1st Conference: Core decisions of “metadesign”

The Thick Work

Osvaldo Zorzano, Feb. 20th, 2021
Who am I

Designer, master in automotive design (Scuola Politecnica di Design, Milano) and academician at Universidad de Chile. Co-organizer and team advisor for the Atacama Solar Challenge event since 2011 and design advisor for electromobility research projects in Chile (2013 Lufke, 2015 Soki, Eolian).
Purpose + sense
The upcoming presentation is primarily aimed at teams that are starting an experimental electrosolar competition vehicle project, in order to help them make decisions with the most conscientiousness prior to the first sketch.
Purpose

+ sense

However, I hope it can be of help in the same way for those teams that are more advanced, but still have important aspects to solve ...

Or at least to reinforce the peace of mind of having made the right decisions (so far).
What is MetaDesign
What is MetaDesign

An emerging conceptual framework aimed at defining and creating social, economic and technical infrastructures in which new forms of collaborative design can take place. It consists of a series of practical design-related tools for achieving this...

...Or at least that’s how the definition from Wikipedia* starts.

* https://en.wikipedia.org/wiki/Metadesign#Re-designing_design
What is MetaDesign

“Meta” means “beyond” and in a practical sense, it means that in order to design something (simple or complex), the context, the workflows and transdisciplinary tissue must be created first. Every object we create is the result of the way we project it. And projecting starts before “designing”.

What is MetaDesign

Defining what materials will we use, how they are integrated with each other and in what sequence implies not only a technical and budgetary challenge, but also and above all human. Each part of the gross work of a project involves finding the person capable of executing it.

The thick work is that space where the most tiring part of the construction challenge is defined, but it is also the one that summons the most actors from various disciplines, hopefully from the beginning (and not when they are “really” needed).
Some concerns regarding MetaDesign

There are many issues to deal with and they are always proportional to the size of the achievement. But let’s focus on the Design related issues (they seem to be enough).
What is your ear?
What is the **purpose** of a solar car?
...A trial and experiment platform?
...An icon of paradigm shifts?
...A glance into the future?
...A breathtaking experience?
...A means to question the establishment?
What is the **purpose** of a solar car

You could say all of the above ...
But no can do!

And this is a key question. What is the purpose and meaning of a vehicle will determine its aesthetics, robustness, priorities in its components and above all its durability and validity over time (due to obsolescence or fatigue) ...
And that implies the amortization of the time and money invested on it plus how long it will be remembered.
Regulations vs Common Sense
Regulations vs common sense

Each rule in a regulation has its “why” and the vast majority are understandable logic. However, many times the solution that is found to comply with these rules is not the most successful.

The reasons can be various, from lack of time, reflection or budget to inexperience. But all these reasons have something in common.
World Solar Challenge 2017 Car Dimensions

- 7 Adelaide
- 22 MDH
- 8 Punch
- 45 Lodz
- 46 JU
- 40 Eindhoven
- 21 Twente
- 2 Michigan

Dimensions:
- Width: 0 m to 2.2 m
- Length: 0 m to 5 m
2019BWSC Challenger Class

Duel of tendencies
“Bullet cars” > Sleek and lighter sometimes hard to maneuver (due to the narrow gauge)
“Catamarans” > Good wheelbase
Careful with the “spinnable”
double center of inertia
A logical “stowagewise” solution is placing the heaviest component (cockpit) in the middle. However this solution presents greater aerodynamic resistance and access difficulties.
Here’s an excellent example of the difference between complying with regulations and doing things right.
...What if...

A “Challenger Crossover” type vehicle was designed, which has the bodywork of a bullet car, but the track width of a catamaran in the front axis.
...discuss!!!
Package & layout versus ergonomics
Pkg+Lyt vs Ergonomics

On the one hand, a vehicle needs to house many components necessary for its operation in a practical and safe way, in many senses. But on the other hand, a vehicle carries people (at least a driver) who operate it and who must be housed in a cabin not only safely but comfortably in order to resist several hours of considerable effort.
Pkg+Lyt vs Ergonomics

We generally see these issues to be resolved as extremes of a balance (or even scales where they are weighted). However, this changes if we consider the occupants of a vehicle for what they really are; the most important and delicate (and irreplaceable) component.
These two experimental aircraft are only 12 years apart (the same existence of several electrosolar teams) and 13 aircraft in between. I know what you’re thinking but no... Budget is not everything.

