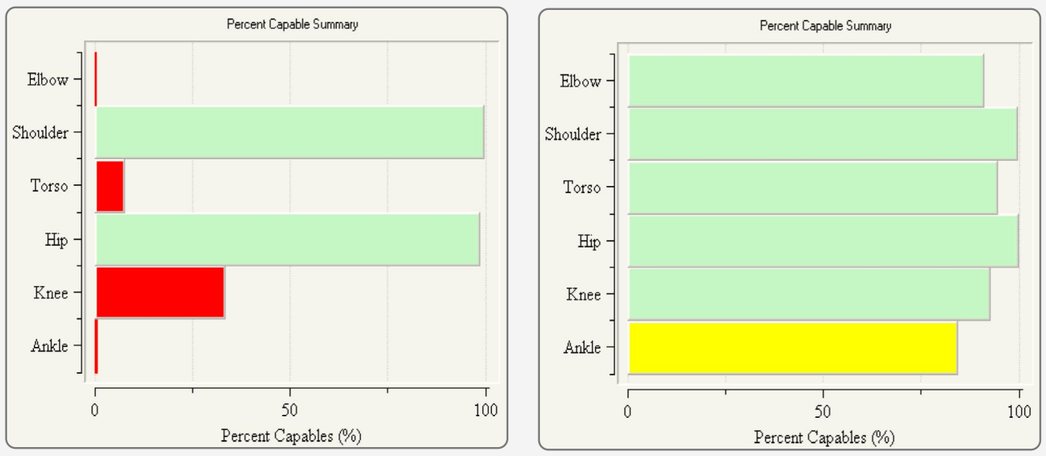


Cluttered Vision
design features block forward field-of-view

Uncluttered Vision
design features do not block forward field-of-view

3





Unacceptable - strength requirements exceed the capabilities of a worker population
Needs attention - strength requirements exceed the capabilities of some of the workers
Acceptable - strength requirements are within the capabilities of a worker population



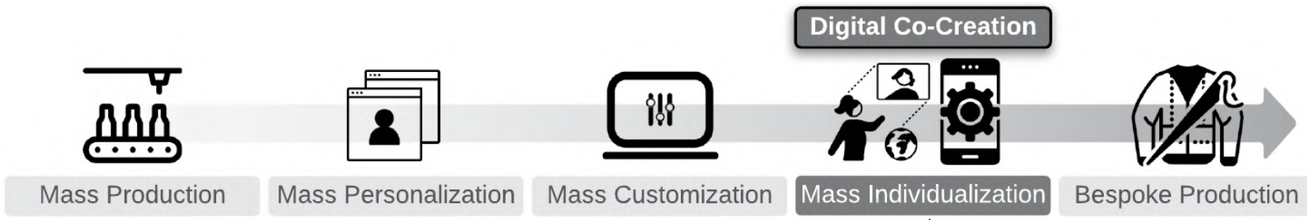
Demirel, H. O., & Duffy, V. G. (2017). Incorporating tactile cues into human-centered virtual product design. Human Factors and Ergonomics in Manufacturing & Service Industries, 27(1), 5-16.
doi 10.1002/hfm.20402

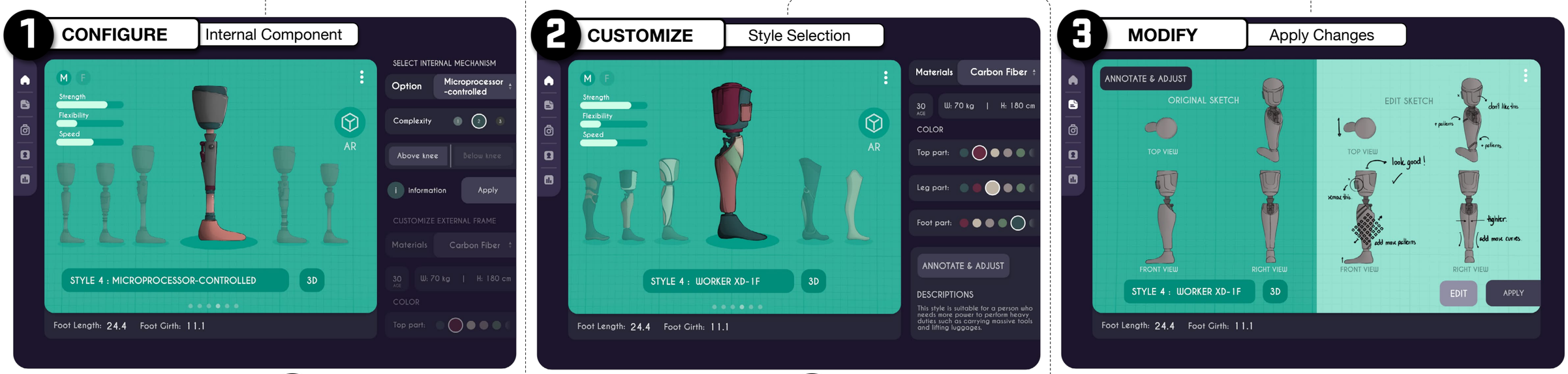
ABOUT

The co-design framework in this research bridges mass customization and bespoke production. It uses common functional product bases, modular add-ons, and digital tools to allow customers to directly participate in product design. This case study demonstrates a conceptual design application that enables direct customer-designer interaction, where product design information is visualized and modified in both directions.

