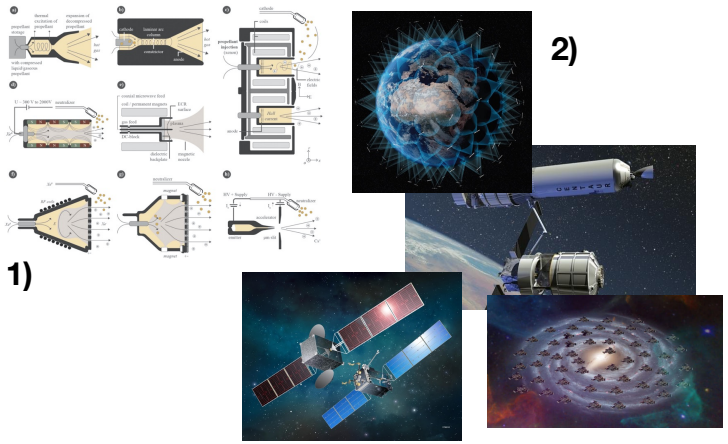
Club Design: a Flexible Digital Tool for Value-Cost Assessment of Electric Propulsion Design Alternatives

Massimo Panarotto, Chalmers University of Technology

Design / Technology

Mission / business



1)

2)

New disruptive concepts, both

- **in the technology**
- **in the mision/business domain**

However, the comparison between these radical concepts is difficult today, (due to **different parameters, scales and governing logics** among the alternatives).

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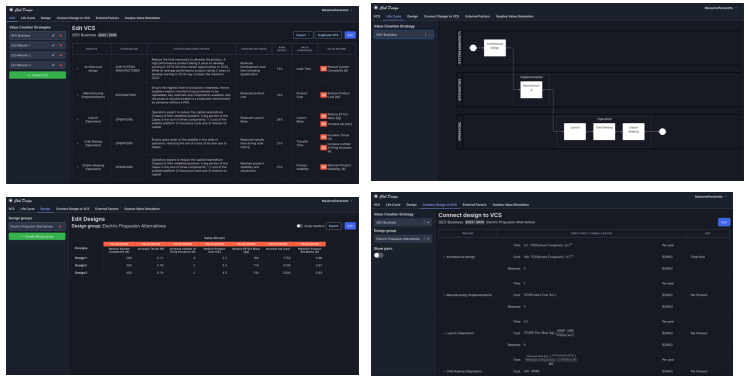

A web-based tool to conduct cost-benefit analysis of design and business alternatives within the electric propulsion business.

The use of the tool is demonstrated in a case study related to hall effect thrusters for geostationary communication and LEO mega-constellations.

The results point at the **flexibility of the tool** to run extensive and **automated digital experiments for both mission/ business and design**, fostering collaborative decision making between business and engineering.

Sources of figures:

1) Holste, K., Dietz, P., Scharmann, S., Keil, K., Henning, T., Zschätzsch, D., ... & Klar, P. J. (2020). Ion thrusters for electric propulsion: Scientific issues developing a niche technology into a game changer. Review of Scientific Instruments, 91(6), 061101.

