STRATEGY & TOTAL VEHICLE OPTIMIZATION

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2/27/2021

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 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 4's you can see how we have streamlined the design that has lead us to two championships. Solar Miner finished Suncayce 17th out of 30 with an average speed of 28.6 mph.

Solar Miner II 1999

With the aid of new software packages and past experience, Solar Miner II was a large improvement from its predecessors. The integration of theses new technologies and new ideas resulted in a 1st place finish in the 1999 Suncayce with an average speed of 25.3 mph. The race was challenging and rarely sunny. The team also won the "Best Prepared Team" award plus free entry in the 2001 World Solar Challenge where they placed 3rd in their class and 22nd overall at WSC.

E-Cubed 1995

E-Cubed was the second car produced by the team. With a team of nearly 30 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 Suncayce 32th out of 36 with an average speed of 13.5 mph. E-Cubed stands for Education, Energy, and Environment.

WHAT IS STRATEGY

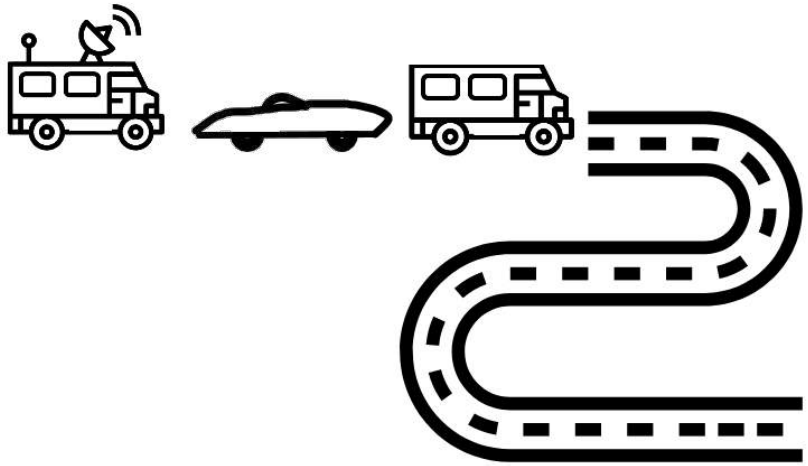
- Optimization, Modeling, Process, Plan, Design, Operation, Maintenance…
- Data Driven
- Decision and performance: Minimize the bad, maximize the good
- Time is a major Factor
- Team is the biggest factor