DESIGN ACTIVITIES

1. CAD Modeling — mechanism design and configurator
2. Surface Modeling — style selection
3. Design Change — co-design, modification, and feedback
4. Design Review — visual inspection and structural
5. User Experience — model test in augmented reality (AR)







Anattasakul, R., Slama, T. J., & **Demirel, H. O.** (2023). Digital co-creation: an early-stage product individualization framework to bridge the customer–designer void. In Digital Human Modeling and Medicine (pp. 659-677). Academic Press.
doi 10.1016/B978-0-12-823913-1.00022-1

ABOUT

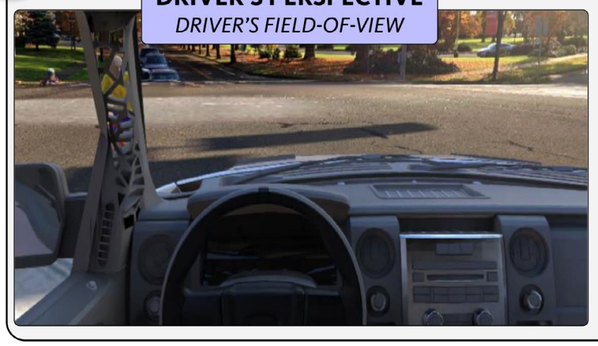
The proposed computational framework links urban planning with human performance analysis, enabling designers to explore what-if scenarios, such as bicycle and pedestrian safety, in the early stages of urban conceptualization. It provides a platform of methods with varying levels of fidelity, including human modeling, computer vision, and immersive environments, to assess design decisions from public's perspective (e.g., cyclists, drivers).

DESIGN ACTIVITIES

1. Urban Planning — modeling and what-if scenarious
2. Concept Evaluation — low to high-fidelity methods
3. User's Perspective — bicycle and driver safety