2) https://www.esa.int/ESA_Multimedia/Images/2019/11/Mega-constellation_coverage

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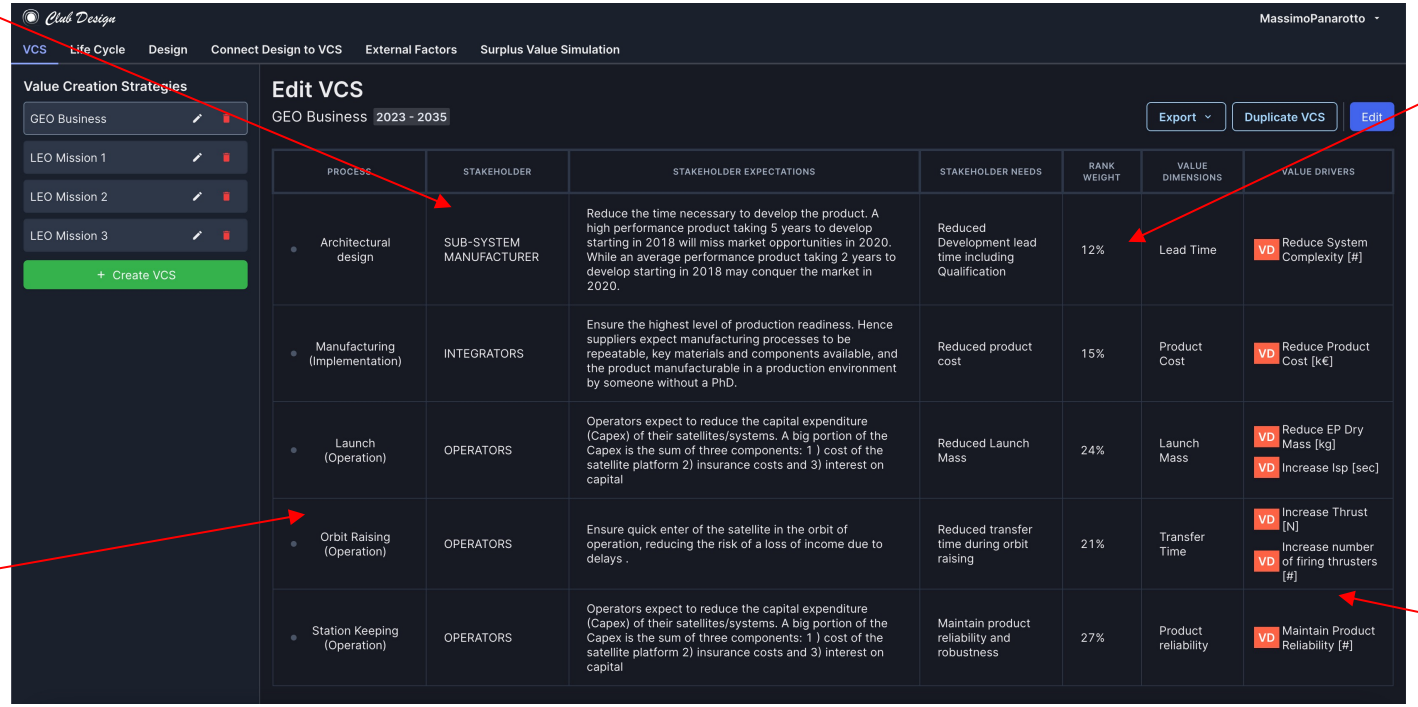
1. Define Value Creation Strategy

expectations **as expressed by the stakeholders**. Stakeholder expectations can be of any format, granularity or detail

List of lifecycle processes, adapting **ISO 15288 standard.** This link is what will enable the cost/benefit simulation



A Value Creation Strategy (VCS) is a **set of rank-weighted Needs** that have to be satisfied. Changing the needs will allow us to define a **new business scenario/mission**. No design is created yet.

Value drivers: What engineering aspects impact this need - that you can control during design?

