

SOLAR CAR CONFERENCE 2023



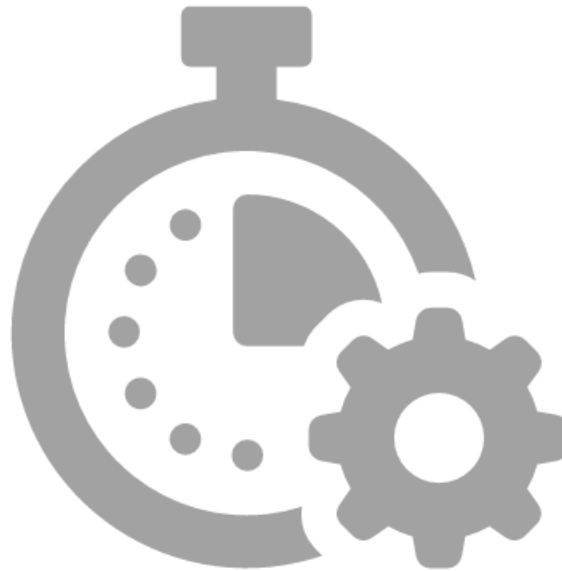
STRATEGY & OPTIMIZATION

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OBJECTIVE



Review key factors and insights for establishing a team competitiveness strategy across all areas to maximize gained benefits at each phase in your vehicle's design, construction, test, and race plans.



JOURNEY

Experience

Perspective

Knowledge

Solar Miner II 1999

With the aid of new software packages and past experience, Solar Miner II was a huge improvement from its predecessor. The integration of these new technologies and new ideas resulted in a 1st place finish in the 1999 Solarcar with an average speed of 25.3 mph. The race was challenging and very busy. The team also won the "Best Prepared Team" award for entry in the 2000 World Solar Challenge where they placed 3rd in their class and 22nd overall at WSC.



Solar Miner 1997

The solar miner that started it all. This car was the first made with the body manufacturing style that we still use today. In comparing this body to that of Solar Miner II's you can see how we have streamlined the design that has lead us to two championships. Solar Miner finished 31st out of 36 with an average speed of 20.6 mph.



E-Cubed 1995

E-Cubed was the second car produced by the team. With a team of nearly 50 students and greater resources, the vehicle was fabricated using carbon fiber composites and other new materials. The team also concentrated on aerodynamic improvements and a more efficient array configuration. The team finished 50th out of 36 with an average speed of 15.5 mph. E-Cubed stands for Education, Energy, and Environment.



WHAT IS STRATEGY

- Realistic look at current situation
- Decision driven
- Data supported and process controlled
- Optimization, Modeling, Process, Plan, Design, Operation, Maintenance...
- Time is a major Factor
- Team is the biggest factor

SECRET TO STRATEGY

- Recipe specific to your team
- Perfected by iterations of testing and refinement
- Validate in the real world
- Culmination experience, skills, and wisdom
- Unique to each car, group, and rayce.

WHERE ARE YOU AT

1) Starting out

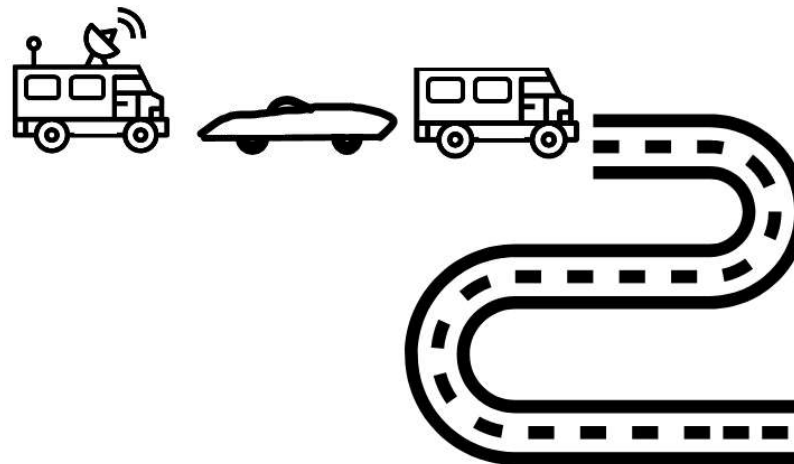
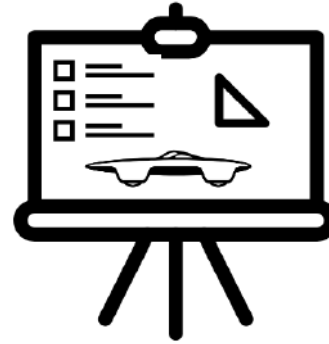
- History, Research, Asking Questions
- Initial Design Considerations
- Cost and Time analysis
- Production and quality

2) Existing cars building new

- Strength and weakness
- Reuse vs Redesign
- Baseline characterization
- Maintaining rolling test bed
- Team development