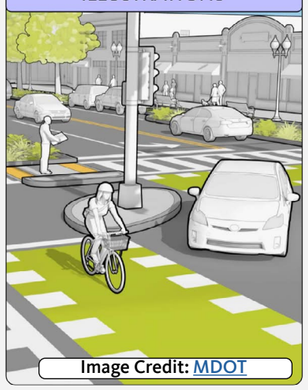
3





1

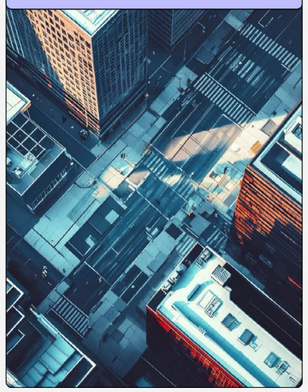
URBAN PLANNING
ILLUSTRATIONS



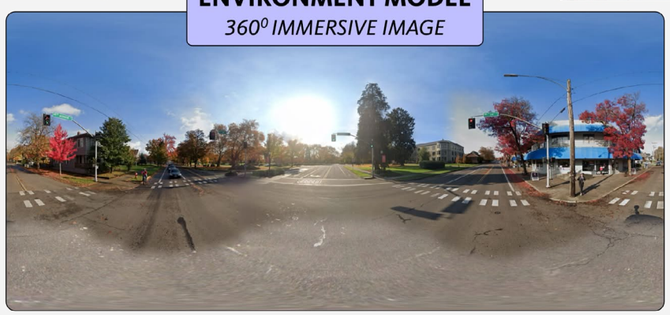
MODELING
HYPERREALISTIC RENDERING



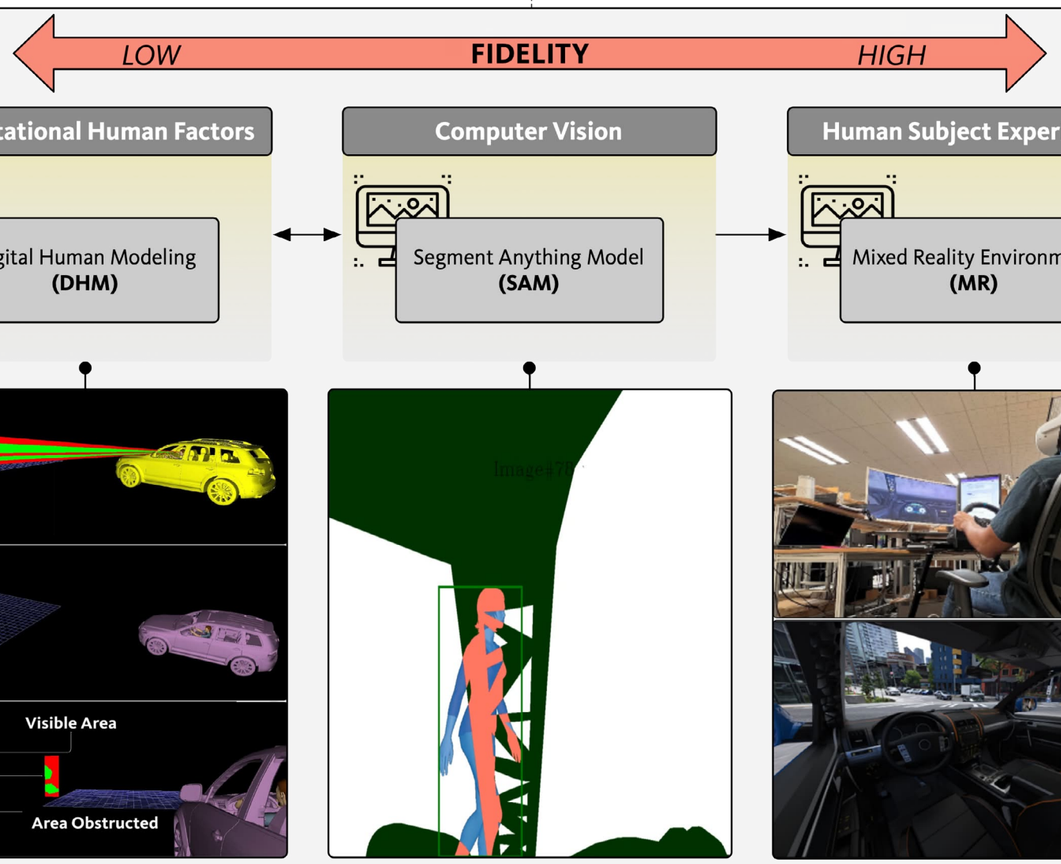
SCENARIO BUILDUP
MODELLING INTERSECTION



ENVIRONMENT MODEL
360⁰ IMMERSIVE IMAGE



2





Demirel, H. O., & Srinivasan, S. (2022). A proactive ergonomics framework to assess a-pillar vision obstruction. *13th International Conference on Applied Human Factors and Ergonomics*. Digit. Hum. Model. Appl. Optim, 46.
doi 10.54941/ahfe1001895

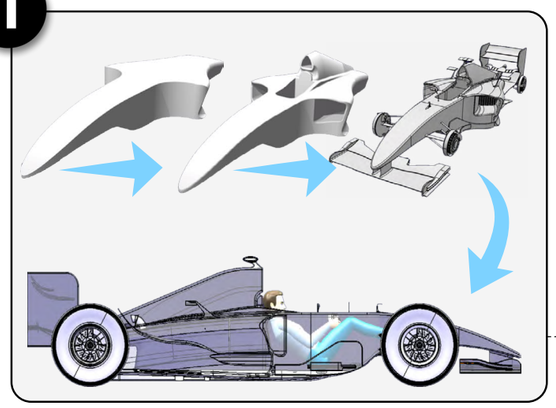
ABOUT

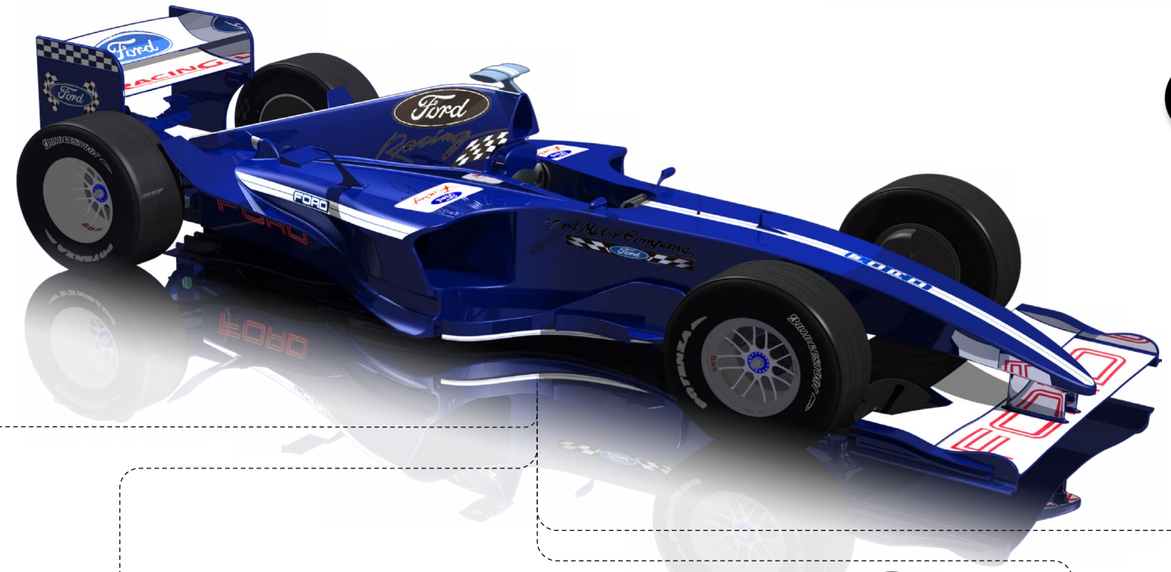
The study illustrates a vehicle packaging study focusing on developing a Formula-1 (F1) race car monocoque safety cell. The F1 model, including the monocoque chassis and the manikin representing the driver, uses an integrated digital prototyping approach to assess drivers' comfort based on joint angles.

DESIGN ACTIVITIES

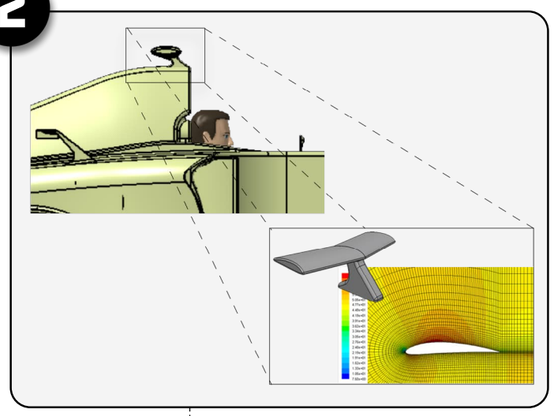
1. Modeling —freeform CAD with human models
2. Analysis — fluid dynamics with human models
3. Occupant packaging — comfort based on joint angles
4. Validation — CAVE automatic virtual environment

