Idiot's Guide to Running a Formula SAE Team

A Faculty Advisor's Perspective*

and

Faculty Advisor Compiled After-Action Reports, Alumni Comments, etc.

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1. Preface

This document is a compilation of lessons, suggestions, and guidance gained from my experience as Faculty Advisor for the GTMotorsports team since 1991. In the fall of 1991, I was a newly minted Assistant Professor teaching ME 3110 (first M.E. design class under the quarter system). A student in that class, James Jeffer, struck up a conversation about this student design team he was on, "GT Motorsports." Completely unaware of what I was getting myself into, I accepted an invitation to visit their shop, which was located at that time in the basement of the Coon Building. Standing about in the dim light, next to something that was alleged to be a race car (what ultimately became Car 42), I spent a very enjoyable hour or so asking questions of James and the other students engaged in the chaos of activity all around me. Some weeks later, James dropped into my office and asked if I'd be willing to serve as the team's faculty advisor; it seems that as I had been the first faculty member to come through the shop in quite sometime, I'd been at risk of not being permitted to leave. That year, the team finished Car 42, lit the engine for the first time, and then put her on the trailer to drive to Detroit for the competition. I met them there, the first of many competitions I've attended with the team (I've missed only one, in 2006, when I was in Australia on a sabbatical).

My involvement with the team and its members is constantly evolving, constantly adjusting to the team's attitudes, temperament, and willingness to listen. My role is fundamentally that which my title implies; I am an Advisor. I help the team to understand the task before them, to help them become better leaders, engineers, and colleagues.

I am still in contact with students from every team I've ever advised. This team has been both my greatest joy and greatest heartache during my career at Tech. Joy in having some small role in assisting teams to achieve their potential (top finishes in Detroit, wins in UK and Australia); joy in watching those students celebrate their justly earned achievements. Heartache in watching helplessly as teams come up short as when watching the car roll to a stop before the checkered flag in the endurance event, and understanding all too well the consequences of such an event; heartache when teams have failed to mesh, and let distractions prevent them from achieving even the barest level of success, or even when such distractions have completely undermined the team.

Which bring me back to the purpose of this document. Your time on this team is limited; you have not the luxury to learn by experience those lessons that the team MUST adhere to in order to succeed in this most complex of endeavors, the magnitude of which you might scarcely imagine. My intent here is to give you a foot up the learning curve, to give you the advantage of my "corporate memory." The FSAE event has evolved to the point where any fault in preparation, any shortcut or lack of attention to detail, or any weakness in team dynamics, will stand in the way of you achieving that success and satisfaction that participation on this team so richly offers you.

This document is continually evolving. The most critical sections for your edification and consideration in the early months of any new competition year are Sections 2 through 6; I expect that you should be conversant with these sections in short order.

Section 2 – A listing of "Commandments." These commandments, if obeyed, put the team on a footing to be competitive; if ignored, put the team on a path to disappointment.

Section 3 – Matters of ethical conduct for when you disagree with the leadership

Section 4 – A list of "rules" for the time period prior to competition. These "rules," and some elaboration as to the background of many of them, provide a basic framework for how the team should conduct its operation over the course of the year

Section 5 – Another listing of rules, but these are targeted toward the competition itself.

Section 6 – A challenging section originally written as a standalone document following the 2003-2004 campaign; it's food for thought.

The remaining sections should be read, absorbed, discussed and integrated in your conduct, expectations, and planning once you've master the above.

Sections 7 through 12 are a collection of "After Action" reports from various competition years. They represent part of the "lessons learned" of the team, its corporate memory. Unfortunately, some lessons have been (un)learned repeatedly. If we don't learn from the past we're doomed to repeat it. Yes, a trite cliché, but one I've lived through with the team beyond counting these past many years.

Sections 13 and 1 are some thoughts on the team provided by one of its founders and from a respected alumnus.

Section 15 is a commentary written some years by one of the design event judges.

Section 16 is a commentary written some years ago by Carroll Smith, the CHIEF design event judge. Heed his words!

2. Dr. C.'s EIGHT COMMANDMENTS

A bit of history: the original set of 'commandments' (and this Idiot's Guide) were generated following the 2001 FSAE competition in Detroit. They were originally formulated in order to ensure that the team was thoroughly prepared for the FSUK competition in July of that year. The commandments were modified after the 2003 FSAE-A event. These commandments are key aspects of team preparation that, if obeyed, position the team for success; if ignored, they put the team on the path to disappointment.

The commandments' form a set of *minimum* conditions that must be met in order for the team to compete: if the team can not satisfy the commandments, then there is no point going to the competition.

I have ordered these 'commandments' to reflect priorities with respect to competition at FSAE and FSUK/FSAE-A.

An underlying assumption here is, if for some reason the team does not compete in Detroit, then it forgoes the overseas competitions, as well. The overseas events are second-rate competitions compared to Detroit: it gives no honor to the team to compete abroad unless the team is prepared to perform at the same level as is required to be successful in Detroit.

In the following, I first provide a listing of the commandments, and then expound upon the ramifications of each.

The Commandments

1. The team must present for review a completed visual design display, capturing the key analyses, tests, and aspects of the car that make her the best car ever. The design display must be ready at least one month in advance of the competition, in order to provide you time to revise it.

2. The team must perform the presentation before an audience of myself, Jeff Donnell, and such other professors as are willing to participate. The presentation must be what you intend to give in Detroit/UK, and must be given by the person who has been definitively identified as the presenter in Detroit/UK. The presentation must be performed at least one month in advance of the competition, in order to provide you time to revise it and present it again.

3. The team must demonstrate to my satisfaction that there are no fluid leaks, of any kind, of any magnitude, anywhere on the car. The team must demonstrate that all brackets, tabs, etc. are sound and sufficiently rugged to survive endurance event (body work, muffler brackets, etc.). Body work must not drag the ground under any normal driving condition. Nothing can appear to be loose beneath the car (e.g., no seat belt ends dragging).

4. The team must demonstrate to my satisfaction that the car is 100% competition ready.

5. The team must demonstrate that the car clearly meets the noise limits imposed by rule, and must demonstrate the capability to pass the brake test.

6. The team must demonstrate to my satisfaction that the car has fuel economy within the limits set by the rules.

7. The team must have 'Georgia Tech' prominently displayed on the bodywork, and must acquire and display US, Georgia, and Georgia Tech flags or banners.

8. **Specific to FSUK/FSAE-A, etc.** The team must provide me a complete accounting of its finances. All current assets and liabilities must be documented. Further, the team must demonstrate that going overseas will not leave next year's team in dire financial straits. I would like an affirmation from next year's team leaders that the trip will not harm the team's finances. The team must have the money in hand to complete the trip, including all the niggling little expenses we'll get hit with in attending any overseas event, and there must be enough left over to start next year's car. Vague assurances that "we will have

enough” won't cut it: you've got to have the funds in hand, and prove it to me. You all have to agree that it is fiscally responsible to go.

The Expanded Commandments
This section explains the WHY of the commandments, attempts to clarify their importance, and briefly discusses the root cause for each of them (“provenance”).

1. The team must present for review a completed visual design display, capturing the key analyses, tests, and aspects of the car that make her the best car ever. The design display must be ready one month in advance of the competition, in order to provide you time to revise it.

The design event at competition requires a select group of team members to present and defend the design basis of the car, the assumptions and analyses that went into EVERY system of any significance. The design judges want to see substantive evidence of rational engineering processes, not mere hand-waving and assurances of competence. They’re testing what you know about the car. You have to be able to draw the judges’ attention to key elements of each design, explain your reasoning, and prove that it worked. How? Design displays present the “canvas” upon which the team paints the picture of the car’s design.

The complexity of the car, and the timeline over which the design is conducted, are such that it’s not possible to pull together an effective design display at the last minute. Designs performed last fall are difficult to dredge up from memory in the heat of final preparation for competition.

The design display is not just posters; it’s prototype parts, laptops showing machining processes, FEA and CFD analysis and animations, floor stands for the car, support systems for the display materials, etc. Take a look at photos from prior competitions for insight on how we and other teams have handled design displays.

Provenance: This commandment followed from the team repeatedly not having the materials on hand necessary to convince the design judges of how design was developed; having the materials and not using them; putting together the materials at the absolute last second and finding them inadequate to the task; and using material from other cars, not even the current car, on their display materials.

2. The team must perform the presentation before an audience of myself, Jeff Donnell, and such other professors as are willing to participate. The presentation must be what you intend to give at competition, and must be given by the person who has been definitively identified as the presenter at competition. The presentation must be performed at least one month in advance of the competition, in order to provide you time to revise it and present it again.

The current FSAE rules call for the presentation of a business case: a proper business case must be developed and analyzed, and is not something that can be done as an after-thought in the week before competition. Standing up in front of an audience of professionals, with team honor on the line, is quite a bit different from the typical classroom presentation. It takes practice, polishing, and substance. The person who makes the presentation to the GT audience should be the same person expected to make the presentation at competition.