3) Finished car preparing to race

- Route planning and road testing
- Data collection and analysis
- Caravan coordination
- Race and breakdown simulations



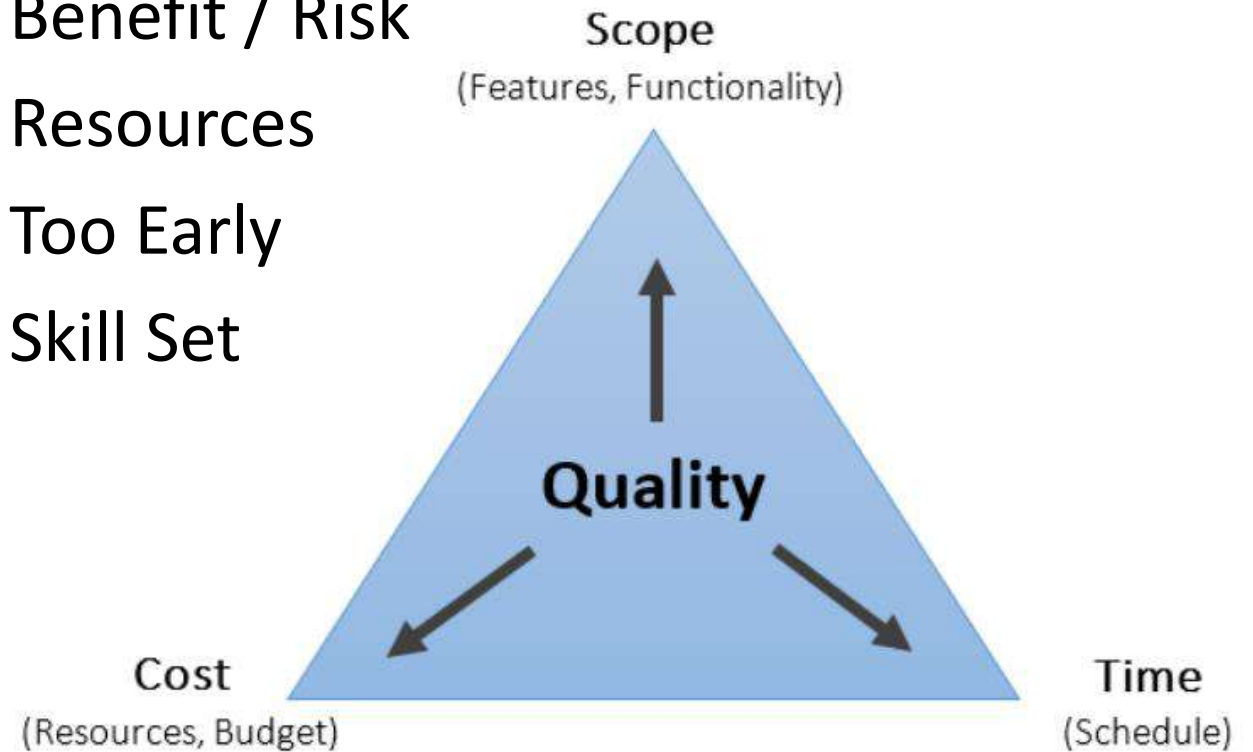
OPTIMIZE

Why

- Win
- Perform better
- Engineer Solutions
- Play with numbers

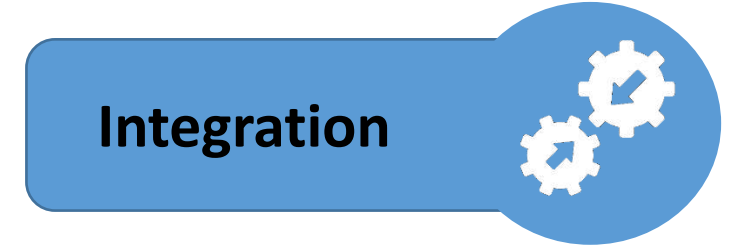
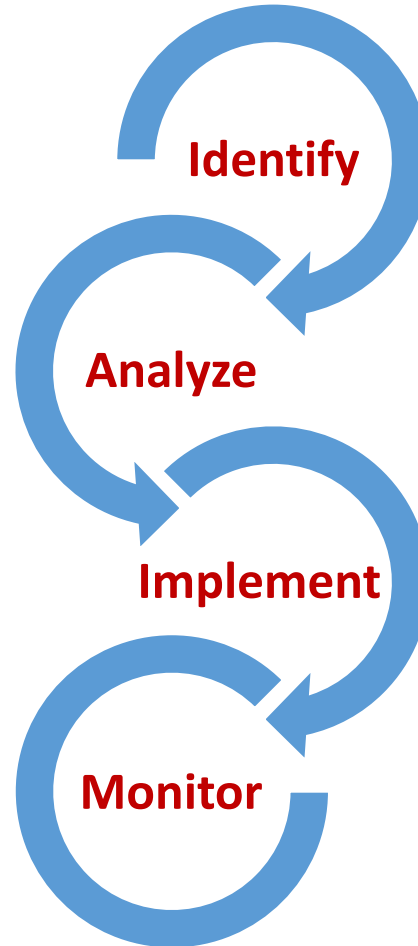
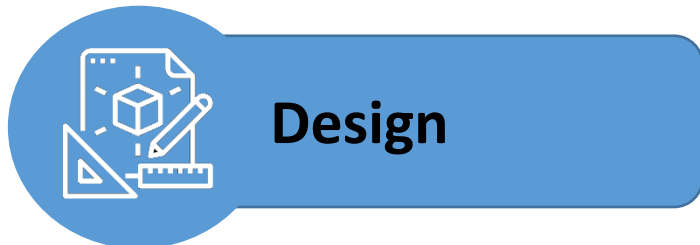
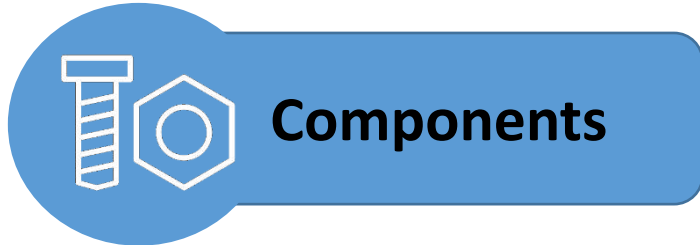
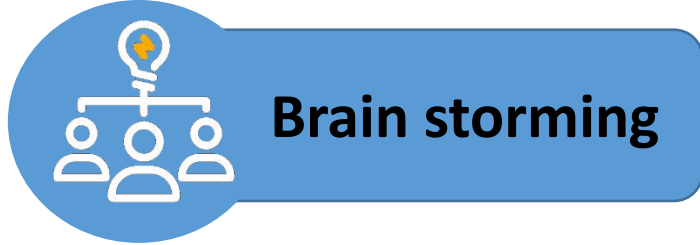
Why Not

- Not finishing
- Benefit / Risk
- Resources
- Too Early
- Skill Set



AREAS

Applied optimization is not confined to your design



TOP ISSUES

- Not finishing car on time
 - Started late, low resources, spent longer than expected on X, failures

Not having road tested

Not having backup or redundancy

Missing experts, documentation, or information available

Not taking care of team (sleep, food, roles, organization, schedule)

BRING FOCUS



OPTIMIZING THE TEAM

The success of a team is the culmination of all the small decisions into a larger solution

Creating a positive team culture around good decision making and collaboration

Use group time wisely with respect to the students, faculty, advisors.



Debate

Golf ball dimpled leading edge



Proper suspension alignment

Team leaders must direct the flow of work and discussion to maximize production gains.