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



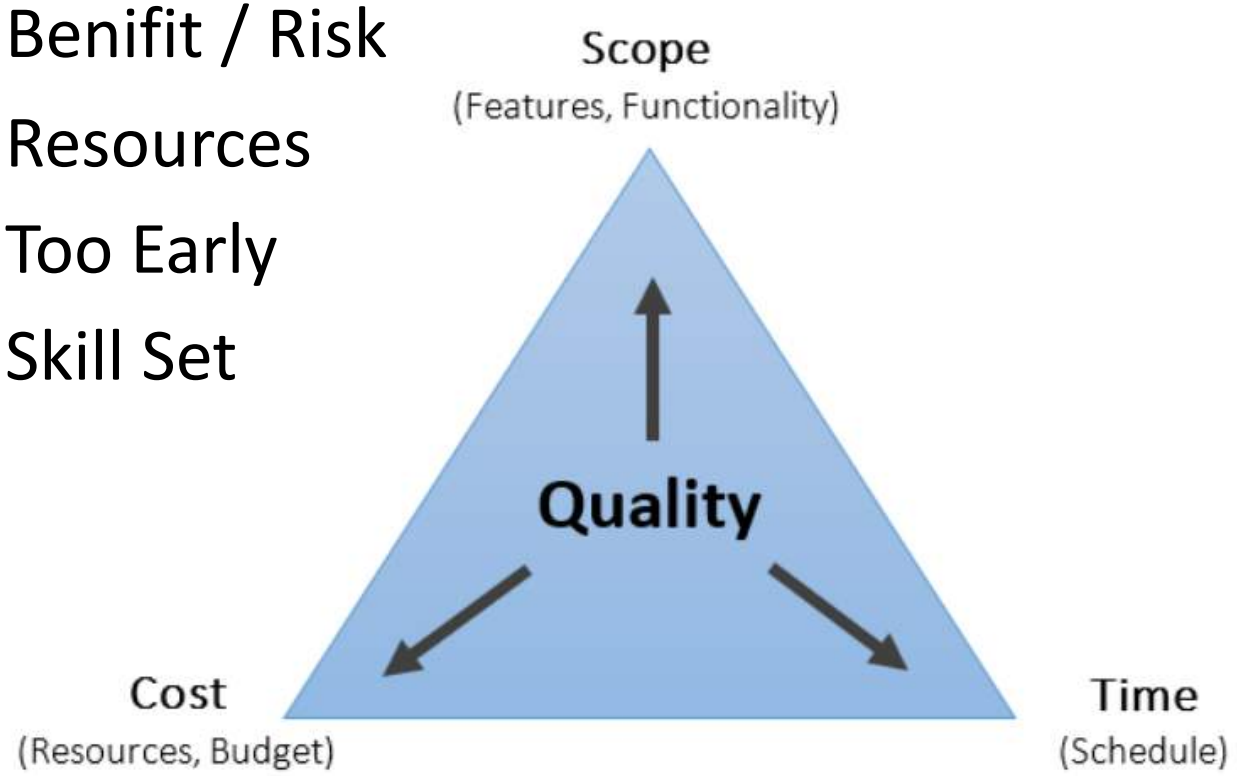
OPTIMIZE

Why

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

Why Not

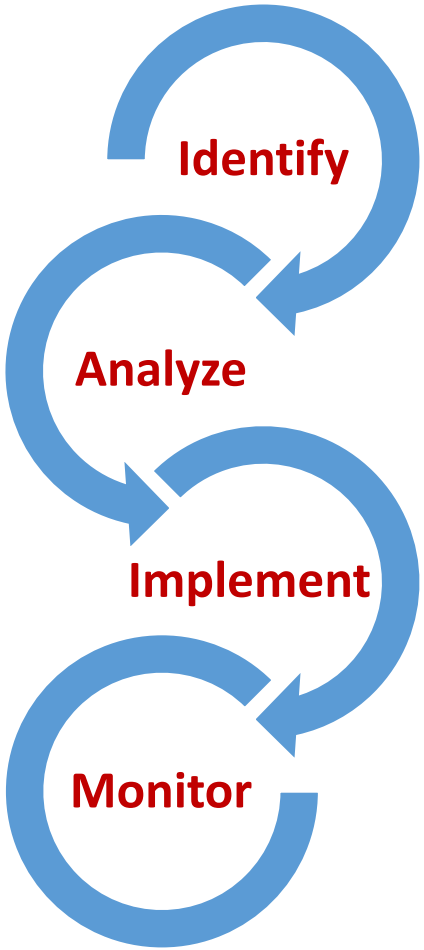
- Not finishing
- Benifit / Risk
- Resources
- Too Early
- Skill Set



AREAS

Applied optimization is not confined to your design

- Brain storming
- Components
- Design
- Manufacturing



- Integration
- Testing
- Maintenance
- Raycing

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 decision 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

VS

Proper suspension alignment

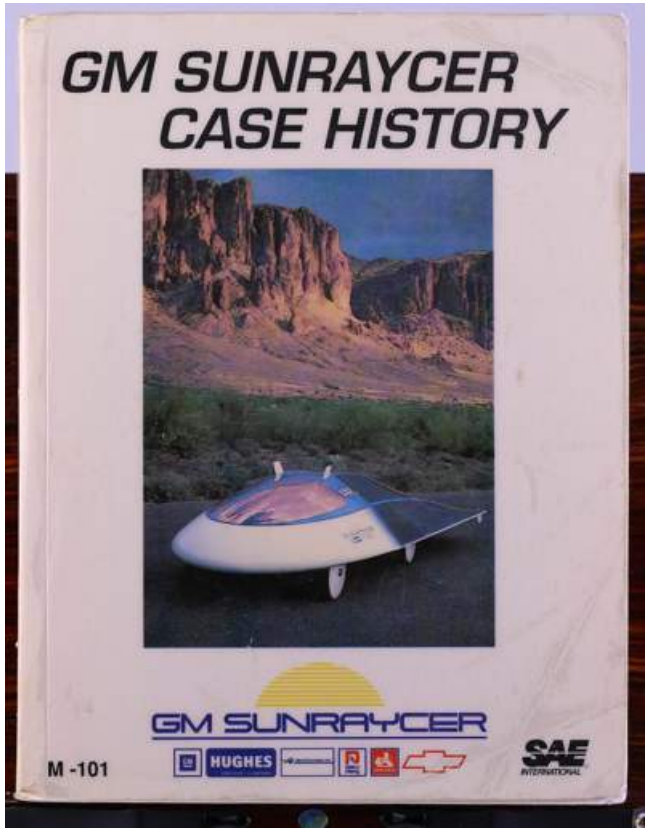
Team leaders must direct the flow of work and discussion to maximize production gains.