Provenance: This commandment followed from the team repeatedly putting together at the last minute, even as late as just a few hours before it was scheduled for delivery at competition. Also, teams would not even designate who would perform the presentation until the last minute.

3. The team must demonstrate to my satisfaction that there are no fluid leaks, of any kind, of any magnitude, anywhere on the car. The team must demonstrate that all brackets, tabs, etc. are sound and sufficiently rugged to survive endurance event (body work, muffler brackets, etc.). Body work must not drag the ground under any normal driving condition. Nothing can appear to be loose beneath the car (e.g., no seat belt ends dragging).

The car must be robust if it is to survive the dynamic events at competition. It must convey the impression that it is rugged. Leaks can lead to disqualification from ANY of the dynamic events,

including the all important endurance event. Even a few drops of oil can lead to disqualification, and a score of zero for the event. A lose bracket could lead a tech inspector to conclude the car is unsafe to return to the track, and our day is done, with no recourse or protest; the tech inspector's decision is final. Design judges watch the cars during the dynamic events, and if the body work is contacting the ground (through poor design, mounting, etc.), it conveys the impression of excessive suspension motion or roll, and we're judged down accordingly.

Provenance: This rule followed from instances where the body work scrapped the ground, and where KNOWN leaks were left unsolved with disastrous consequence.

4. The team must demonstrate to my satisfaction that the car is 100% competition ready.

The car can't begin to score points in the dynamic events until it clears tech inspection. If the car doesn't pass tech, the team has to invest time and effort to bring it up to spec. But, there are other events going on that prevent the car from being worked on exclusively to pass tech (cost, design judging). If the car doesn't pass tech, we get into a situation where the clock is against us, and we risk losing points by not being able to compete. The ideal situation is one where the car passes tech on the first attempt. In order for this to happen, the car must KNOW that car is tech ready, and that the rules have been fully complied with. There's a copy of the tech inspection form in the FSAE rules; as competition time approaches, this form should be repeatedly used to check the car for compliance; any deficiencies should be rectified immediately. Fundamentally, nothing should go on the car unless it's rules-compliant.

5. The team must demonstrate that the car clearly meets the noise limits imposed by rule, and must demonstrate the capability to pass the brake test.

The last part of the tech inspection is the brake and noise test. It's not a surprise. The FSAE rules state exactly the noise limit the car must comply with. If we can't pass the noise test, we can't drive in the dynamic events. Yes, designing a quiet exhaust system may be unglamorous, but it's a more critical system than any gee-whiz gadget deemed more exciting. Without passing noise, we don't drive. If we don't drive, we don't score points. Without passing brakes, we don't drive. If we don't drive, we don't score points. And, the brake and noise test line can get awfully long, and we're wasting time waiting in it for retests. It is the height of wishful thinking to believe that an untested muffler will work, only to find out at competition that it doesn't. It is the height of wishful thinking to believe that an tested brake system will work, only to find out at competition that it doesn't.

Provenance: The team has repeatedly failed the noise test, the brake test, and sometimes both at the same event, with consequent stress, loss of time, and great embarrassment. Without passing the brake and noise test, we can't run. We've lost points because of this.

6. The team must demonstrate to my satisfaction that the car has fuel economy within the limits set by the rules.

Full economy is a point-scoring event; when we neglect to pay attention to fuel economy, we put those points at risk.

Provenance: This commandment follows from, shall we say, "testosterone driven" drivetrain folks having an excessive focus on power, and haven't paid enough attention to fuel economy. Prior versions of the rules stated that if the endurance event fuel economy limit is exceeded, then a four minute penalty is added to our endurance time, and, a score of zero is earned for the event. Such penalties would pretty much guarantee that the team would finish somewhere out of the top 30, no matter how well we've performed in other events. We've been hit repeatedly with the fuel economy penalty.

7. The team must have 'Georgia Tech' and "GW Woodruff School" prominently displayed on the bodywork, and must acquire and display US, Georgia, and Georgia Tech flags or banners.

You represent Georgia Tech, the Woodruff School, and the State of Georgia. They're your biggest sponsors. Keep them happy.

8. **Specific to FSUK/FSAE-A or any other overseas competition** The team must provide me a complete accounting of its finances. All current assets and liabilities must be documented. Further, the team must demonstrate that going overseas will not leave next year's team in dire financial straits. I would like an affirmation from next year's team leaders that the trip will not harm the team's finances. The team must have the money in hand to complete the trip, including all the niggling little expenses we'll get hit with in attending an overseas event, and there must be enough left over to start next year's car. Vague assurances that "we will have enough" won't cut it: you've got to have the funds in hand, and prove it to me. You all have to agree that it is fiscally responsible to go.

Teams must always understand that there's a team that comes after them. When you consume the resources of the team without regard for the future, you impair the future of the team, and your own legacy.

Provenance: This one follows from teams ending up the year deep in the red, and hurting the following team. This would be made all the more so if going overseas.

3. Ethical conduct when you disagree with GTMS team leadership, or, the “one shot” rule

It happens more often than you might imagine; as a team leader or member you find that you don’t agree with, don’t like, or don’t appreciate some decision, policy, or practice of the team. As members and leaders of the Georgia Tech Motorsports team, it is important for you to understand your ethical responsibility in such situations, as your conduct at such times can impact your standing within the team and even cause you to loose your membership. In the following, I'll use the term "decision" to refer to any matter that applies to the team at large, whether a decision by the leadership, policies and procedures required of the team and its members, and the actions of the leadership.

In a professional, hierarchical organization, and GTMS most certainly aspires to that ideal, it is generally recognized that you have one shot to reverse a decision of leadership that you disagree with. Yes, in that one opportunity you give it your best shot, and you may argue with passion and conviction. But, once the leadership has affirmed the decision you have but two choices: 1) support that decision with all of your effort, or 2) resign with no expectation of being a team member again.

What does the above mean? It means you don't get to pick and choose which decisions, policies, and procedures you support and follow. It means that after your one shot you exert your best efforts to implement and follow the decisions of the leadership. It means that when you take your one shot to *change* a decision you'd best be thoroughly prepared, as you won't have another opportunity. It means that when you take your one shot, you DON’T rehash the same arguments as already heard by the leadership; those arguments didn’t work the first time, why should they a second? It means that if you continue to argue, debate, or oppose a decision after you've had your one shot, if you do not abide by the decision, if you contine to publicly state your disagreement with the decision, or you continue to argue against it in private with other members or leaders, you will be dismissed from the team without recourse. It means that if you find you can not support the leadership, you resign your membership without complaint, fuss, or hysterics. In short, it means you follow ethical expectations of personal conduct in this setting.

Note that the above doesn’t mean you have one chance, and one chance only, to have some matter of importance to you considered and approved by the leadership. The one shot rule applies to *changing* a decision. If your design wasn’t accepted by the Chief Engineer, you have one shot to change that decision; but, as noted above, you’d best bring new arguments to the table, as the old ones didn’t work.

Lack of preparation on your part is not a basis for exception from this rule; if you bring something to the leadership that’s a good idea but is presented in a half-baked, unsubstantiated manner, then leadership does not have to afford you repeated attempts at convincing them so that you can get your arguments in order; your next time is your one *last* shot. Plan accordingly.

The team is neither a committee nor a debate society; it has a leadership structure that must be respected.

4. Tips For Preparing For A Successful Competition

The following tips or “rules” are brief lessons learned that, if heeded, will help the team position itself for a successful, rewarding campaign. Some of these have overlap with the commandments.

1. Finish the car early.
   All good things follow from having the car competition ready as early in the year as possible. What are some of those good things? The luxury of time; time to test, develop, and revise. Time to prepare the team for competition. Time to identify and fix problems before they stop the car at the event. Time to train drivers, presenters, defenders. Time to train support crew. Time to pay attention to all those other details of competition.

2. There is no substitute for having the *entire* car competition ready months in advance. That means body work, too.
   There’s a difference between “finished”, and “competition ready.” “Finished” is the state the car is in when it enters the development phase. “Competition ready” means that you’ve tested and developed all that you can; the car is configured as she will be when run at an event. Having the car competition ready months in advance means you’re not having to make parts, body work, etc. at the last minute. When the car is competition ready, the team’s focus can turn to making the TEAM competition ready.

3. Nothing should go on the car in Michigan that hasn’t already been tested and developed in Atlanta. Nothing should *ever* go on the car for the first time in Michigan.

4. Finish the car early.

5. Body work should be designed such that it does not drag: dragging body work makes the car look bad, and makes the judges think we’ve too much roll in the suspension.
   The bodywork is the skin that judges and the outside world sees first. But, it’s a functional skin, one that has to come off the car repeatedly throughout the competition for tech inspection, design judging, cost judging, maintenance and preparation activities, etc. The same attention to detail, function, usability, robustness, fit and finish, must be given the bodywork as is given to any other critical system.