TEAM COMMUNICATION

Establish your teams communication protocols and standards

- Create a Repository

Google Drive, Git Hub, One Drive, Dropbox

- Take Notes

OneNote*, SLACK, Wiki

- Timeline

Outlook or Google Calendar, MS Project, Excel

- Dry Erase To Do List in work area

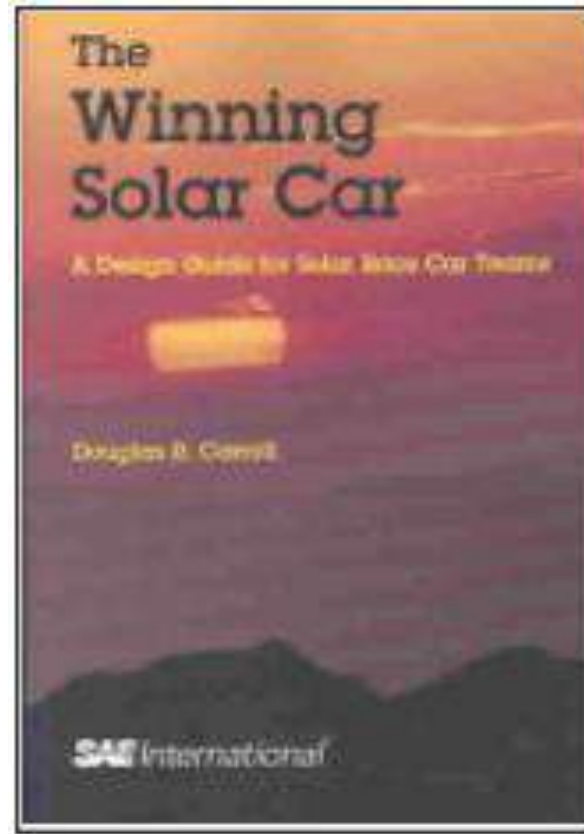
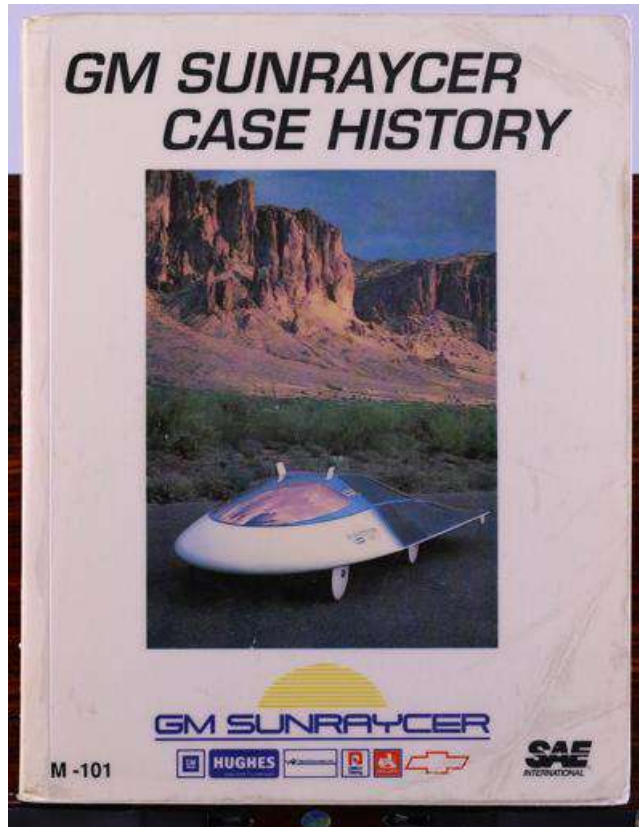
Priorities, warning, messages

- Physical Copies

Print (2) Vehicle Specs, Operations, BOM, Checklist, Instructions



GET YOUR TEAM A LIBRARY



FREE Technical Journals

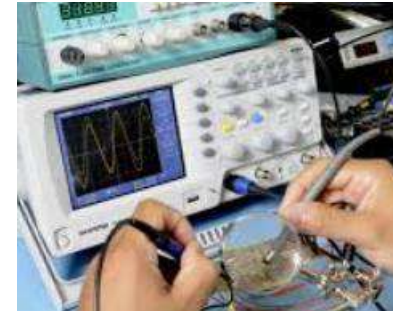
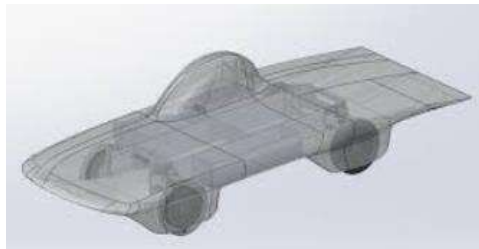
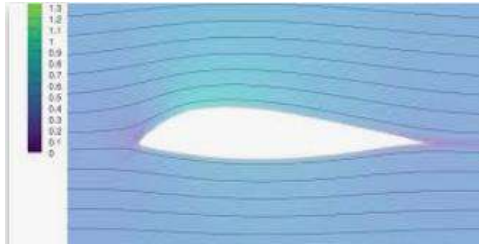
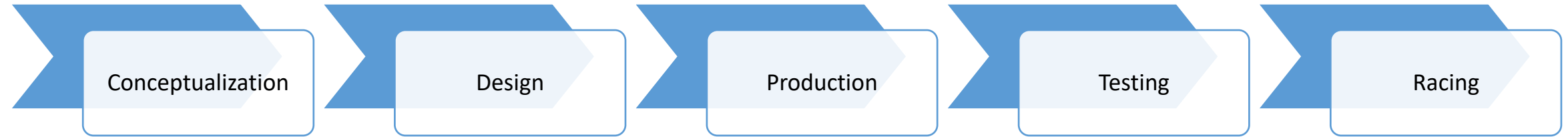
- ECN
- Electronic Products
- Tech Briefs
- Machine Design