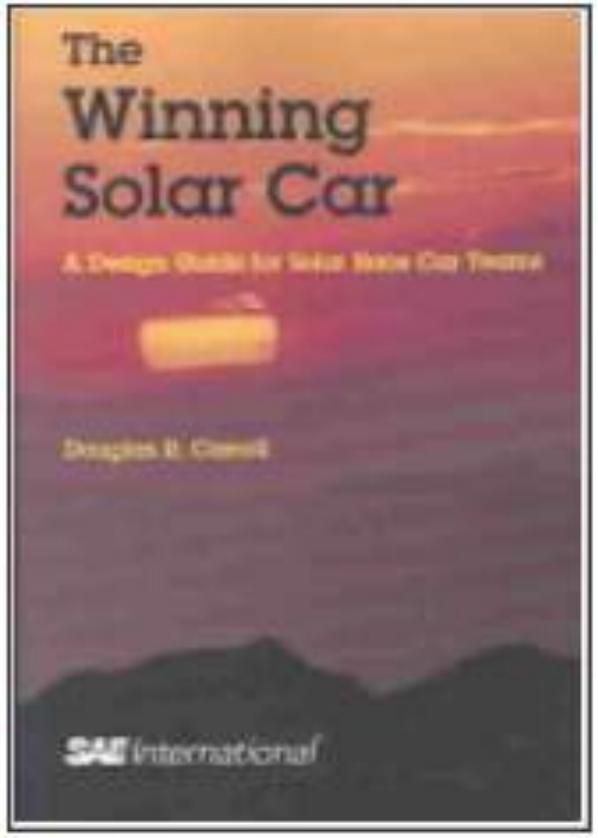
TEAM COMMUNICATION

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

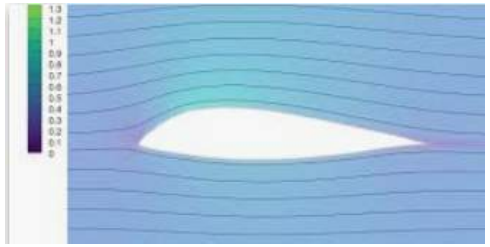
Electronic Libraries

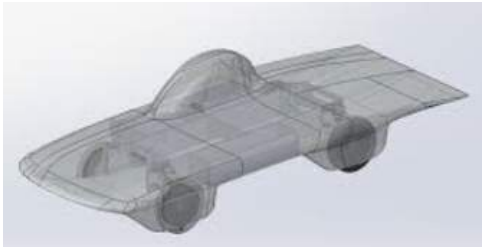
- IEEE Org
- SAE

REGULATIONS

When to Read

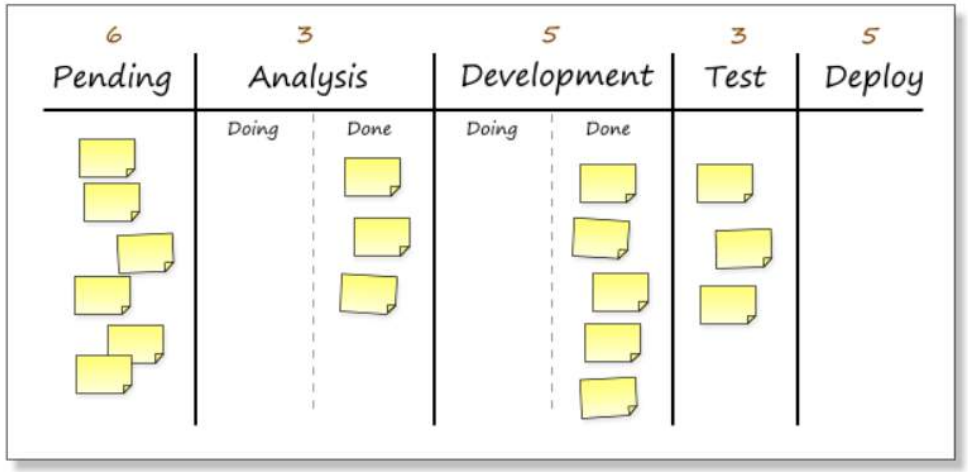
Conceptualization → Design → Production → Testing → Racing