6. Body work attachments should be rugged yet simple.
   With the skin having to be removed numerous times throughout the competition, and often so in heat of time pressures, it’s imperative that the mounting system be able to handle abuse, yet be quick and simple to operate. Both the hardware on the chassis and the hardware on the removable pieces must be robust. It’s highly desirable that the bodywork be removable WITHOUT the use of specialized tools. If specialized tools are required (as for some styles of Dzus fasteners), then the team needs to have on hand numerous copies of the tool such that there is never a delay caused by waiting on someone to “Find the Dzus tool!” or "bring me a flatblade screwdriver!"

7. Finish the car early.
   Time is a priceless commodity, and one that cannot be saved, or stored for use later. You can ill afford to believe “I can do this tomorrow; there’s plenty of time; competition is still 3 months away.” Think of all the demands that are going to be placed on your time in the coming year, by friends, by family, by school, and this team. Think of the magnitude of the task before you. I’ve seen estimates that teams invest 5000 to 10000 man-hours in the design, construction, and development of a car. If you don’t put in the effort now, there won’t be time later to make up for it. Never procrastinate. Never put off to tomorrow (or next week, or next month) what could have been done today. Do not delay.

8. Finish the business case presentation early (including handouts); consider warranty, maintenance, and other detailed matters. Perform it in front of a critical audience, with the person who will deliver the presentation at competition also delivering it in rehearsal. There should be no more than one transition between speakers. Alternating back and forth between speakers is disruptive to the audience, and should be avoided.

The presentation event is to be a business case. Properly done, such a case involves market research, analysis, and planning. A good business case can't be thrown together in the days before competition; smooth, confident delivery can't be achieved when the rehearsal is at 2:00 AM of the morning of the event. The presentation event will score the team points; effort put into winning this event is just as valuable to the team as effort put into winning.

The business case should incorporate images and data from THIS year's car; not just some mélange of random images from who knows which car. The only way to have such images available early is for the team to make a routine habit of photographing its activities and archiving those photos in an accessible, organized manner. The team goes to an SCCA autocross? Someone should be designated as photographer. First time the car's on the dyno? Bring out the cameras.

9. Prepare the design display in parallel with the completion of the individual design elements: the analysis, decisions, and justifications will be fresh at hand. Trying to recall or reproduce analyses done months before is terribly inefficient.
   The design display is the canvas upon which the team lays outs its design concepts, objectives, and analyses. They provide the detailed content for the team members who are defending the car in front of the design judges. The car can't sell itself, and hand-waving doesn't cut it. If we don't make the design semi-finals, we've already given away 50 points, and probably given up a shot at #1. We can't make the design semi-finals if we don't have materials on hand to substantiate the design, materials that the appropriate team members have reviewed and rehearsed.

10. Finish the car early.
    Hmmmm……. this one keeps being repeated. I wonder why.

11. Do more than was asked, do it better than the standard, and finish it earlier than is needed
    High quality work, completed well in advance, and covering all the bases puts the team in control of its own destiny. If all the team members follow this rule, we're in great shape, and we're having fun.

12. Maintain design notebooks for each element on the car. Use these design notebooks to assist in preparation of the design report and the design display.

13. Unveil the car and the business case presentation at the same event. At unveiling, the car should be 100% competition ready.
    Unveiling imposes a target. It's a tangible commitment of having the car and team presentable by a certain date well in advance of competition. There are lots of good benefits of a well executed unveiling. You've shown the sponsors that the team is ready; the sponsors include your professors, school staff, administrators, the media, and, those folks who give you cash and in-kind donations.

    For an unveiling, the team should appear in its "dress" uniform; that means the team shirts have to be on hand, embroidered, prior to unveiling. That means they had to be ordered with delivery weeks earlier. This is a good thing, as is forces advanced planning and preparation.

    The unveiling is an opportunity to explain to a locally, highly interested audience the key features of the car and the team. Also, it provides a great venue for a dry run of the presentation. Exploit the opportunity.

14. Read the rules, and prioritize upon what's important therein.
    To pass tech, the car has to be rules compliant. The only way to know if the car is compliant with the rules is to read them, and compare against the design. And, just because something made through last year doesn't mean it will do so again.

    Also, the rules tell you the value and scoring for each and every dynamic and static event at competition. This sets out a value system for various activities in terms of prioritization and

planning. Realize that the dynamic event scoring can be used to analyze performance vs. event tradeoffs.

15. Test and document, test and document. Use test results in your design display.
    The design judges want to see not only the predictive element of your design process (your analyses and models), they also want to see your test data. And, they want to see it compared against the prediction. If all you have is test data, though, that will count against you; it conveys the impression that all you did was build a car without any formal engineering, and then are trying to justify that design after the fact through test.

16. You do not have the luxury of expecting anything less than on-time completion of projects.
    Yes, you all have competing demands on your time. Yes, you're all colleagues and fellow students; but when you fail to meet the obligations you accepted, when you procrastinate and dither and fail to advance the completion of the car and team preparation, then you're wasting that most precious of commodity: time.

    There is no shame or loss of honor when you say "I can't do by that date." There's no shame when you say "I need help." Far from it; you've let team management know that you need assistance to meet your commitments; it's their job to provide that assistance. When you don't keep team management honestly apprised of your status and progress, that's when things can go bad, as you're not being honest with yourself or the team.

    This applies to team members, and even more so to team leadership. Leadership fundamentally cannot and must not merely command performance; it must lead by example, lead by encouragement and motivation. When management itself practices late completion of tasks, then there is no reason for the team at large to do anything different. This behavior is a recipe for breaching rule #1.

17. There are a number of special-interest award competitions associated with the main competition itself. Assign individual team members to take on responsibility for coordinating the team's efforts for each such award: integrate consideration of these awards into the design process, so that the team's efforts on the awards are not merely an afterthought. Awards of near-term potential include the braking award and the safety award.

18. Finish the car early.

19. Ensure, through documented, rigorous, and precise testing, that fuel economy targets are met.
    Read the rules; what's the cost of not meeting the fuel economy target? It's a score of 0 in the fuel economy event, and that pretty much guarantees a finish well out of the top 10. When you intentionally give up points, you're making it all the more challenging to place well.

    FUEL ECONOMY MUST BE GIVEN A PRIORITY EQUAL TO POWER WHEN DEVELOPING THE ENGINE.

    Recall the lesson of 2002; just before pushing into the endurance queue, we'd put the car on the dyno and found the engine was producing only about 50 Hp. It was determined that one cylinder's coil-on-plug driver was dead, and there was no time to change it. Therefore, we pulled the connector off that cylinder's injector, leaving us effectively a 450 cc engine (but with added drag). WE PLACED THIRD THAT YEAR, 2nd IN ENDURANCE ONLY 10s BEHIND THE WINNER.

    Download each year's scoring spreadsheet from the SAE website; look at our fuel economy vs. that of other, top performing teams. Consider that in several prior years we have been hit with the fuel economy penalty, and certainly didn't show any sort of domination in the dynamic events.

20. Perform routine design review and progress review meetings. These should not be cheerleading sessions. They should be organized, and there should be clear expectations of substantiated progress from week to week. Schedule these meetings at a time where the FA or other interested faculty and staff can attend: they SHOULD NOT be scheduled before or after a team meeting.

Word of mouth is a lousy way of measuring progress. You need to be able to assess where the team stands with respect to completion of both preparing the car, and preparing the team. This project lasts 9 months; you can't keep it in your head or on scraps of paper. You need to impose structure, discipline, planning, and assessment. The team leadership meetings should follow an agenda and should publish/post minutes. There must be tracking and management of deliverables, accomplishments, and barriers to progress.

21. Keep your sponsors and alumni well informed of what you're doing. Letters to all sponsors should go out immediately after each competition: don't delay, you don't need to send a 'sponsor pack'.

    GTMS runs on money. Without money, the team can't compete. The team is fundamentally responsible for raising the funds we need, year in, year out. The role of "Sponsorship Leader" is one of the MOST important positions within the leadership structure. Without money, we don't run. Without happy sponsors, we don't get money, and we don't run. Sponsorship involves more than just external relationships; it also includes our relationship with internal GT entities, for example, the Corporate Development Office.

    The school has no obligation to raise funds for the team; it does so only because we've kept them happy (though that enthusiasm historically has waxed and waned because of the team's attention to or neglect of its obligations). When the school's Director of Development (Tom Lawley as of 2017) or the Institute's Corporate Relations office (Caroline Wood and David Zaksheske as of 2017) asks, we answer, and do so immediately. We must keep the Institute apprised of our sponsorship activities at all times, and must seek the Institute's permission to approach new sponsors.

    Sponsorship, though, is much, much, more than just seeking new sources of funds; we have to keep our current sponsors happy and interested. When we neglect current sponsors, when we become complacent about their support, then we lose that support. The team, unfortunately, has a spotty history of sponsor maintenance ("stewardship" in the lingo), and we've let many a good sponsor slip away through neglect… or having outright forgotten that they were even a sponsor. Some individuals have financially supported the team (Caroline Wood, me,..).

