STRATEGY & OPTIMIZATION
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
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 race.
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
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)
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
DATA
SHOW IT

- Designs must be presented (documented) with supporting calculation
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

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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