1

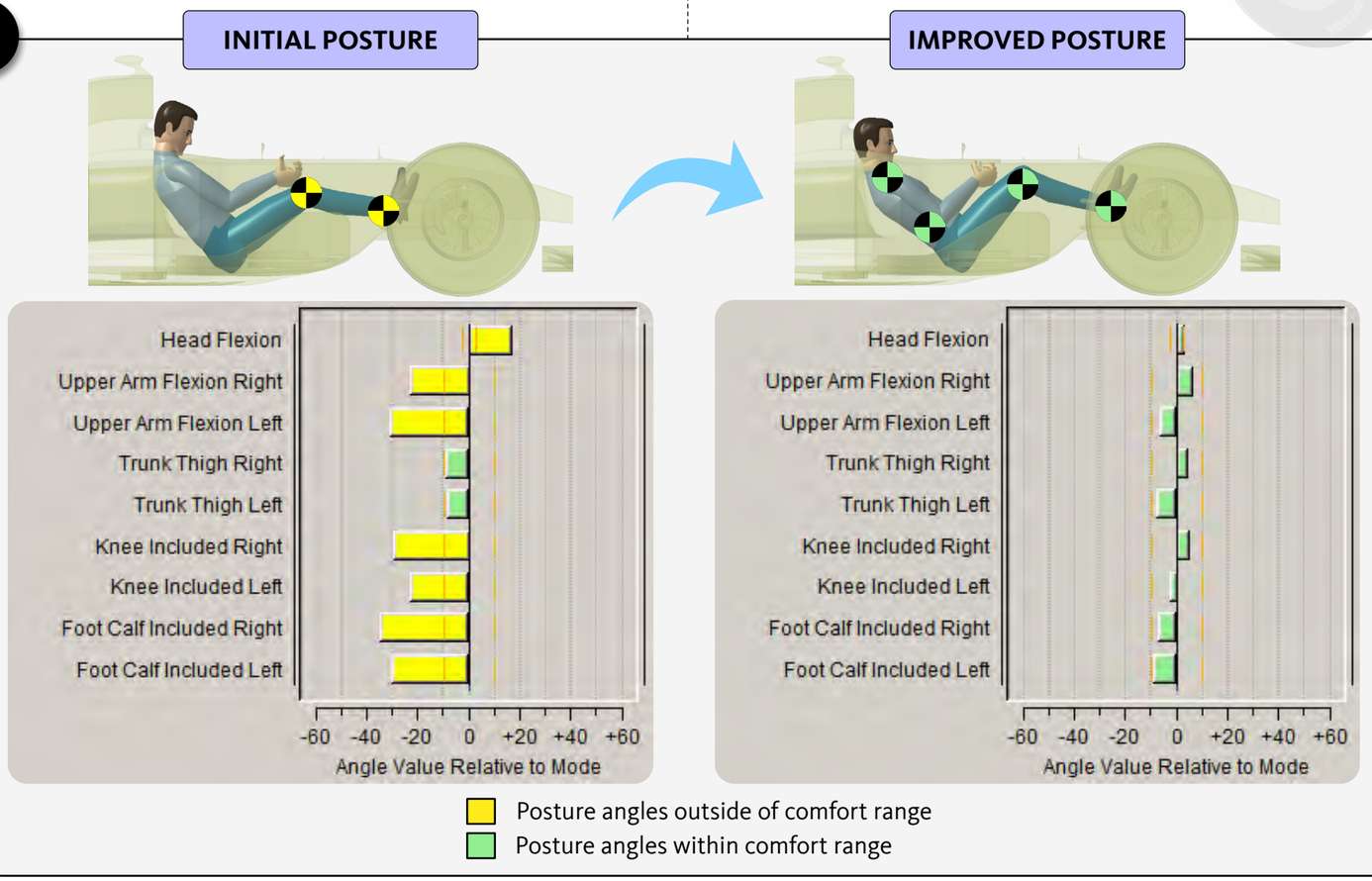




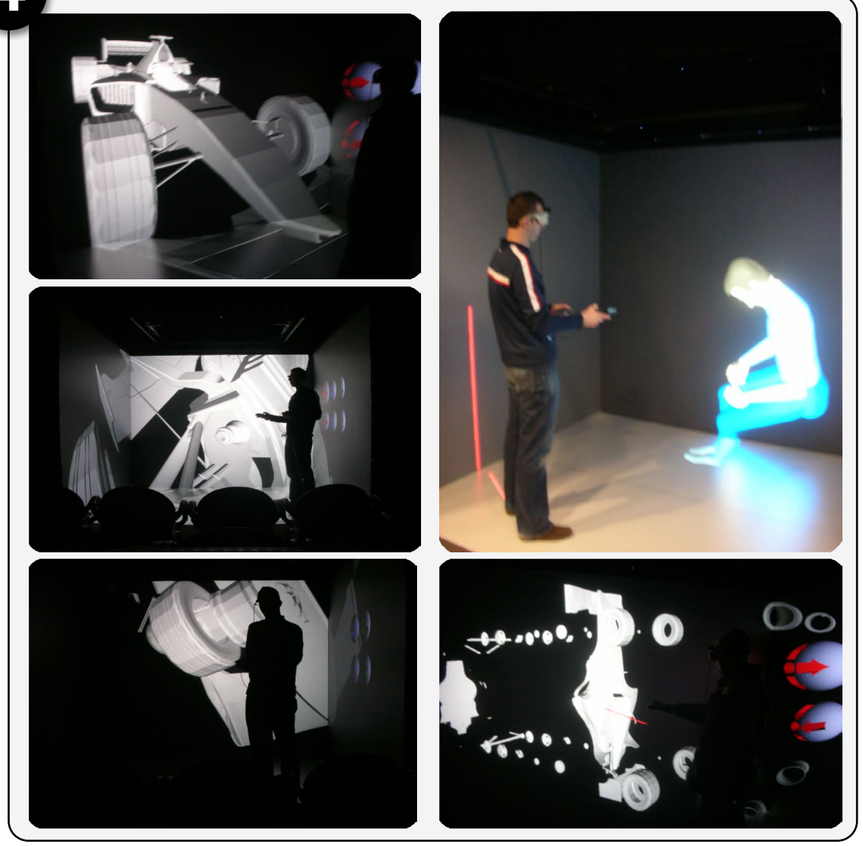
2



3



4





Demirel, H. O., Ahmed, S., & Duffy, V. G. (2022). Digital human modeling: A review and reappraisal of origins, present, and expected future methods for representing humans computationally. *International Journal of Human–Computer Interaction*, 38(10), 897-937.
doi 10.1080/10447318.2021.1976507