    Given the importance of sponsorship and sponsor relations, it's imperative that the team leadership recruit an enthusiastic dedicated person(s) to fill the roll; the leadership must make all team members understand the importance of sponsor relations (internal and external) and must put the proper priority (none higher!) on responding to sponsor support requests.

    Sponsor activities include, but are not limited to, "meet and greet" sessions with sponsor representatives, attending sponsor information seminars and recruiting sessions, providing a car and team members to the school for Homecoming and Parent's weekend related events, the unveiling, GM pizza nights in the Student Competition Center, etc.

22. Finish the car early.

23. Inform the FA of any action or incident that will bring publicity to the school, good or bad. Don't let the FA or School Chair get blindsided.

    The team must always behave in an ethical, honorable manner. The school will trumpet your successes, and will help you learn from your mistakes. Letting good news go unheralded is a lost opportunity; hiding bad news from the school and the Faculty Advisor is the fast track to loss of reputation, honor, and potentially, puts the team itself at risk.

    Understand that the team and ALL of its members can be disciplined for the actions of single individuals, if the Institute decides that an incident (or its cover up) indicates team responsibility.

24. Keep the Institute's Corporate Relations office (Caroline Wood and David Zaksheske as of 2017). THIS CANNOT BE NEGLECTED.

    The Corporate Relations folks should be our ally, someone we should seek out for guidance, advice, and ideas. The fastest way to poison our relationship with Caroline, David, or Tom is to

not respond in a timely manner to their requests, to neglect our sponsor obligations, or to approach potential new sponsors without their prior approval.

25. Work with the school's Director of Communications (Susan Volert as of 2017) and Writing Coordinator (Jeff Donnell) to ensure your documents and publications are effective and appropriate. This should be done for EVERY document intended for external circulation.

    The team helps its image when it presents proper publications to its current and potential sponsors. "Proper" here mans that the documents use correct English, are well laid out and attractive, and properly acknowledge the support and participation of critical parties.

    There's little more embarrassing to the team than a poorly written document published to sponsors; such conveys the impression that we're careless at best, incompetent writers at worst. And, when you realize that much of an engineering career well be spent in communicating your ideas to others, what are you saying about your own abilities in that arena when you release sloppy materials?

26. Nobody owes GTMS anything, and you deserve only what you earn. The school supports you far more than you know, so treat it right. Treat the resources that have been afforded you with respect and care.

    It's about responsibility and maturity. You have been given extensive privileges and freedoms; the way to lose them is to abuse them.

    One resource we CONSTANTLY abuse, to the harm of our reputation and image, is the work spaces we're granted access to. These include the team offices, the team work areas in the Student Competition Center, and the dyno rooms in the MRDC building. The Faculty Advisor, Student Competition Center Supervisor (Jason Barnes), nor any other school representative should EVER have to tell the team "Clean the shop." The fact that we have to routinely do so is a stain on the team's honor, integrity, and image. Not too mention that you'd be fired in the real world for maintaining such a poor work environment. The TEAM creates this mess, and the TEAM is responsible for fixing it. Yes, you are your brother's keeper.

27. Keep all Woodruff school staff happy and satisfied. Give them no opportunity to criticize GTMS in anything you do.

    The school should always be treated as our #1 sponsor and fan; without its constant support and the access to resources they offer us, the team would die. This puts a high onus of responsibility on the team. When we neglect that responsibility, we put the team in peril. When we abuse the privileges, break the rules, don't follow the procedures, practices, and polices required of us, we put the team in peril. ALL TEAM MEMBERS MUST UNDERSTAND THIS!

    A classic point is purchasing; the school requires us to follow fairly rigid procedures to make and account for purchases. We can never, ever, ignore these procedures. Why? Realize that the team has no legal right to ANY of the funds it receives; they're all given to the Institute in trust for the team. The Institute HAS to account for them following the procedures mandated by state law; we put our purchasing privileges at risk when we don't follow those procedures.

28. You control your own destiny: you know what it is required to win.

    No one is working to hold you back; you control the timing, the details, and the execution. You need only look to yourselves when the team comes up short. Equally so, when you achieve success, you can cherish the knowledge that you EARNED it.

29. You are a Georgia Tech organization participating in a Georgia Tech approved activity. Therefore, the student rules of conduct apply, no matter where you are (e.g., Michigan, UK, Australia, Auburn, Michilen, etc.). Fundamentally, you don't have any 'private time'; when you're doing anything related to the team it's all on the GT clock. You can be held accountable for any conduct that reflects ill upon the team or the Institute. Note that the team leaders are held responsible for the conduct of the team members.

30. When competing overseas, don't assume that things will be as they are here in the states. Routine tasks that are easily accomplished here may be fiendishly difficult, if not impossible, when overseas. For example, while we expect and exploit 24 hour copy centers over here, they are much less common overseas!

    It's rather easy for us to carry our pre-conceived notions with us when we compete overseas. When the team traveled to Australia in 2003, they decided that they would find a local "Kinkos" for some printing and copying needs. No one thought to check the business hours for such operations in Australia; they're open 24/7 in the States, aren't they? Well, most Australian service businesses close up at 5:00 sharp on weekdays, generally by 2:00 on Saturdays, and are closed on Sundays. The team found itself in a rather difficult position; they'd put off to the last minute something that could have been done earlier, and they hadn't made sure that they would be able to do what they intended to do.

    Always investigate the local conditions carefully when you know you'll need to rely on local support while overseas.

31. When competing overseas, make contacts with local teams for assistance with resources in the local area, local practices, etc.

    FSAE teams are generally incredibly hospitable to one another; the teams are particularly enthusiastic about overseas competitors. They want to beat you on the track, not in the pits or hotels. Linking up with the teams is a great way to smooth over the transition from the States to abroad; and, it gives us the benefit of access to local knowledge.

    In a like vein, I'd like to see the team offer to host or assist some overseas teams; the Venezuelan teams, for example, have a bit of a connection to us through me.

5. Care And Feeding Of Your Team, Faculty Advisor, And Car At Competition

The Lessons Of 14 Years Of Sitting In The Hot Michigan Sun (And Freezing Rain), Under Rainy English Skies, And In The Blistering Australian Bush, A Guide For Team Leadership

1. Tell your team what your plans are for each event, well in advance of each event. Be specific as to *what* the plan is, and *why*. Not only are you keeping them informed, you're training them for the future.

   If the team knows what's happening, they'll be better prepared for whatever may come. They'll know the time constraints they face, and will be able to plan their activities. They won't be wandering off unaware of what's to come. And if they're coming back next year, they'll be better experienced in team operation.

2. Attention to the 'why' is important for matters of strategy. For example, if you're delaying pushing into the autocross queue for reasons of strategy, let your team and FA know that's the plan, and also explain the strategy behind it.

   Tactical decisions make a BIG impact on team operations. But, it benefits future leaders (and current team members' understanding of what's going on) only if you explain the tactics. In 2004, having advance knowledge that the weather was going to close in early on the Autocross event (how did we know? Because we had delegated a team member to stay at the hotel and track weather using the weather channel and various on-line resources, including real-time radar), immediately after the dynamic event entrance queue closed for the morning event, we pushed in so as to be the first car in line for the Autocross. We did all of our car prep as first in line; this tactical move put us in complete control of our timing for the Autocross event. Ultimately, we were one of only 12 cars to run on a dry track. Yes, it was inconvenient to do a car check in the open, in line, but since we explained WHY we were doing it, everyone understood and made it work (it was also rather fun to hear other teams go "Oh crap, GT is already in line for Autocross!"; rather quickly, other teams followed our example and began to queue up behind us. But WE had the first spot in line).

3. Why is it important to explain your strategy? So that future team leaders have the opportunity to learn the sorts of strategic decision making that takes place at competition. If you're concerned about exposing your strategy to other teams, find a way to inform your team in confidence.

4. Tell team members what their role is to be. Be specific. Each team member should have an unequivocal understanding of what they're responsible for.

   Everyone should have a role(s) at competition, and clearly understand that role. Folks who are to prep the car should know that's their job, and be trained and prepared for the job. Folks who will be maintaining the paddock area and trailer should be equally trained and prepared. Similarly so for those doing the design, cost, and presentation events.

   In addition, folks also need to be flexible, and able to pitch in willingly at any time, and in any capacity. One comment that is guaranteed to get the FA into high dudgeon is "That's not my job". Yes, it is.

5. Ensure that everyone on the team knows when they're supposed to be at the paddock at the start of the day, and what they're supposed to do once they get there. Be specific as to time and task. Let the FA know when the first group of the day is leaving the hotel for the site, and what their tasks are.

   You can buy spare tires; buying spare team members was outlawed by constitutional amendment back in the 1860's. This one goes to making sure the team uses its manpower resources carefully and considerately. With restricted access to the paddock becoming the norm, it's even more imperative to be prepared. Last minute planning and delegation leads to confused instructions and lost time. Team leadership needs to have their heads out of the car and into the team.