Electronic Libraries

- IEEE Org
- SAE

REGULATIONS

When to Read



TIME

- Set Deadlines

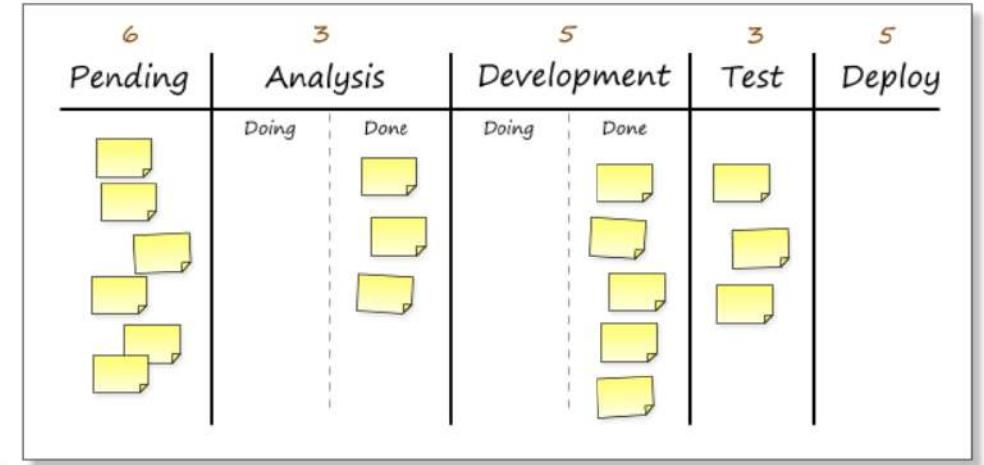
- Unveilings
- Press Conferences
- Road trips
- Car showings

- Gantt charts

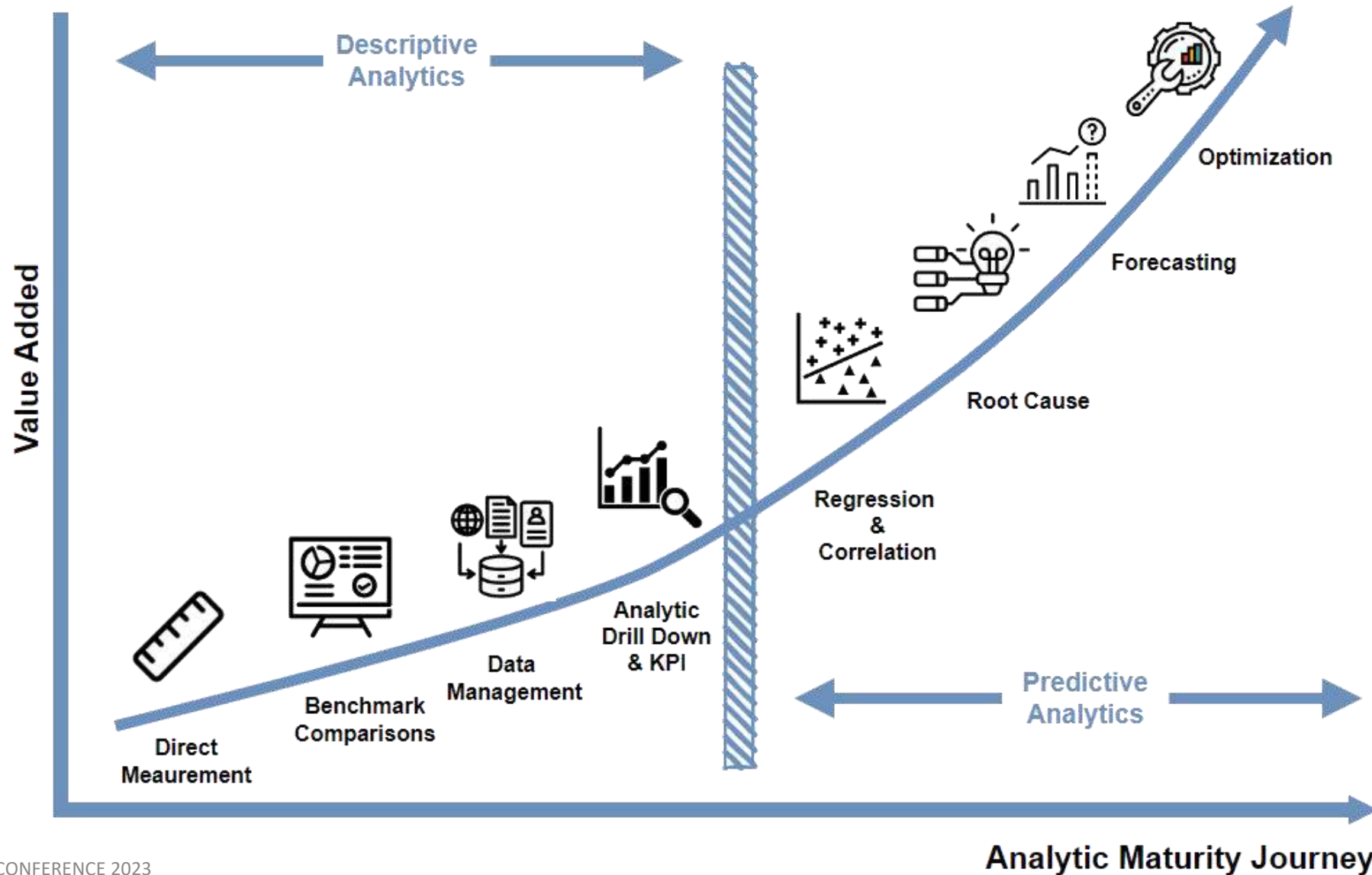
- Visualize what needs to be done

DRY

- Build on past experiences
- Recycle Components
- Optimize designs from good to great