DESIGN WORKS

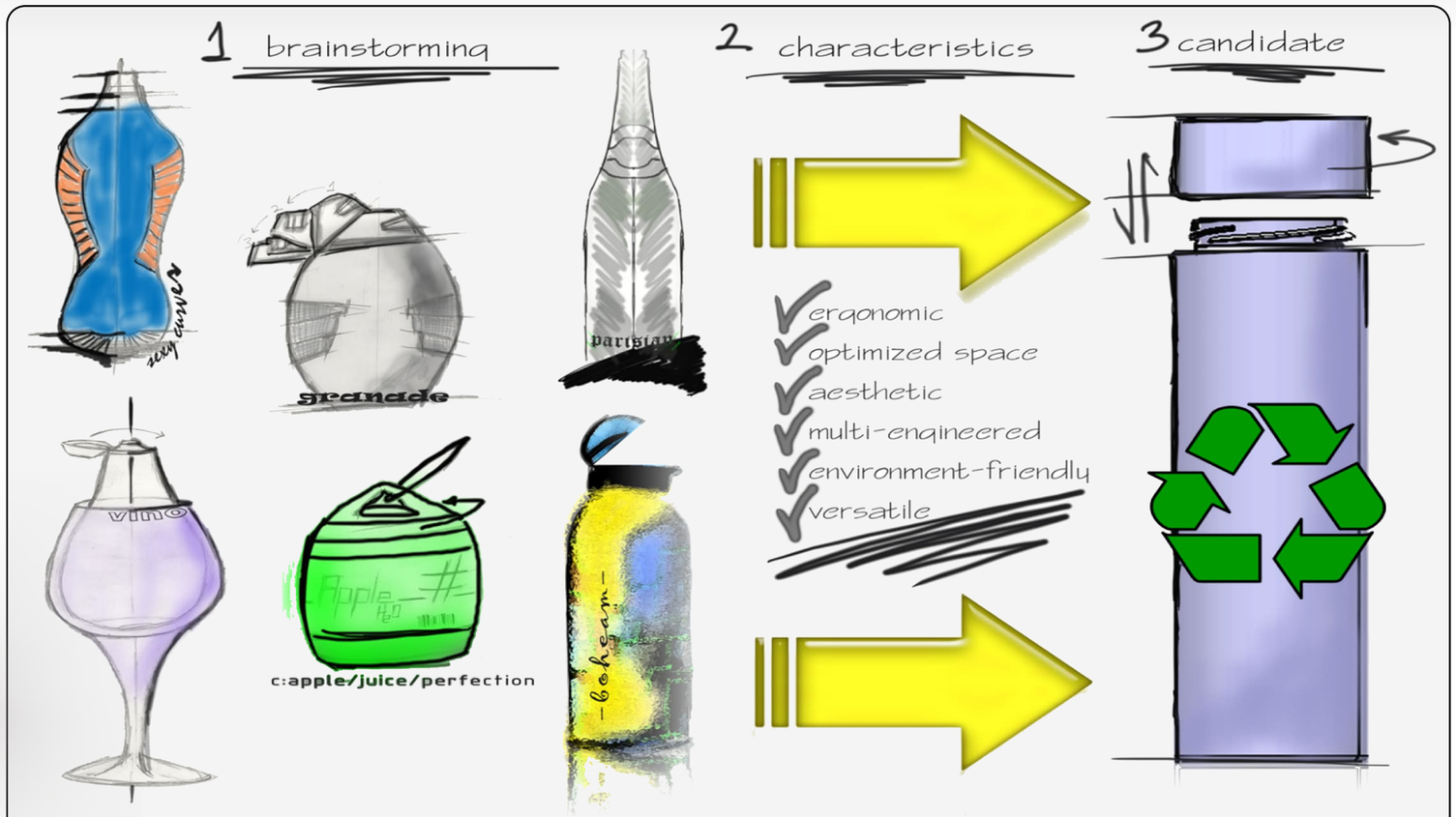
Design Art

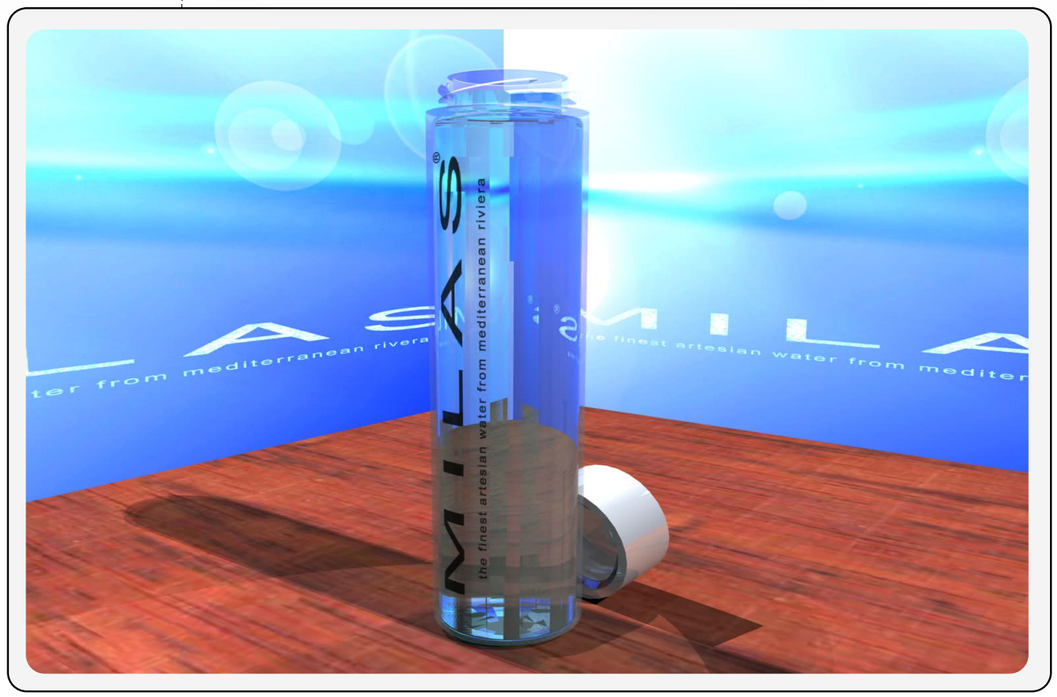
W.8	SUSTAINABILITY	pg. 13
W.9	BIOMIMICRY	pg. 14
W.10	DIGITAL ART	pg. 15

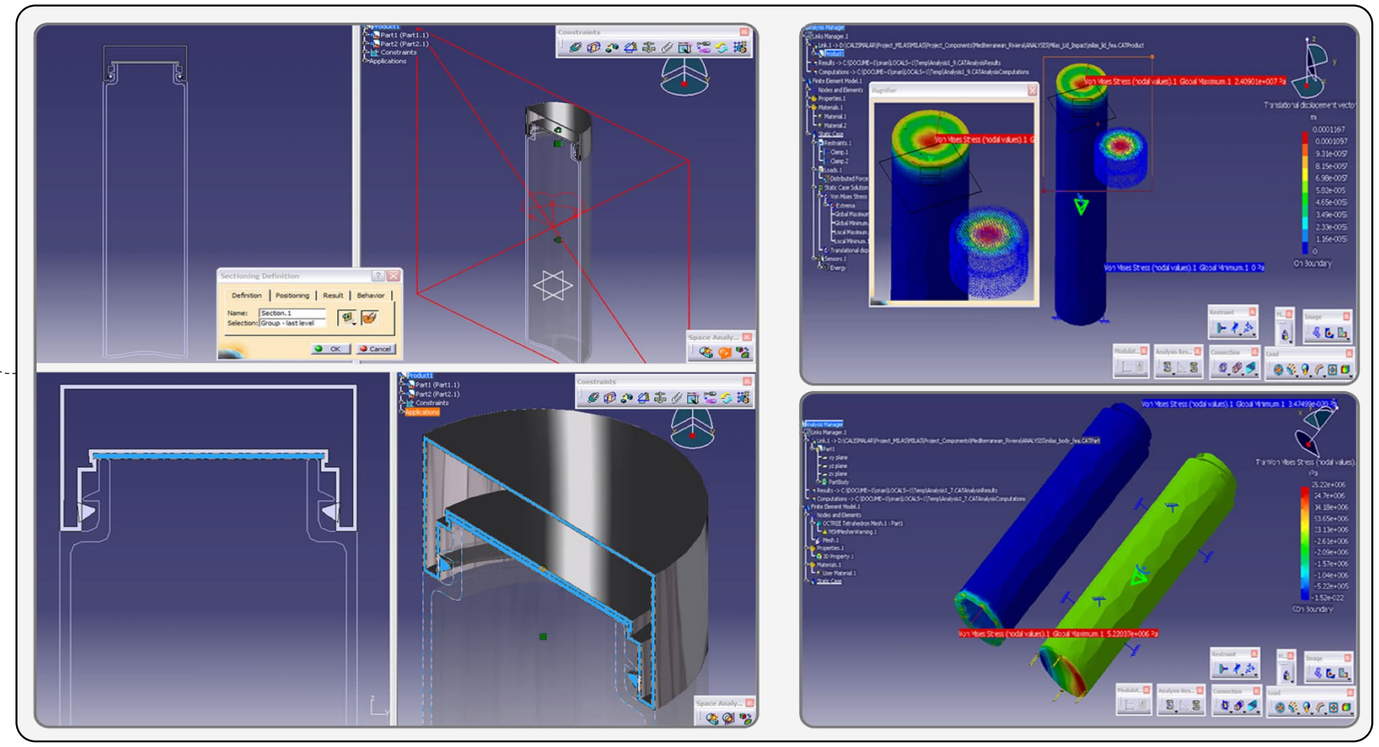
ABOUT

An aesthetically pleasing, simple, versatile, and sustainable bottle design study that demonstrates sketch-to-prototype product development with design activities including analog sketching, digital design, parametric modeling, engineering analysis, and rendering to support business decision-making.