6. Don't let any team member leave the site without having told them when to come back (this also means that all team members should check in and out with team leadership). A sign that you're not

managing your team's time properly is when you have team members sitting in the hotel lobby not knowing what is going on.

No one is an individual at competition; the team represents a limited resource of manpower that must be managed, and which shares mutual obligations and responsibilities to one another.

7. After pushing the car back from an event, immediately prepare the car for the next event. *Never delay car preparation*. Have a set routine for checking fluids, setup, bolts, shock settings, hose clamps, etc. Develop and use a checklist. The team members who are to prepare the car should be instructed as to their exact tasks, and these tasks should be practiced before coming to competition.

   Time pressures rule the competition. The car must always be made ready for her next appearance.

8. The team leader's head should not be down inside the car tightening bolts: the team leader should keep an eye on the big picture and that's hard to do when narrowly focused on car preparation. Also, the leader is constantly distracted in such situations, and a fatal oversight might occur due to such a distraction.

9. Plan team activities to avoid, at all cost, rushed preparation of the car. For example, the endurance entrance queue is highly structured, and the team will be called into position well before the car actually runs. So, you must plan on being ready *well before* an event's queue actually opens.

10. Never let the team believe that the organizers have treated the team unfairly, or that it was 'just bad luck.' The team must accept responsibility for the performance and reliability of their car, and for the performance and execution of the team itself. The team's fate is under its own control.

11. When the car pushes out to an event, have a designated support crew that follows the car, and a support crew that operates from the trailer. Use radios to coordinate between the car and trailer. Use bicycles to ferry items between the two. Team members should have no doubts as to which crew they're on.

12. Keep the paddock and trailer clean and organized: you're representing the Georgia Institute of Technology, and you want to convey a professional image. Whenever the car is absent from the paddock is a great opportunity to straighten up. The FA should not have to constantly remind the team to clean and straighten the paddock area.

13. Pay attention to the fatigue and hunger levels of your team members. Don't over use and burn out your key people. Make sure folks are getting food and water (particularly on hot days). Have sunscreen on hand, and encourage its use. In cold weather, watch out for hypothermia.

14. When a driver is in the car, keep him or her cool and dry: use umbrellas to shield the driver from sun and rain. Have rain shields on hand to cover the car. "It won't rain" is just wishful thinking: be prepared.

15. If you perform a repair at competition that could have critical impact should it be anything less than perfect, try to get on the practice track prior to the next event and prove that the repair works as intended.

16. There can be no fluid leaks of any kind, of any magnitude, ever. The endurance event is now a zero tolerance event for leaks: expect that, in time, so will all other dynamic events.

17. Time behind you is worthless: time ahead of you is priceless. The clock is not your friend.

18. At the end of each competition each individual in a leadership position should write an 'after action' report. The report should detail what was done right at competition, and what could be done better. Maintain an archive of these reports such that future teams can use them to learn what to do, and not do, at competition.

19. The car cannot speak for itself: you must sell it to the judges, using data, data, data. You must *interpret* the data for the judges, drawing them to the same conclusions that you made.

20. Have team member sit at the back of the presentation room with “time remaining” cue cards. The team member at the back should monitor the speaker’s time, and use the cards to give timing information to the speaker.

21. Keep the FA up to date at all times: the more the FA knows what you’re doing with the team, the less likely he is to interfere.

22. Transportation vehicle keys should be kept at the trailer, and should not be held by individuals (how many times in prior years did we hear the call "who has the keys?").

23. Immediately after competition, have each team leader prepare “after action reports.” These be critical assessments of how the team performed throughout the entire design, build, and competition process. The reports should be completely objective: focus on the process, not the personalities. Use bullet lists of what was done right, what was done wrong, and how to improve. Maintain these lists as part of the team’s “Corporate memory,” and use them as a reference and improvement tool in future years. Remember, your faculty advisor will display symptoms of Alzheimer’s, and won’t remember all the good and bad.

6. Dr. C's Post-2004 Rant (some of the rules-related issues addressed below no longer apply; but the lessons still do)

This message was sent to the team after the self-induced disappointments of the '03-'04 campaign. The lessons here are as valid now as then.

This will be a long section of the document, and it may take a few readings to digest it, but I strongly encourage you to take the time to read this carefully and deliberately. My intent here is to provide you a sense of where this team has been, where we stand today, and what the future may hold. My intent is to challenge your concept of the team and what we do, to challenge you to think about what is necessary for GTMS to push to the top.

It pains me to point out that the lessons of Section 7, below, were not learned, and greatly harmed us in 2005, and to an extent in 2006. The lessons of Section 7 are now distilled in the section "Ethical conduct when you disagree with GTMS team leadership, or, the "one shot" rule", as well.

1. Why We're Here

1.1 The GT Motorsports Team exists for one reason and one reason only; to compete in the Detroit Formula SAE Competition. If you're in this team to drive fast cars, you're here for the wrong reason.

1.2 This team has a legacy of team members whose sole reason for being members was to see what they could accomplish as engineers, and who had no particular desire to actually drive the car in competition.

1.3 The overseas competitions do not have the prestige nor challenge of Detroit; yes, we've won overseas, but I contend it was like the empire beating up on the provincials. Our priority has been, and must continue to be, winning in Detroit. A top finish in Detroit opens the door to go overseas; a poor performance closes that door.

2. The Cars We Build

2.1 Take a look at the first three cars that this team built: car 66, car 23, and car 42 (images are available on the team's public web site). They are quite distinct from each other, in a way that none of the cars since have been. Car 66, the first that the team built, used a tube frame chassis and unstressed engine. It also sported a wing at one time. Car 23 was the second car that the team built, and featured a hybrid monocoque and tube-frame chassis. Car 42 was the third built by the team, and featured another monocoque chassis, but one that was radically different from 23's.

2.2 Now, look at all the cars built after car 42, starting with car 99 (the 4th car through to the present day). Car 99 and its descendents employ a tube frame chassis, semi-stressed engine, and trailing link suspension. We've run essentially the same rear uprights (with improvements) since at least car 42. While details of the chassis have changed (e.g., integrated suspension points with the front down tubes, modifications to accommodate the F4 engine), it takes a bit of a practiced eye to pick up the differences year to year.

2.3 As a historical anecdote, starting very soon after car 99, the team became very much averse to making significant changes in the design. Engine selection was based on what we had, the inventory of parts, the number of spares, rather than for explicit design criteria. The uprights were kept "because they worked." The downtubes were kept, "because we like them." The 13" wheels were kept "because". The team argued about why they couldn't change, rather than why they should. The mid- and late-90's became a time of "cool" technologies for the car (using the tubes as a pressure vessel for an air-

shifter, variable-vane turbo, auto-launch capability, etc.), technologies which were never developed early enough and which became liabilities for the team at competition.

2.4 True, over the years we've had significant improvements and evolutions in many areas, such as in the brakes, steering rack, differential housing, and engine control. Most recently, we made a significant change to our inlet, but we built it, rather than designed it from first principals; we developed it by testing, rather than by *a priori* prediction. Nonetheless, where is the large scale design innovation as evident in 66 to 23 to 42? Where is the risk-taking?

3. The 2004 Competition

3.1 I hope that each of you have analyzed the scores from the 2004 event (they're available from the FSAE web site), testing "what if" scenarios: "what if" we'd finished endurance, "what if" all teams had finished autocross, etc. Such an analysis reveals that by the end of the autocross, we'd already given up 150 points to Cornell, which is twice as many points as Cornell gave up over the entire event. Assuming that we could have scored about 350 points in the endurance/fuel economy event, the best we could have finished was 5th place. If all teams had the opportunity we assured for ourselves of running in the dry for the autocross event, we would have finished even lower (we placed eighth, and only some 13 cars ran in the dry). Our performance in the dynamic events was on the whole on par with teams of the 90s, not those of more recent vintage.

3.2 Those of you who went to competition may think it was just "bad luck" that we finished 31st: bad luck is when some other team's wheel comes off and hits us. We created the situation that led to our finish months before we ever left for Detroit. The #1 rule in the Idiot's Guide is one learned through hard experience: "finish the car early." The team forgot this lesson, or chose to ignore it for reasons I still find unfathomable. As an example of how we shaped our 31st place finish, be aware that the car at unveiling was as far from competition ready as any previous car, and unveiling was later than it ever had been.

3.3 True, we were not under time pressures at competition to the extent of prior years. Indeed, except for the car's mediocre performance, the 2004 event was nearly an "ideal" competition for us from the perspective of time management (first in line for autocross was a tour de force in tactical and strategic time management). But, without a reliable car, without a developed car, without a well practiced design team, without thoroughly experienced and trained drivers, our finish was nearly foreordained.