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

SHOW IT

- Designs must be presented(documented) with supporting calculation

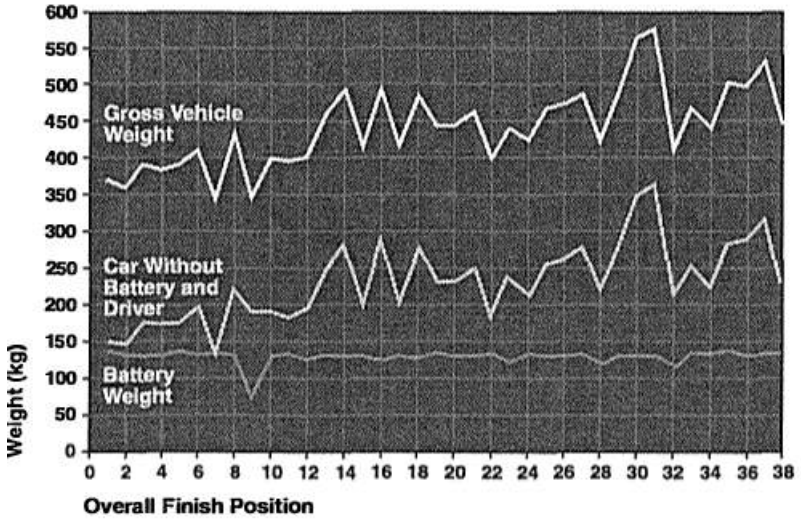
ollision of ybrid solar car	displacement (mm) about the test axis	Elastic strain	stress (MPa)
ont collision	4.431 mm	0.958E-03	47.3
ear collision	4.630 mm	0.404E-03	62.16

And graphical shows a comparison betw
ventional cars over hybrid solar car. It is comparisor
basic as shown in below

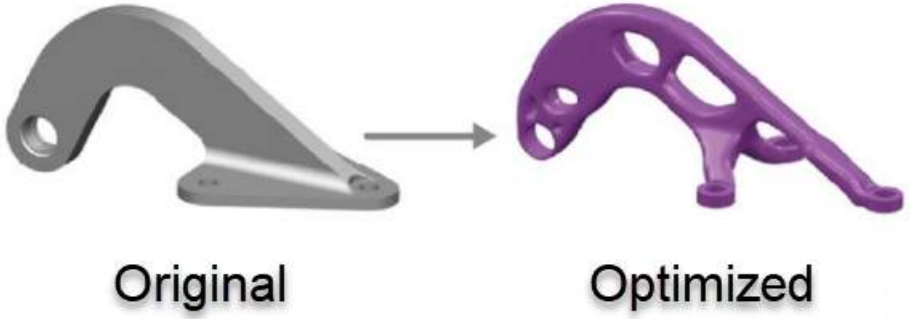
uel consumption based
mission level based

Both figure 9 and figure 10 shows the HSC are the b
ation which solve the major problem of
sumption and pollution level in urban city .This type
minimize all problem of conventional

LIGHTEN UP



Sunrayce 95 Techincal 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)