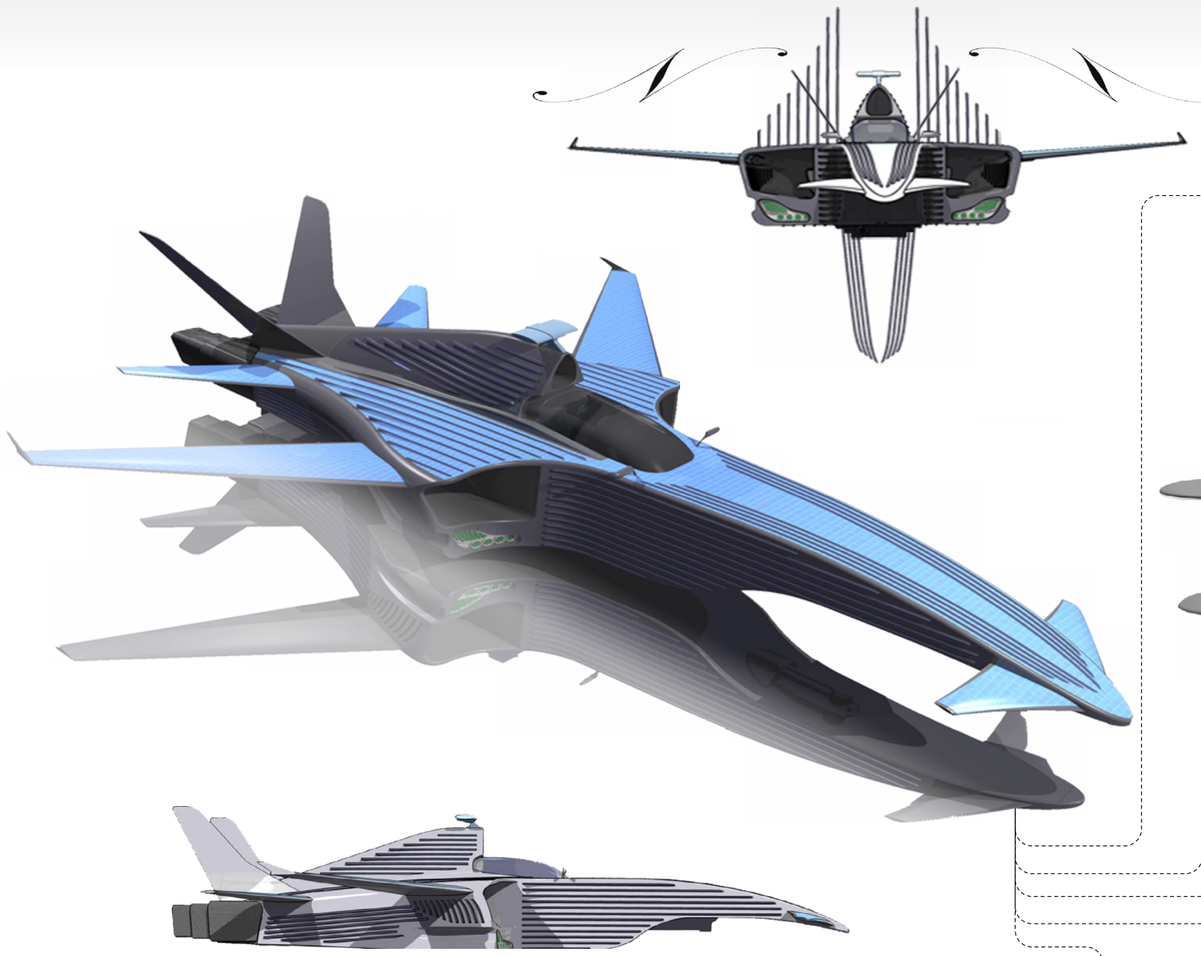






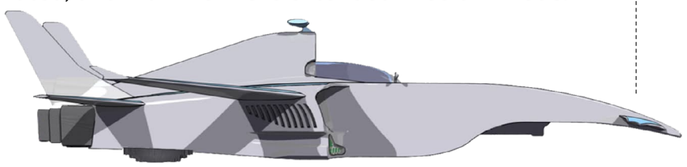
ABOUT

This concept vehicle design study, named Nitro Solaris, demonstrates advanced surface modeling, 3D parametric design, rendering, and storytelling. In this study, I utilized engineering and creative approaches within the biomimicry context to conceptualize a futuristic vehicle.

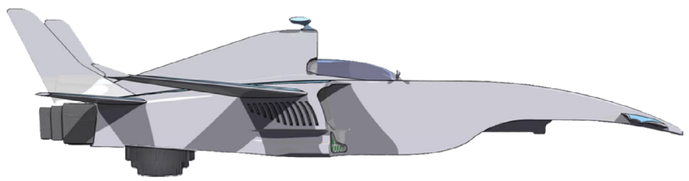


V/STOL nozzle is fully-retracted, the solar turbine is shot down, nitro-electrolysis struts are activated, and main nozzle is extended in scram mode.

Vertical and/or short take-off and landing (V/STOL)
Nitro Solaris's unique jet chamber is powered by nano-crystal solar cells at low speeds. When high speeds are needed, it extracts nitrogen from the air through the nitro-electrolysis system.