4. What it Takes to Be in the Top 10, Top 5, and to Win

4.1 To place in the top 10 is quite a bit easier than to win outright (I have provided a grid of historical scores to Michael Dam for posting to the team's internal site). If you look over what it takes to place in the top 10, you find that it is essential to be consistent, but not necessarily dominate, in all events. The typical point spread between first place and 10th place is on the order of 200 to 300 points (this year it was 190 points). To place in the top 10, one must score in all events, and finish endurance with a non-penalized fuel economy.

4.2 Why do I emphasize the importance of a non-penalized endurance score? Take a look at our endurance scores in 2000: we gave up a top 5 finish in Detroit, and probably a win in England, because we were hit with the 4-minute fuel economy penalty. Neglect any aspect of the rules, and pay the penalty; tune solely for power, ignoring economy,

and pay the penalty. The fuel economy penalty alone will make a top 5 finish become a 20th or lower finish.

4.3 Top 5 is also quite achievable, as the spread is typically 100 to 150 points. Top 5 requires stronger performance in all events, and a strong endurance/fuel economy score. Static events are critical, as we saw this year. By the end of the static events in 2004 we had already given up 150 points; this put us at the fringe of a potential top 5 finish. Our 3rd place finish in '02? 150 points behind Cornell. Our 4th place finish in '03? 80 points behind Wollongong. 2002 and 2003 were our top recent finishes; in neither year did we dominate the events as the winners did.

4.4 To win, it is imperative to give up as few points as possible in each event, which requires near dominance; look at Cornell's 2004 performance.

4.5 Where the team falls within the above spectrum is clearly a function of the development time invested in the car, the knowledge invested in the team, and the preparation time invested before ever getting to Detroit. If the team is deficient in any of these areas, then a win is almost automatically excluded; lower investment yields a lower finish, and our performance in the 2004 event is an example of this.

5. Challenges in Where We Stand

5.1 When was the last time that the team stepped back and considered the *why* of what we build? When was the last time that we made a fundamental change to the overall design of the car, not just evolved the car? When was the last time we evaluated chassis options? The last significant change that I was involved with occurred in the late 90's, when the team finally acknowledged that turbo chargers we more of a liability to us than a benefit (of course, in those days the team never finished a car early enough to develop and solve the problems we experienced with the turbos, nor, was enough *design* effort invested into determining why we were having problems).

5.2 When was the last time we seriously considered changing engines? The arguments I hear today as to why we should keep the same engine (and displacement) are the same sort of arguments as were made to keep turbo chargers: power is good. Why? The team has completely ignored, or is unwilling to acknowledge the lesson, of car 21: we took third place on the strength of a car running on 3 out of 4 cylinders, that is, a car with a 450 cc engine. Do we really understand the role of engine choice on our design? Have we really "designed" an engine choice, or, merely kept what were familiar and comfortable with? Kept what our testosterone demanded, that is, raw power?

5.3 I've heard it stated repeatedly that we build great cars, that we don't need to change our designs. I must respectfully disagree. The scores don't lie, particularly in the dynamics events. We have not brought a car to Detroit that has dominated the dynamics events as it must in order to win, even when we've had tens of hours of development and test time. We can't use our overseas performance to justify our designs, as we did not compete against the best teams from Detroit.

5.4 My somewhat stronger, more general observation is that the team has become unwilling to challenge its own designs, that it has become unwilling to break its own mold.

5.5 Our evolutionary design practice, as well as our current concentration of design responsibility into too few hands, creates an environment that hurts our ability to

recruit new, creative designers, and, that promotes the gradual loss of knowledge concerning our legacy designs.

5.5.1 Consider this; when a new member joins us in the fall, they find that much of the gross design has already been settled upon, as we're carrying forward a significant number of legacy designs from previous years. How can that person contribute, other than as a fabricator? What's their motivation to learn and explore as designers, if they have but limited freedom to actually design? How can we expect to develop new designs in anything but a limited number of systems if we don't encourage innovation and creativity by more than just a limited number of experienced people? If someone joins us and then comes to the realization that their ideas have no chance of making it onto the car, how can we keep them interested?

5.5.2 For those same legacy designs (e.g., the rear uprights), how does the detailed knowledge of such legacy components get passed on? What were the assumptions in their original conception? What were the loads? When was the last time we evaluated and understood the load cases that went into the design of the suspension members and chassis members? If only a limited number of "designers" are focused on changing but a few details if the car, how do new (and current) members learn the details of what went into the legacy components? Given the complexity of these cars, it is too much to expect for one chief designer to know all details of every system; but if we don't train and pass along knowledge, we lose it.

5.6 Tell me, which car's FEM analysis is on the design board? I've heard that it's car 32's, and is certainly not car 4's. Tell me, what contribution to the torsional and bending stiffnesses do the downtubes provide? These are fundamental questions, but I've never heard the answers presented to a design judge, and not to me or any other team member over the past 4 years that I've been posing the question. My point here is that we are not analyzing our designs to the extent that we must do in order to be competitive in the design event, nor, quite frankly, to the extent necessary to understand the designs of what we're building. We don't do enough predictive analysis before starting to cut or weld. Also, this is an example of a legacy feature of the car that has not been adequately evaluated, justified, and passed on to the team members that come after.

5.7 I have heard some comments that the custom brake calipers are a problem, that the rotors are a problem, that the diff housing is a problem, etc. I've heard comments that for the 2005 car we should just buy components off the shelf (e.g., brakes). Yet, I put it to you that these very components embody the best of what the FSAE event is about, *design*. These components, and our understanding of them, have served us well in the design event. Yes, we may need to develop new designs and solutions for our components, but I think that we should seek to build *more* custom components, rather than fewer.

5.8 I am not convinced that the team leadership as a whole has given adequate thought as to how to proceed with the 2005 car. No offense to Kevin intended, but it seems as if we've defaulted into a refinement of car 4. Is this the best path forward? How many iterations of car 99 are we going to build? As noted above, we seem to be locked into the same design, unwilling to break the mold, and only willing to tweak here and there from year to year. *If we continue this practice we will continue to find ourselves in the*

position of not having the experienced people willing to explore new design solutions, for reasons as explored above.

5.9 But here's the conundrum, the counter argument against radical design changes for the 2005 car: we have lost more expertise and more skills than in any previous year (except for maybe after the first year of car 42). We've lost a great deal of design, welding, machining, and driving expertise. We essentially have no one capable of CNC, and our general machining skills are almost non-existent. We have no one truly skilled in welding. We have no seniors with experience in the senior level design classes, CAE/CAD classes, FEM analysis, CFD analysis, composites design classes, materials selection classes, etc.

5.10 Even prior to our loss of skills, our practices in the design and construction of the car have become inefficient.

5.10.1 We don't do enough *design*. We build, rebuild, and re-re-build. We design individual components, but don't integrate them well as systems within a larger whole. How many components on car 4 had to be machined again and again? How many errors were made in the jigging of the chassis? How many interferences between components were discovered only once assembly began? (These problems were not unique to 4, but seemed magnified for some reason.) Design extends beyond just the mere mechanical strength of a component; it includes CFD analyis of the inlet, a proper cooling system design, proper electrical system design (not just building a harness, *designing* it; not just wiring in a Motec, *developing our own ECU system*)

5.10.2 We work too much to the clock, and not enough to task. That is, putting in time seems to be the measure of contribution, not the successful completion of a design or fabrication task.

5.10.3 We have 24/7 access to the shop, a resource that 99% of other FSAE teams lack, and yet we don't efficiently manage our time and resources effectively. What good is it to have people at the shop at 10:00 on Saturday unless there is work for them to do? Unless the tools, materials, and detailed drawings are available to permit proper fabrication of components?

5.10.4 I don't believe that the team truly appreciates the time required to complete a car, nor the interactions and interdependencies among the systems and components (some few may, but that knowledge is not getting passed around). What's the critical path to completing the car? What components need to be designed and fabricated, and in what order? Do we fully understand the level of complexity in these vehicles, and the amount of detail required to complete one? These questions, by the way, motivate my suggestion that we tear down car 4 as an instructional exercise.

5.10.5 I don't believe that the team uses effective engineering management tools to measure progress toward completion. How do we know that the design is complete, when it's arguable that very few team members appreciate the detail required to complete the car? How do we determine fabrication completion, when we don't know the resources and time required to complete the car?

5.10.6 As with design changes, the counter argument to the above two points is that we don't have the manpower to perform such scheduling and resource management

practices; that we can't find anyone interested in performing such tasks. Such is not the case. We have had project managers on the team, folks with the experience and interest to perform detailed project management across the whole car. At one time, the entire design and fabrication process was setup within a program called Microsoft Project, a program that implements standard management tools. We've had project managers who struggled mightily to get area leaders to provide status and resource information, to be thwarted by ingrained work habits and lack of support from the team as a whole.

5.11 We have become averse to breaking the mold first cast by car 99, in 1994. I am hearing more about why we can't change something, than why we should. Every decision to keep a certain subsystem or component constrains our design freedom to the same decisions made before, decisions which we may no longer understand.