DATA



SHOW IT

- Designs must be presented(documented) with supporting calculation



TYPE OF collision of ybrid solar car	MAX. displacement (mm) about the test axis	YIELD - YIELD Elastic strain	YIELD - YIELD stress (MPa)
Front collision	4.431 mm	0.958E-03	47.3
Side collision	4.630 mm	0.404E-03	62.16

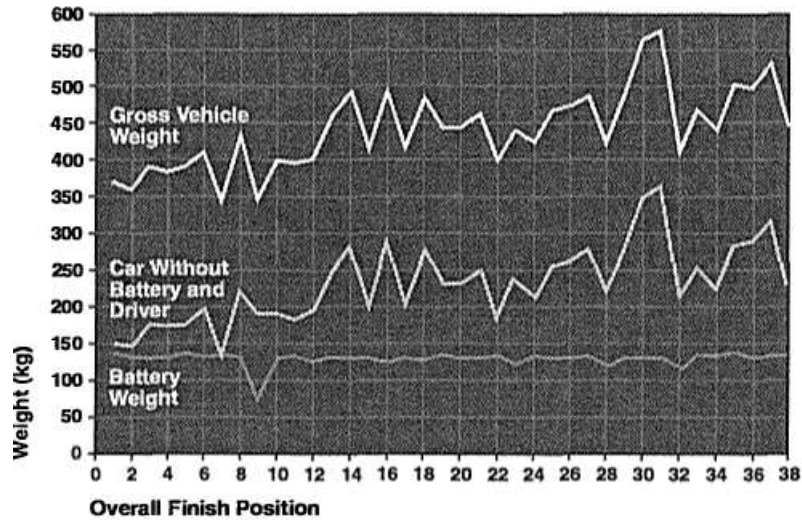
And graphical shows a comparison between conventional cars over hybrid solar car. It is comparison of basic as shown in below

fuel consumption based
emission level based

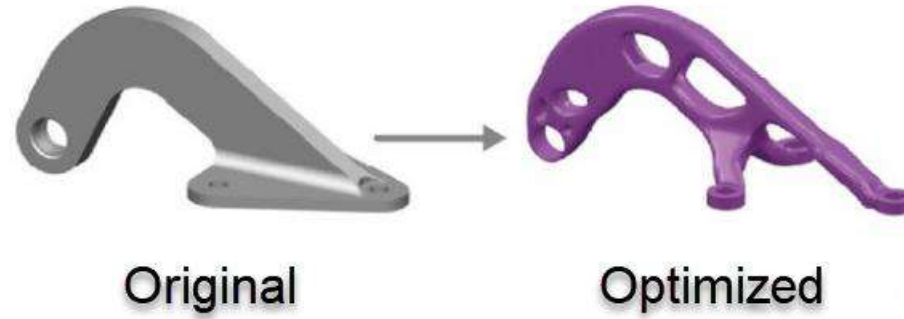
Both figure 9 and figure 10 shows the HSC are the best solution which solve the major problem of fuel consumption and pollution level in urban city. This type of car minimize all problem of conventional.



LIGHTEN UP



Sunrayce 95 Technical Report King Stafford Tamai



$$\left\{ WC_{rr1} + NC_{rr2}v + \frac{1}{2}\rho C_d A v^2 \right\} x + Wh + \frac{N_a W v^2}{2g}$$

Solar Vehicle Performance, Dr. Eric Slimko, December 1, 1991

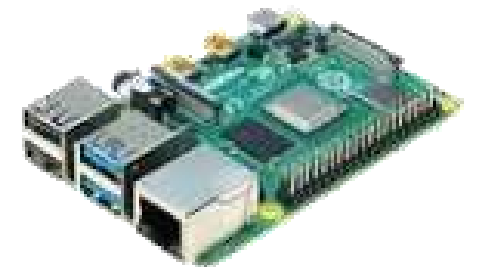
PICK, DON'T PROCRASTINATE

- Work out Bill of Material(BOM)

- Stock only allowed fasteners
- Budget for waste and rework
- Organize on-hand inventory



- Acquire main constraining components early



STANDARDIZE

- Only metric tools and parts
 - Common software language
 - Communication protocols
 - Connector keying
 - Attachment hardware
 - Wire Color
-
- Assembly Requirement
 - Torque
 - Clearance
 - Alignment
 - Tooling



HAND ON

- Build prototypes or mockups out of cheap and easily crafted materials
 - Cad is great but a real analog is so much more informative to integration and manufacturing
 - Works to improve experience and craftsmanship towards fit and finish
 - 3D Component placement and wire routing often uncovers constraints