In some research environments, accommodating components around a pilot is not new... But the challenge is that those components are rarely the same.
The package+layout issue is usually seen as an engineering problem, due mainly to the fact that it is connected with technology and production.
As you have to start somewhere, it is very common to start from the chassis or frame. This error is very frequent, because in the traditional automotive world it is usually a frequent starting point. But when it comes to experimental vehicles, this decision may mean having to develop the entire project “with the hands tied.”
It is important to consider that though an experimental electrosolar vehicle is not a “street legal” car, ergonomics is negotiable to some extent, which is when safety and functionality are compromised.
SIT LIKE A PRO
Good driving starts with a proper seating position

ŠKODA MOTORSPORT
How many projects start by the beginning?

The example consists of “accommodating” a 1.8m tall person, starting from the **H point** (hips), reclined 25° and with the feet located slightly lower than the hips. The use of graph paper is for didactical purposes only, but it can be of great help in determining intermediate measurements and their projections, such as knees and ankles.

Ideally, this postural exercise should be done with the real dimensions of each driver in the vehicle. This will allow to establish a range for the volume necessary to comfortably position each one, taking into account the regulatory constraints that are being worked with (in this example BWSC2019).
Only once the most important component has been defined within the vehicle design, the other components can be organized in a practical, functional, regulatory and above all harmonious way.
Only once the most important component has been defined within the vehicle design, the other components can be organized in a practical, functional, regulatory and above all harmonious way.
Ergonomic considerations go beyond regulation and posture, safety and comfort. It also has operational and efficiency scopes in the use of the cockpit. This implies considering “a priori” aspects such as access (in and out) the vehicle and the type of control interfaces.
What is your car

Engineering

Package + Layout

Materials & Fabrication

Regulations

Sense

 vs

Communications
Styling versus Engineering
Styling versus Engineering

In the world of vehicle design, the relationship between engineering and design is usually sweet and sour... Love and hate... Virtuous / vicious.

And many times, the discord involves how a vehicle should look versus how a vehicle should behave and these decisions are a bit like chicken and egg.
Styling versus Engineering

It is impossible to conceive of a vehicle without sketching a formal approach to discuss. But in turn that approach is a waste of time if you do not consider the engineering constraints up front (before the first sketch).
Defining the driver’s position, will also define his “safety cage”, which in turn defines how the bars or columns of the rest of the vehicle’s chassis will extend, to accommodate, support and protect the rest of the components.
The components must be arranged around this main structure, applying safety criteria (above all) stowage, accessibility and relationship with the fairing and the exterior.
Finally, the fairing or bodywork of the vehicle is the result of crossing criteria of safety, aerodynamics, functionality, accessibility and (if possible) aesthetics, where the exterior must “converse” with the interior.
How is the driver supposed to feel inside the cockpit? ...
How do we understand the experience of driving a concept vehicle?
We usually understand Design as an aesthetic aspect applied to styling... However, each component in a vehicle deserves a reflection on how should it be designed.
And this implies thinking about the most functional and structural aspects, as well as the most delicate aspects of the interaction with the car.
When this is done correctly, the result is an elegance that has nothing to do with the budget spent, the nobility of the materials or the hi-tech of a cockpit...

...But the intelligence with which it is resolved.
Materials & Fabrication
Materials & Fabrication

Each sketch, each surface modeled in 3D, each mock-up made of cardboard, wood, clay or plastic must be translated into definitive materials... And each material implies a whole associated work environment (workshop).

Each shape needs to be molded, sculpted, turned, postformed, extruded, etc. Each material needs a mechanism for clamping, assembly, adhesion. And each process involves being prepared, made, applied, dried, cooled, masked, stripped, welded, 3D printed or simply done by hand.
This implies time, financial resources, infrastructure, specialized skills and appropriate workspaces. But it also means premeditation, rehearsal and preparation, coordination between people (sub-teams) and links... And a lot of resilience (because many things don’t turn out the third attempt).
We usually see a car as a whole and integral object, but...
1. **DRS**
   - Operates the Drag Reduction System (DRS) which opens the slot gap in the rear wing, dropping drag and increasing top speed.

2. **Skip 1/10 Preset**
   - Used to manage the critical control sensors on the car and Power Unit. The driver uses this to increment in steps of 1 and 10, through the 100 control sensors.

3. **Gearbox Neutral**
   - To prevent unwanted on-track selection of Neutral, Neutral is only selectable via a push button on the front of the wheel, rather than the gear shift paddles on the rear of the wheel.

4. **Pit Lane Speed**
   - Holds the pit lane speed limit. Even if the driver goes full throttle, the car won’t accelerate beyond the speed limit.

5. **Pit Confirm**
   - Sends an automated alert to the garage to get the crew ready regardless of whether it’s been indicated on the radio that the driver is coming in.

6. **Engine Braking**
   - Adjusts how much the engine slows down the car when the driver is not on the throttle and not on the brakes.