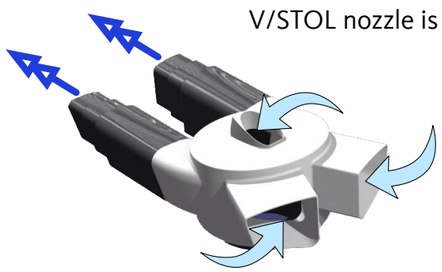


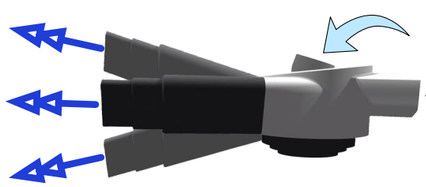
V/STOL nozzle is semi-retracted, solar turbine is in alernative thrust mode.



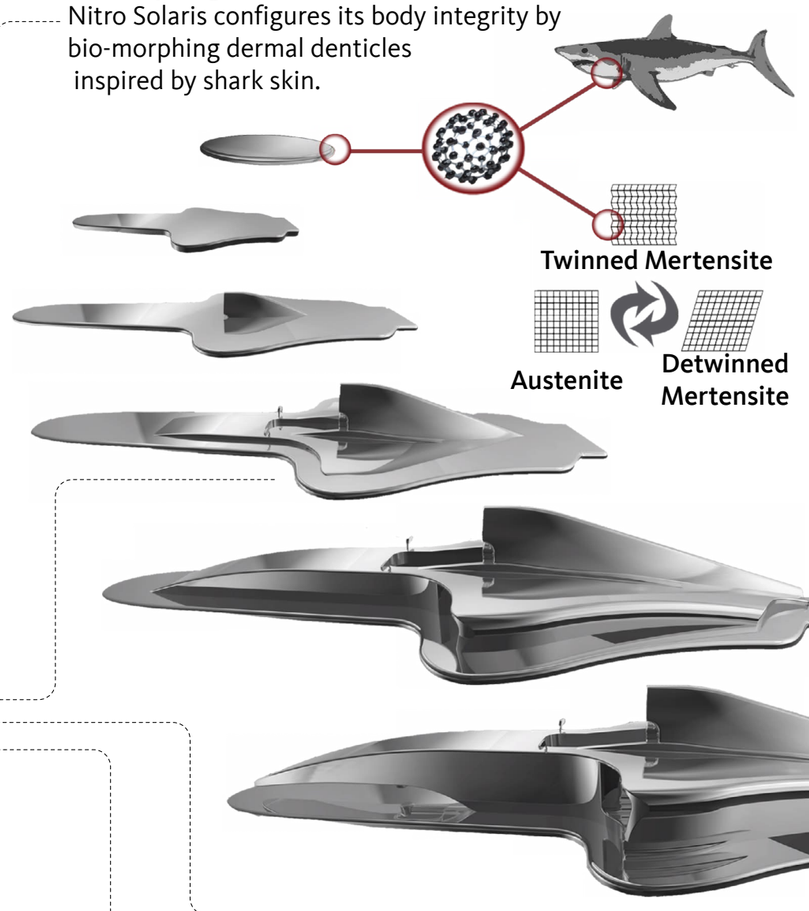
V/STOL nozzle is extended, solar turbine is in full power.

Scram Jet
Extracted nitrogen runs the scram jet. Nitro Solaris offers a comfortable journey at extreme speeds thanks to its silent scram jet technology and 3D-vector-thrust capability.





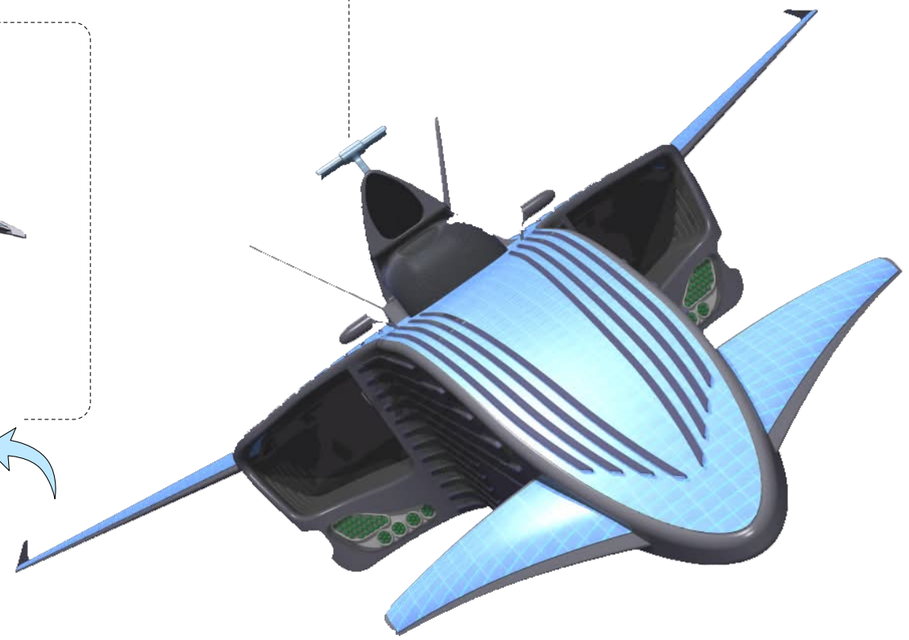
Biomorphing
Nitro Solaris configures its body integrity by bio-morphing dermal denticles inspired by shark skin.





Dermal Denticles
Provide rigidity and elasticity without deformation based on the same engineering principles as most advanced compounds.

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



ABOUT

This page includes a short selection of digital artwork that provides a window into my ideation and illustration process.