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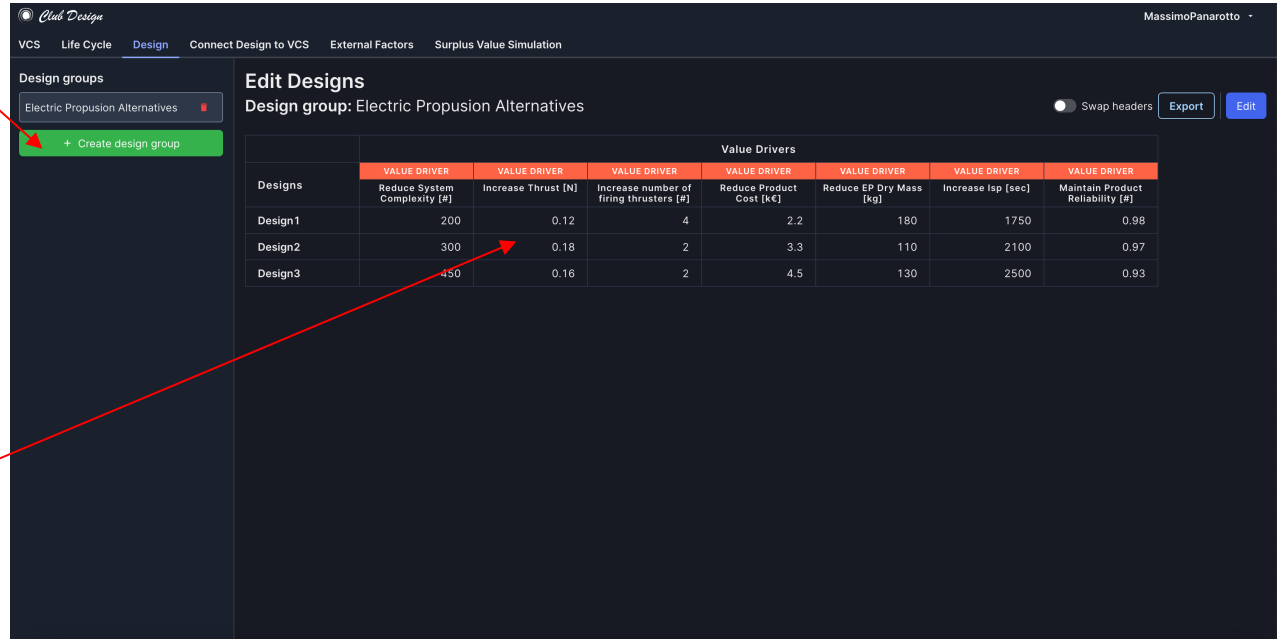
2. Create Designs

From the VCS view, a design **table is created automatically**.

The values for the different alternatives can be set manually, or can be imported from Excel if simulations have been run with other tools.



	Value Drivers						
Designs	VALUE DRIVER Reduce System Complexity [#]	VALUE DRIVER Increase Thrust [N]	VALUE DRIVER Increase number of firing thrusters [#]	VALUE DRIVER Reduce Product Cost [k€]	VALUE DRIVER Reduce EP Dry Mass [kg]	VALUE DRIVER Increase Isp [sec]	VALUE DRIVER Maintain Product Reliability [#]
Design1	200	0.12	4	2.2	180	1750	0.98
Design2	300	0.18	2	3.3	110	2100	0.97
Design3	450	0.16	2	4.5	130	2500	0.93

More radical designs can be created and analysed (through the **create new design group function**).