GET ROLLING

Use old vehicles or build rolling test bed

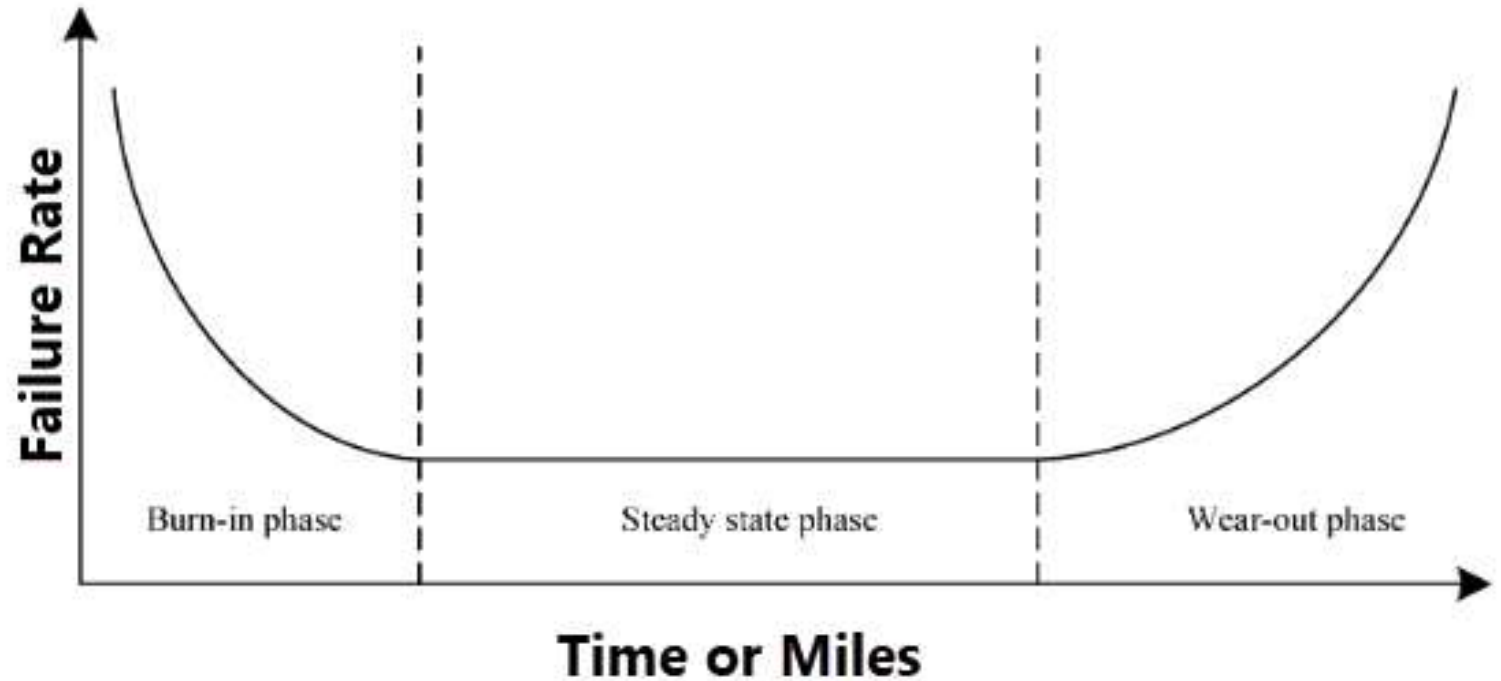
- Training runs
 - Sub system optimization
 - Data Collection
 - Performance validation
 - Validate new components
-
- Learning to plan and pack for trip
 - Logistical capabilities(navigation, repair, food, shelter)
 - Characterizing performance of vehicle under various conditions
 - Learn roles and responsibilities
 - Run mock scenario (tire change, bps shutdown, driver swap)
 - Effective communications
 - Operating safely as a caravan
 - Gaining confidence