7. **Differential**
   - Used for differential adjustment (to change the amount of torque transfer between the rear wheels) at different phases of the corner – entry, mid and exit.

8. **Brake Balance**
   - Changes the brake balance of the car to either the front or the rear. While the buttons are used for fine tuning, the rotary switch will change the baseline map.

9. **Mark**
   - Used to identify a point of interest in the data as indicated by the driver.

10. **Accept**
    - Used to accept the default modes selected by the Skip 10 and 1 buttons.

11. **Strat Mode Rotary**
    - Used for a number of power mode settings during the race.

12. **Menu Rotary**
    - A menu switch for the chassis side which allows the driver to change various parameters on the car in one place – from the volume of the radio to the brightness of the display.

13. **HPP Rotary**
    - There are a large number of Power Unit settings to control things like energy management during the race or MGUK settings, many of which will be communicated to the driver by the engineers.

14. **Radio**
    - Enables the driver to communicate with engineers in the pits.

15. **Race Start**
    - Sets the car up for the race start so it deploys maximum power.

16. **Shift Paddles**
    - The left paddle is used for downshifts, the right one for upshifts.
Bonustrack!
Final Recommendations
Read a lot and learn from someone else’s experience (SunSwift document, Nick Elderfield’s page, etc.)

Dive into the net issue by issue
It’s not a waste of time...
It’s an investment

Rehearse the fabrication sequence and procedures (define deadlines + partial budgets per stage)
>Associate every task and duty to a person responsible (and then listen, respect and trust his/her proposal)

>Always have your stuff to make “rough notes” at hand. (they don’t need to be pretty nor clear... Just fresh!). Download an idea from your brain while it’s still there.

>Sketch everything and make the exercise to measure everything (in terms of size, time, weight, cost, etc.)
Osvaldo Zorzano, Feb.20th.2021

Fine Finishes
2nd Conference > Devil is in the details
Trimming/Connections/Transitions

Interfaces & inner interactions

Promotion & Advertising

Interaction with the outside

Graphics & branding & markings
Trimming
Connections
Transitions
A vehicle is conceived as an “everything”. A one piece object. However, it is made up of a series of parts and crafts that must be integrated. Some will be welded, others glued or riveted, or will have screw fixings. Closer to the end comes the primer, paint and varnish, stickers, etc.
Foreseeing these assemblies and choosing the appropriate ones in advance is not enough. It is also necessary to determine the assembly sequence and measure the time that each process could take. This should involve the coordinated work of a materials manager and CMF (Color+Materials+Finishing) and a general production coordinator (who should not be the team captain).
Despite the fact that an electrosolar car is simpler than one of series production, the sub-assemblies of components that must be integrated require the attention of a product in itself each, while at the same time they must be compatible with the rest.
Something as simple as defining the “gesture” with which the upper part of the fairing opens involves a series of technical challenges that range from defining the materials and connectors to the assembly techniques and when to do it.
Digitally handcrafted components can be of great help when what is needed is not available in the market. A glance into areas other than automotive might be very helpful and necessary.
Söki is a street legal threewheeler tadpole electric vehicle developed by 2015 in Chile. Its assembly line was a “taylor made” production chain that involved a series of steps and suppliers, combining self-made components and market parts and crafts. The assembly sequence will be summarized on the next slide.
Sôki on demand production “Pipeline” (summarized)

- **Chassis construction**: It involves outsourcing a welding workshop or mechanic workshop.
- **Assembly of axis and wheel terminals**: Components that can be found on the market or can be ordered from a mechanical workshop.
- **Installation of motor and batteries**: Buyable or developable, depending on the type of assignment.
- **Drivers installation**: In this case MTTP, ondrivers, BMS (electronic differential is not needed).
- **Cooling system assembly**: Homemade can be an option, but purchase and adapt it is highly recommended.
- **Windshield assembly**: Custom made by an automotive specialty glassware supplier (installed by supplier).
- **Body panel and/or fairing assembly**: Composite materials supplier and installer.
- **Connection of electrical systems (wiring)**: Definitely homemade (rehearsal is highly recommended).
- **Assembly of seats & panels**: Custom made by... Upholsterer? Carpenter? Craftsman? Polymer supplier?
- **Door assembly and installation (wiring included)**: Unavoidable headache (delegating or outsourcing is not recommended).
- **Optics installation**: Find certified products on the market and fine-tune their integration (hopefully from the beginning).
- **Installation of accessories (wipers, mirrors, antennas, etc.)**: Definitely buy/order.
- **Static and dynamic tests**: Define and standardize on a prototype for repeatability.
- **Finished Vehicle**
Interaction with the outside
Interaction with the outside