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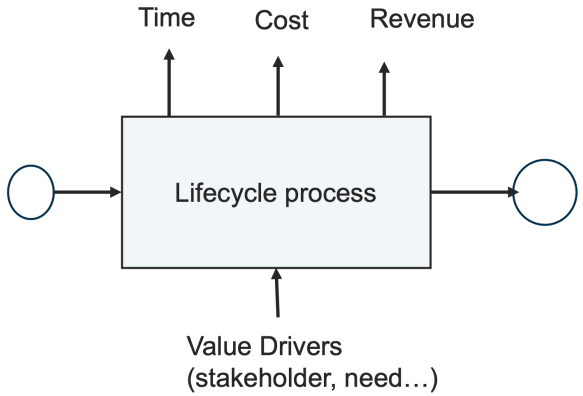
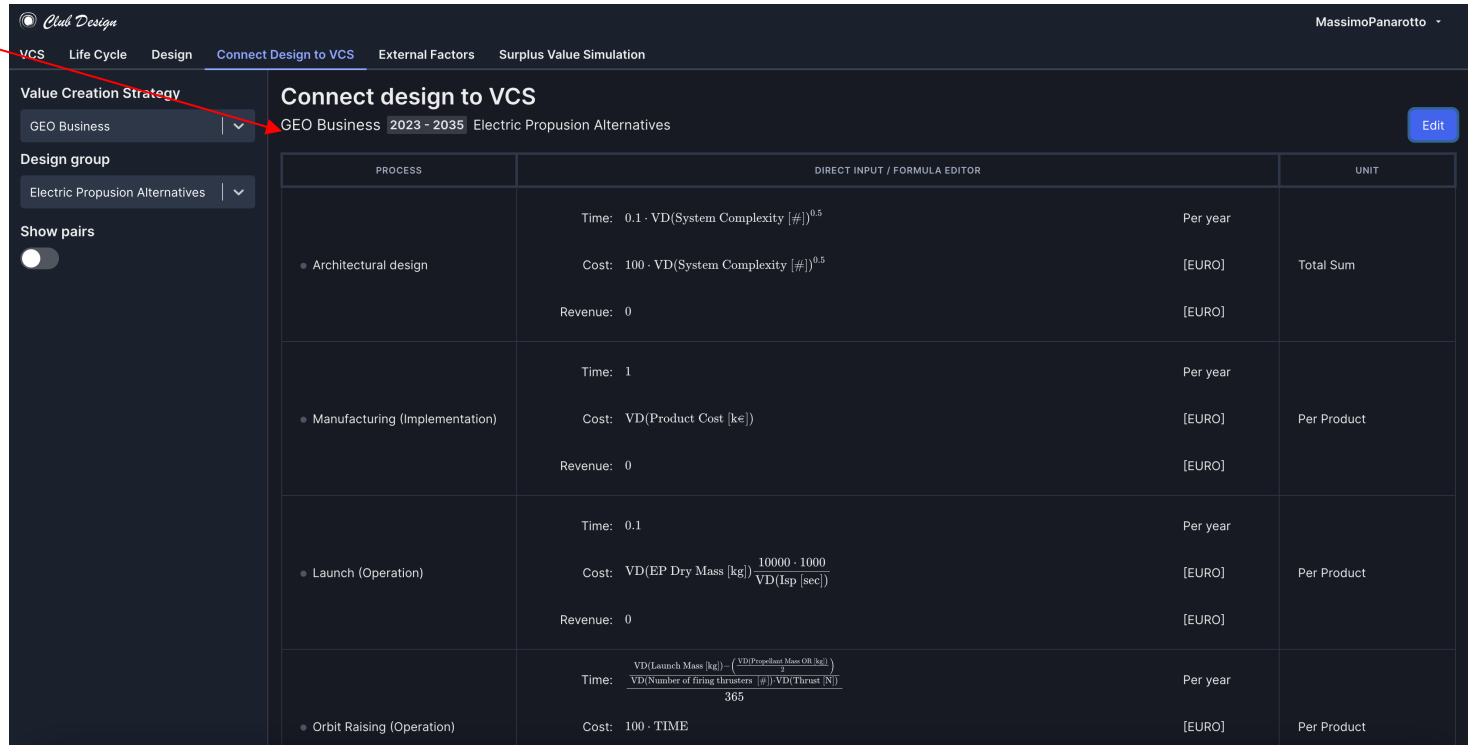
For each pair of mission and design, a set of relationships between the value drivers and the time, cost and revenue for each process can be defined



This link is what will enable the cost/benefit simulation

3. Connect Design to VCS



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4. Run Surplus Value Simulation

the model optimizes **the combined profit** of the customer, the manufacturer and eventual suppliers (i.e. the combined profit of an imaginary corporation that performs all three roles).

the simulation allows to understand the impact of the design alternatives on the **cost-revenue profiles over time for each mission.**

the simulation allows to **confirm or disconfirm** the **initial rank-weight** set in the value creation strategy (e.g. in the trade-off among thrust and Isp)

Option 3 is the one that allows to generate higher revenues, due to its high thrust (**earlier enter in orbit) and relatively low mass)**. However, **the pay back is longer due to its higher complexity** (a more innovative and risky concept).

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