5.12 The above problem is compounded by a lack of effective procedures for bringing new design ideas forward. The Chief Engineer position has evolved into something it was never intended to be, with far too much responsibility for the detailed design falling to that position. The role of the Chief Engineer position was to ensure that the design objectives of the car as a whole were being met by the system leaders, and, that the systems would work together. The global objectives were to be developed by the Chief Engineer in consultation with the design leadership. The current practice puts too great a design burden on a single individual, and other areas go wanting for lack of attention and leadership. This also promotes the problem described earlier, that is, the loss of knowledge about legacy systems.

5.13 We have damaged our relationship with the school because of actions the team has taken with respect to the machine shop (impacting John Graham) and our negligence in how we maintain the common area machine tools. There is a risk of losing these tools if we do not correct our practices.

5.14 We have damaged our relationship with the M.E. school's Director of Communications (Rona Ginsberg) by not being responsive to her requests with respect to our brochure. The school has paid for the printing of this brochure (to the tune of about $2500), as they use it for their publicity and our fundraising. We could not afford to do this brochure on our own.

5.15 We have damaged our relationship with DeKalb Technical College (Richard Egge) by not following through on the educational exchange that this opportunity affords, and which Mr. Egge expects. Given our lack of machining skills for '05, DeKalb Tech may be our best option for fabricating components, but we'll have to pay attention to what is expected of us.

5.16 We have overloaded certain individuals, and not afforded them the respect and support they deserve.

5.17 Lack of backup in our business manager and sponsorship position puts the team at serious risk, far beyond what you might appreciate.

5.18 Yes, we have folks with a passion for this competition, but do we have the experience, knowledge, and skills available to us at a level required to win? I would argue that we simply don't have enough people on hand, with the necessary experience, to address all of the challenges discussed above. This leads, then, to our options for the path forward.

6. The Path Forward

6.1 Consider the composition of the team; many of you will be around for at least two more years. Nonetheless, we are currently manpower, experience, and skills limited. We face serious rebuilding challenges. How are we to address these challenges?

6.2 From a close read of the previous sections and an examination of the historical scores, it's clear that to win will require a dominant performance across all events (not necessarily winning them all, put finishing in the top tier of them all). A top 5 performance requires consistent performance across all events, and a strong performance in the endurance event. We must ask ourselves, do we have the experience and knowledge required to win in 2005? Do we have it in us for a top 5? Top 10? The team should seriously evaluate what it can undertake for 2005, but should also be looking past 2005 for 2006 and beyond. We have both vehicle design issues and team practice issues that need to be addressed, and I don't know if there are enough hands available to do it all at once.

6.3 The decision that the leadership makes with respect to the 2005 car will fundamentally set the path for the team over the coming years. If we do not take steps to break the mold, both in the design of the car and in the operation of the team, we will never improve beyond the best we've accomplished to date; and that hasn't been first place. We cannot expect that minor improvements in our processes and designs will yield a first place finish in Detroit; we've never been that close to winning it all to where a minor improvement will push us over the top.

6.4 Given that we have too much knowledge in too few hands, we need to disseminate it better through the team. Options include:

6.4.1 Design seminars at team meetings.

6.4.2 Tear down and rebuild of an old car, with a design discourse as the car is re-assembled.

6.5 The team should recruit additional team members for those critical areas of design and fabrication that we now lack. Understand that current members may need to take a lesser position as compared to such more knowledgeable folks, but remember, it's all about the team competing, not the individual.

6.6 The team should implement effective management practices for

6.6.1 Resource management and tracking

6.6.2 Design proposals

6.6.3 New member training

6.7 If we emphasize design activities in the fall, then we will not be fabricating significant components until late in the year. This means that we may have difficulty retaining, much less training, new and current members in fabrication skills. How to address this issue?

6.7.1 We need to fabricate a number of components before cars 3 and 21 can run again. Use these as a means for training new members, and, to re-establish relationships with DeKalb Tech.

6.7.2 Use the tear-down and rebuild of older cars as training exercises.

6.8 There is a "GTMS Guide", which is intended to be a far more detailed Policies and Procedures manual for the team than is the "Idiot's Guide." The GTMSG has not been updated since 2002, and I am not sure that many of you are even aware of its existence. The GTMSG is a valuable mechanism for passing on knowledge from year to year, knowledge about the things the team needs to do from a management perspective, not how to design. We should bring the GTMSG up to date, and add new elements to it; things we should add include:

6.8.1 Unveiling procedures (contacts, dates, who should be invited, etc.)

6.8.2 Interactions with DeKalb Tech

6.8.3 Timeline for competition preparation

6.8.4 Driving Rules

6.8.5 Sponsorship practices and procedures

6.8.6 SGA interactions and timelines

6.8.7 Data management policies

6.8.8 Risk Management procedures

6.8.9 Shirt ordering and timelines

6.9 Get out to SCCA autocrosses for driver and team training, and for fun.

6.10 We need to develop some additional checklists:

6.10.1 Pre-departure trailer preparation checklist

6.10.2 Pre-departure team preparation checklist

6.10.3 Unveiling checklist

6.11 The practice of putting systems on the car for the sole purpose of design judging must end.

7. Some Final Points Regarding the "Driver Trials" Issue

7.1 Those of you who participated on the side of advocating for driver trials should understand that your actions may have led to your termination had you been in the "real world."

7.2 Within a hierarchical organization, which GTMS most certainly is, the decisions of management must be supported. When disagreement with a management decision arises, the commonly accepted practice is that you have one shot to attempt to change the decision. If you give it your best shot and management sticks to its decision, then your ethical and professional obligation is to support and implement the decision to the best of your abilities.

7.3 In a professional organization it would be considered to be grossly insubordinate to continue to argue against a management decision, as happened repeatedly with the "Driver Trials" issue, after that decision has been reaffirmed.

7.4 There are now members within this team that have set the example that open rebellion against team leadership is somehow acceptable. In my opinion, the team leadership exercised admirable restraint in not expelling a number of members from the team; had they done so, I would have backed them to the hilt. Instead of such draconian and

justifiable actions, though, the team leadership bent over backward to try and explain its decisions, to pass along its experience (and mine). For some members, it fell on deaf ears, and I am not at all convinced that they yet understand the fundamental wrong they committed nor the harm they inflicted. It is unfathomable how someone who has limited experience with the demands of the competition could somehow believe that they could speak in the best interests of the team, and, against the hard-won knowledge and experience of the team leadership, and against 14 years' worth of my own experience. Further, a team leader not quite in the limited experience category, backed himself into a corner by imposing a condition upon the team leadership for his continued participation; unfortunately, it is not the place of a single member to dictate such conditions. In my opinion, that leader should not have taken his dispute with the decision to the team at large; that action was, in and of itself, inappropriate and insubordinate.

7.5 The fact that I am putting as much effort into this issue at this time is an indication of my deep concern, distress, and fundamental disgust with this issue. Far too much time and effort went into this issue; time and effort that the team didn't have to waste, yet was forced into. We earned 31st place.

7.6 If you cannot support team leadership, then leave.

7. 2005-2006 After-Action Reports

The following is a compilation of After-Action Reports for the 2005-2006 competition. Five students submitted reports, as well as Sterling Skinner. The 5 student reports have been edited to remove the author's name from each. Dr. C also submitted a report, based on his observation of the e-mail traffic over the year, various off-line correspondences with team leaders, and his perception of the After Action reports submitted here.

One of the most difficult skills you will learn in your professional career is that of being able to accept criticism and learn from it. There is much here to learn; but you must set your emotions aside and LEARN. If you waste your time and effort trying to defend what transpired, you're not paying proper attention to LEARNING from this experience.

It must be understood that the purpose of the after action reports is NOT to criticize individuals. The purpose is NOT to apportion blame. The purpose is TO LEARN from the past, such that we repeat the good parts, and don't repeat mistakes.

Dr. C's After Action Report

You might ask the question "What gives Dr. C the right to make a report, since he wasn't even here?" Folks, I can assess evidence as well as you can. I can weigh the events as they transpired, based on 15 year's experience with the team and the competition. I've learned how to interpret what's behind team correspondence.

If you have access to the e-mail's posted by the team leaders over the year (as I do), look at how many were pleas for help, pleas for folks to step up and complete their tasks, pleas for folks to pitch in and get the car running, ready, tested, developed, pleas to keep the shop clean and organized, postings of to-do lists that didn't really get shorter week after week, and so on and so on. These messages were from folks who well understood the fact that the "just in time" class room survival skill is a recipe for mediocre performance, at best, in the FSAE competition.

There's a common theme in the after action reports below: a lack of preparation in key areas. Two weeks before the event is NOT the time to be pulling together (for the first time) key elements of the competition materials. Competition is NOT the time to be learning lessons, yet again, of how to compete. Yes, it seems that the team did respond to the adversity it faced at competition, but a fair amount of that adversity was of its own making.