GOAL - 1000 MILES

■ Shakeout

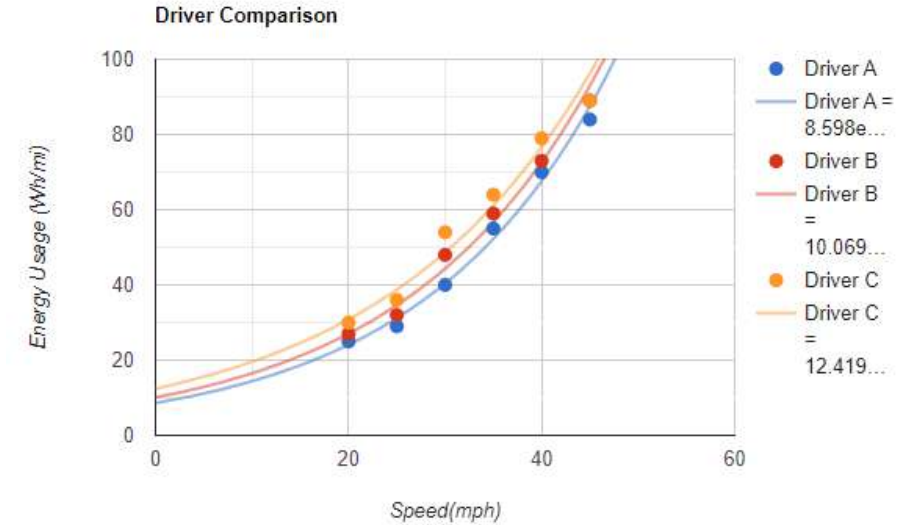
- Discover rubbing
- Control response
- Odd noises
- Smells
- Loose parts
- Assembly mistakes
- Vibration
- Alignment
- Operator Error
- Maintenance Requirements
(Important on old vehicles)



DRIVER TRAINING

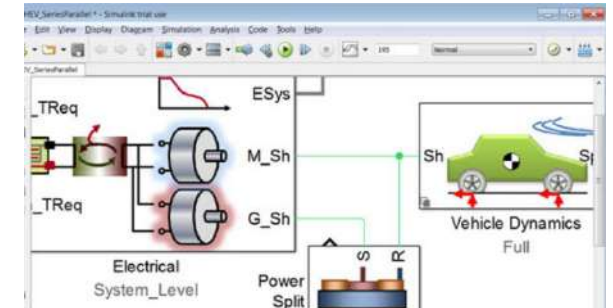
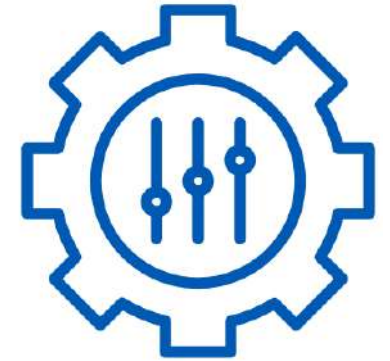
Driver experience is key

- Acceleration Control
 - In Traffic
 - Stability
 - Braking/Regen
- Steering Drift
 - Fighting wind
 - Road Crown
- Feel for vehicle
- Communications
- Style
- Track vs Open Road



DATA MODEL

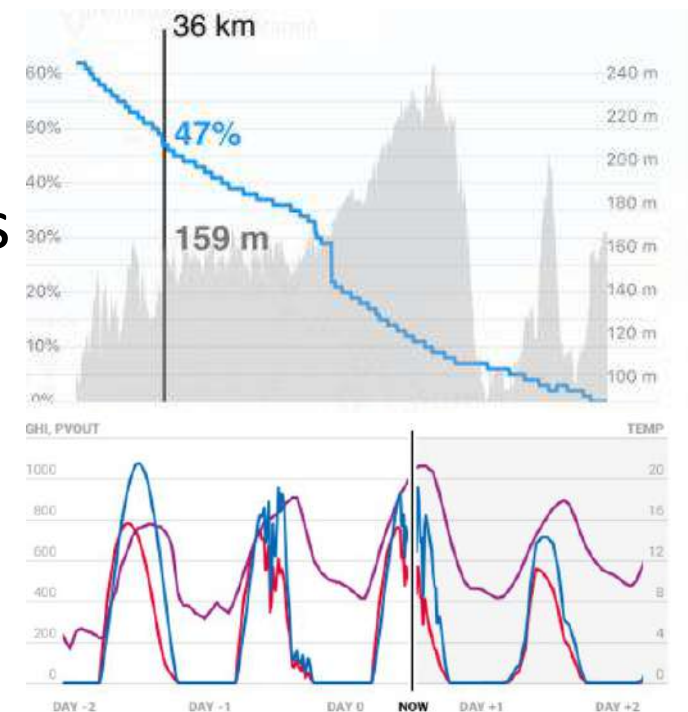
- Have a procedure for collecting, storing, analyzing, and comparing data
- Backup wireless telemetry with vehicle data logger
- Share raw data and analyze with team
- Isolate specific variables from constants
- Create Baseline performance for flat, graded, and terrains.
- Determine how driver inputs and visibility to values
 - Speed
 - Instantaneous Watts
 - Watt/Hr per mile



- Have an analysis toolset that is accessible(MathWorks, python, excel)

RACE STRATEGY

- Break route or track event into profiled segments
- Extract Terrain details by GPS in KMZ
- Get Local Weather Data(wind & solar irradiance)
- Apply Vehicle Power Model to Route Variables
- Determine stage SOC Target and impact to forecast
- Have ability to adjust model on fly with live updates
- Use a Constant Velocity, Watts per Mile
- Factor you driver's performance
- Have contingency plans



GO

Build a legacy...



Q&A