- Acquire main constraining components early

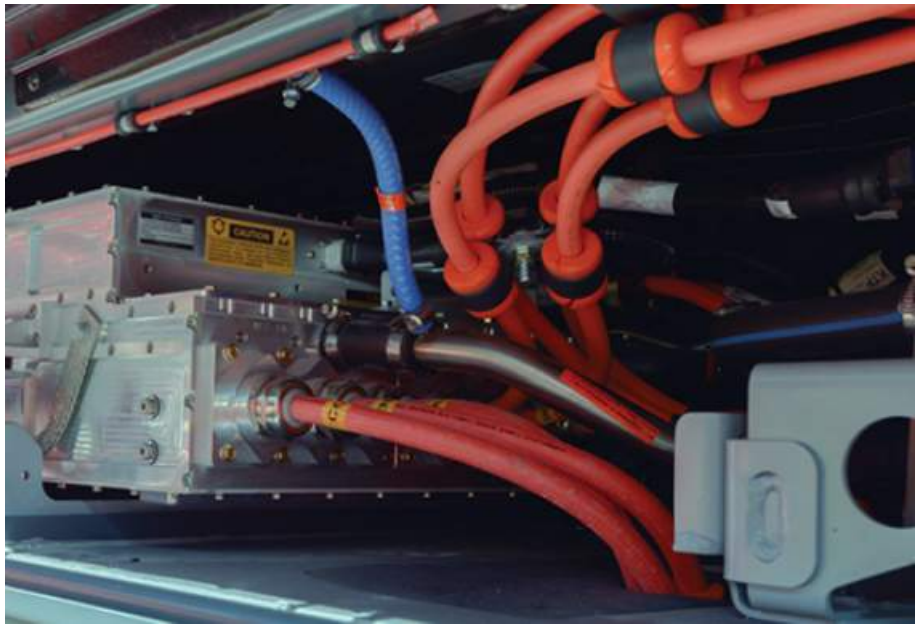
STANDARDIZE

- Only metric tools and parts
- Common software language
- Communication protocols
- Connector keying
- Attachment hardware
- Wire Color

- Assembly Requirement
  - Torque
  - Clearance
  - Alignment

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
- Shake out problems

- 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

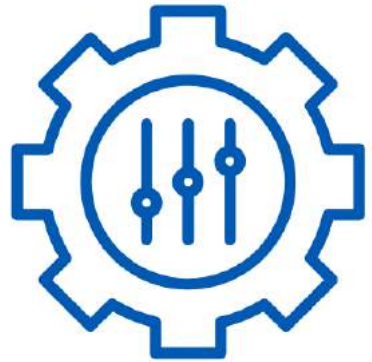
DRIVER TRAINING

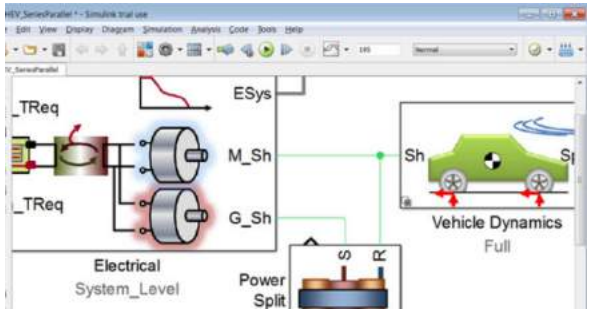
Driver experience is key

- 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)

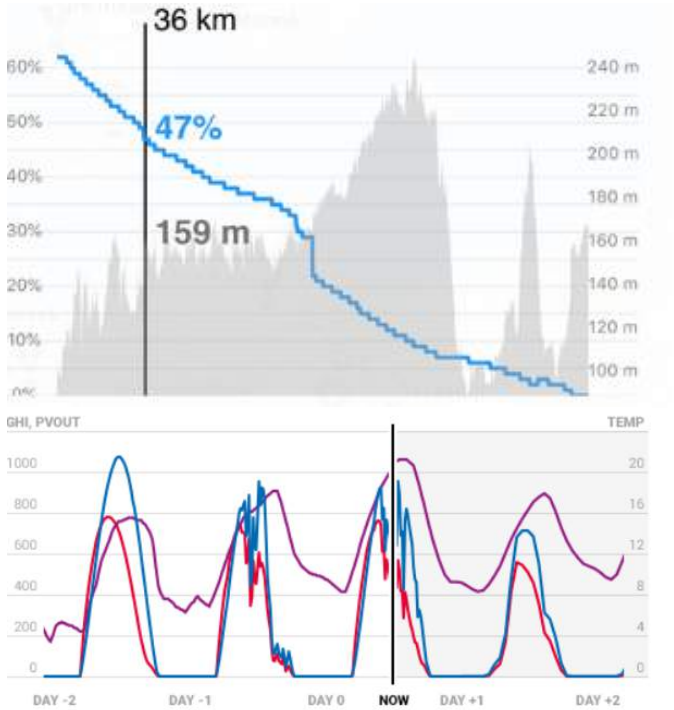




RACE STRATEGY

- 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

  Don’t fix everything with cruise control
- Have contingency plans



GO

Build a legacy…