Usually we dedicate a lot of attention to the development of each internal component of the vehicle and sometimes we disregard details that can become a headache, such as ... Where to locate the charging plug? How should the battery or hardware access doors open? How is the vehicle handled when it must be pushed, lifted, moved? How many people does it take to lift it?
Interaction with the outside

An important part of this issue is to define these interactions or functions that we will call “peripherals”, which most teams solve very well. But one thing they generally “fall short of” is informing them, making them obvious and clear to “anyone” (literally). And this could be solved with information panels; stickers notes that go inside and outside the vehicle with signs, directions, instructions, etc.
Such an accessory decision as where to locate the electrical charging plug deserves a discussion that considers issues such as accessibility, functionality and above all safety.
Many elements and components of the vehicle need to be repeatedly plugged in for monitoring, configuring or assembly/disassembly. Some are mechanical, others electronic. Many of them require specific tools, interaction sequences or care. And generally there are few team members who handle this information, generating fluidity problems at work. Much of this could be avoided if this information was available on information panels (stickers) in the vehicle itself.
Interfaces & inner interactions
Interfaces & inner interactions

We understand by *interface* any device that allows us to interact with the vehicle and its systems. We will immediately think of touchscreens. But there’s more than that; buttons, knobs, levers and especially the steering wheel are elements of interaction. In fact, touchscreens are of little benefit when we think of a gloved pilot or when we consider tactile memory.
It is important to prioritize and define the areas of proximity of interaction of the cabin according to criteria such as urgency and frequency of use. But it is also important to define how many interactions can be generated at the same time or in the same area. It is very useful to make a list of functions and interaction devices and rank them, and then place them in the cabin.
Making a list of components to locate in the cockpit, in contrast to a zoning like the one shown in this diagram, helps to decide which component will go where in very short time.
This implies considering not only ergonomic factors, but even (and above all) hapticity.
And even go a step further in decisions about how many functions are necessary and can be performed efficiently when interacting with the vehicle.

“Over-availability” of functions is also a very frequent mistake.

Screen Mode#3: Car Status Data
Brief summary of real-time vehicle conditions

Screen Mode#1: Car Performance
Driving real-time info (speed, consumption, etc)

Screen Mode#2: Navigation
Driving assistance (maps, incidents, hotspots)
Trimming/Connections/Transitions
Interaction with the outside
Promotion & Advertising
Interfaces & inner interactions
Graphics + branding + markings
graphics+branding+markings
From the beginning we know that the car is going to be full of graphics on its body, but for some strange reason, this is usually left as one of the last things... Wrong!

So far we have talked about information and interaction related to the vehicle, the team and even people outside both. All this information must be hierarchical and organized a priori because that even helps to obtain sponsorships.
graphics +branding +markings

We can identify the graph applied to the vehicle in 3 main categories:

• *Information and safety signs*  
  (Warning signs, signs of use, road safety signs)

• *Regulatory graphics*  
  (logos of the event, sponsoring institutions, identity and number of the team, radio channel)

• *Sponsors and supporters*  
  (Our patrons; institutions that have directly or indirectly supported us financially)
Double layered surface area:
- Excellent visibility in the wheel rim (privilege for B logo)
- Lousy visibility in the fairing surface

Reduced Visibility area for the event logos (that all the cars have).
the wheel will obstruct visibility in all photos when taken diagonally

Best visibility surface (away from the wheel and less fairing distortion).
The size of every logo depends on the “support” given to the team.

Complicated and lousy triangular wedge...
Just suitable for a number
Trimming/Connections/Transitions

Interfaces & inner interactions

Interaction with the outside

Graphics + branding + markings

Promotion & Advertising
Promotion & Advertising
Promotion & Advertising

Not only applying the brands of those who support us in the vehicle is a showcase for our strategic partners. There are many instances in which we can “make shine” those who have made our project possible. And above all, we can share our milestone dates with these institutions so that they can also share them on their own social networks.

Here some suggestions:
• *Publish each partial achievement in vehicle manufacturing process mentioning our strategic partners involved in this achievement* (for example mentioning the brand of our solar cells and adhesives or electronics the day we publish that we finished the encapsulation).
• Organize “sub-events” related to the development of the vehicle and invite them to be part and allow them to share this instance on their own social networks
(For example a test drive or test in wind tunnel)
• Mention them sacredly in each appearance in interviews, reports or conversations with the media (radio, magazines, blogs, etc.) and warn those media about the importance of that mention not being “edited”.
Promotion & Advertising

All these instances must be mentioned in the “compensation package” offered when “recruiting” a new sponsor. This is part of the mutual benefit and symbiotic relationship that we offer to a strategic partner. Always think of it as a “quid pro quo”.

...
The Start Line is the Finish Line
The Finish Line is the Start Line
Thank you very much!
Questions?