I will be blunt; the team had a rare opportunity, and squandered it. What was the opportunity? The team had a near-finished car ONE YEAR BEFORE THE EVENT. None of our competitors of stature, in my memory, has had such an opportunity. No GTMS team since the mid-90's has had such an opportunity (in those days, one could compete a car for two years; the second year team would have a running car for a year of development; those teams generally did pretty well). And yet, we ended up the year in the lowest finish order in our history. Plus, the last few weeks of preparation was just as harried, uncoordinated, and unproductive as any GTMS team that finished a car the day before leaving. What a waste.

We have both an engine dyno and a chassis dyno; were they used?

We have access to the Materials Property Research Lab, where there are MTS machines capable of emulating a shock dyno, and we've used them for such in the past; did we explore this?

We have years' and years' worth of design boards, presentations, design briefs, photographs of competition, the "Idiot's Guide", "The GTMS Guide"; were they used?

We have access to a whole host of engineering modeling tools, from FEA to CFD; did our designers exploit these such that they could tell the design judges what was done, and why, for every system and component?

Did we prepare, well in advance, for the side competitions (do you even know what these are?)?

Did we freeze the design early, or were we still dithering and designing into April and May?

What did we learn that we could tell the judges about design, cost, and business?

Did we train the team that comes next?

Read the “Idiot’s Guide,” and then compare the lessons therein to the lessons in the after action reports that follow. Yes, there are some new points here, but there’s an awful lot that the team learned yet again. In addition to numerous lessons of the pre- and at-competition sections of the “Idiot’s Guide” that were learned yet again, the team breached several of the “Commandments” in the Guide. The Commandments hold special provenance, as failure to observe them is a guarantee of problems at competition. Here are the commandments that evidently were not observed:

1. The team must present for review a completed visual design display, capturing the key analyses, tests, and aspects of the car that make her the best car ever. The design display must be ready by two weeks in advance of the competition, in order to provide you time to revise it.

2. The team must perform the presentation before an audience of myself, Sterling Skinner, Jeff Donnell, and such other professors as are willing to participate. The presentation must be what you intend to give in Detroit/UK, and must be given by the person who has been definitively identified as the presenter in Detroit/UK. The presentation must be performed by two weeks in advance of the competition, in order to provide you time to revise it and present it again.

4. The team must demonstrate to my and/or Sterling's satisfaction that the car is 100% competition ready, and that there will be no last-minute panic in Detroit/overseas trying to track down needed items.

5. The team must demonstrate that the car clearly meets the noise limits imposed by rule.

That the team failed to pass the noise test reveals, yet again, a lack of appreciation of how small details can rise up and smite thee. Perhaps designing a quiet exhaust is unglamorous, but IT KEEPS US OFF THE TRACK IF NOT DONE PROPERLY!

Some things the team should implement:

1) Require submission of design reports for anything that goes on the car. Archive these reports and make them available for future teams.
2) Use the prior years’ cars for development mules; development of new concepts as well as team member development.
3) Formalize the process of competition preparation, in all its myriad complexity.
4) Formalize the team’s expectations of team member performance, and MANAGE TO THOSE EXPECTATIONS.
5) Take advantage of interested alumni. GTMS alumni are generally as passionate about the team now as they were when they were students here. They’re a great resource.
6) Look for ways to use the prior year’s cars for social development of collegial bonds within the team; they’re great cars, and everyone who works on them deserves a shot at driving them. Get to SCCA Autocross events. Link up with Auburn for drive weekends. Get team members into the cars and ignite the passion that will motivate them and carry them through to the competition.
7) Recognize that not everyone wants to drive the cars, that each team members has their own abilities, motivations and passions. Leadership must learn to reward each contribution, not merely time expended. TIME IN THE SHOP IS NOT AN APPROPRIATE MEASURE OF DEDICATION FOR ALL MEMBERS. For example, it’s pointless to expect the sponsorship person to be in the shop for the same number of hours as someone learning to weld; the sponsorship person should be out beating the pavement for support AND THAT EFFORT, AND OTHERS LIKE IT, MUST BE RECOGNIZED AND REWARDED.

There’s a lot more, but this after action report is not the place for such as I think the team needs to undertake.

Watch for a major update to the Idiot’s Guide.

#1 Student Report

This year's competition has left us with a disappointed team. The car, in its final, competition state, was capable of, and during endurance did, produce times equal to the top 10 teams. With a properly tuned engine, the car could have been capable of topping all of those times.

The new braking system performed very well, once it was tested and the bugs sorted out, as did the electrical and shifting systems. The hand clutch worked, but could be better implemented.

The suspension was very well designed and performed very well. Tuning of the suspension went very well, and with working data acquisition systematic improvements were made and then supported by both the data and the driver's feedback. However, the Risse shocks proved inconsistent during testing, supporting our move away from them. It would be nice to have access to a shock dyno.

The tires performed fairly well. They take a little while to warm up compared to the Hoosiers, but they perform very well. This is a very valuable sponsorship, and we must continue to work with Michelin developing these tires. They seem very committed to the development of the tires. This year has proved that the tires are of comparable performance, and with more development, can be superior. And I mean more development on both their and our part.

Machining seemed to go smoother this year than last year. Although, Brian did a large portion of it himself at Dekalb Tech. It is critical that machining go smoothly next year, especially with more of our own machined parts going on the car. A machining schedule should be put together early with input from Dekalb Tech, so that all parts are completed in a timely manner.

The hard line cooling system worked well after the radiator fins were straightened for competition. The data from endurance, a tough event on a warm day, supports this.

The chassis had multiple issues throughout the year. Now we know what to make stronger. Inserts will be used for mounting points on the rear suspension points. We know exactly what the judges are looking for in terms of a front impact structure. We have a well documented front impact attenuator.

The muffling system did not do so well. The thin header held together rather well, but is loud. This may come down to an availability of bent titanium however. The muffler itself was implemented very poorly, by simply slapping on a stock one at comp. I'm sure this didn't help much with the state of the engine tuning either. This problem needs to be solved in the next year, with well done repeatable results for future use.

We were definitely lacking management personnel in the last year and it's only getting worse. A lot of effort must go into recruiting more members this year, beginning now, in summer. We must continue to pass knowledge along to younger members and for this we need younger members.

Team productivity must go up. We need to be more motivated. 52nd place proves this.

However, when the team fails to pass along knowledge, outside resources are usually available. Last year's incident with powertrain left a hole in the powertrain team of this year's knowledge. As far as I know, no effort was put into researching proper engine tuning methods. Our valuable engine dynamometer went completely unused.

I believe proper priorities must be implemented as well. Basic design requirements and establishing a baseline from which to tune must take priority before all other things. Developments must have a starting point from which to measure their improvement, else they don't really prove anything. Many things may work on other cars, but our car is a special case and this does not hold true. For example, in few other cases does less tire contact patch lead to more grip. After this baseline has been established, then improvement can be and documented. That is what the design judges seem to be looking for as well. A working baseline is also much more useful than a half completed development and does not hold back the rest of the team.

As far as the competition itself goes: After going through Tech the first time, the team was able to efficiently make all of the necessary changes to the car, in order for it to pass on the second attempt. The autocross Friday also went well. One run was made, tires were quickly changed to suit conditions, and three more runs were completed, earning us a quick enough time for the afternoon run in endurance. Minus all of the fuel issues, endurance went very smoothly trackside as well.

The autocross and skid pad events went poorly. The fuel issues rendered the team confused, and we were lucky to get times in. Track side operations were also disorganized, and adjustments to the car for the different events were not properly accomplished. The wet track slowed everyone down, but we should have been faster in these events.

#2 Student Report

Things that we did well:
- We worked together and listened to each other respectfully and fairly well, specifically in times of high pressure/stress.
- We were focused
- We dealt with the judges during tech inspection very well, despite the front frame challenges presented.

Things that we did wrong:
- We should have run a finalized fuel map instead of an “almost done” rich fuel map.
- In the spring, we should have made sure our corrected front design was in compliance with the new rules before changing it
- We should have prepared for our design presentations better and highlighted more key accomplishments
- We should have checked our sound level before competition and made sure we were actually under 110dB rather than just assuming it would pass, and then running with the heavier stock muffler when we didn’t pass tech.
- We should have practiced more driver training in the rain
- We should have run the telemetry system during the endurance race so that we could have leaned out the map during the event and at least finished the race.

#3 Student Report

Positives:

We managed to fix everything necessary to make it through tech inspection. This required a few hours of solid and intense work from a number of people. Nearly everyone on the team did what they could to expedite the process of passing tech.

Trailer organization: The members who knew where the tools were did an exceptional job of getting tools to those working on the car. Without these people getting the car through tech possibly would have taken twice as long.

We attempted all events. There were a number of top teams that did not participate in all of the dynamic events. After the fuel pump swap during acceleration/skidpad, we changed our strategy to ensure that we at least got a time in both of those events. We also made it to the other 2 dynamic events even if we failed to finish the important one.

Overall team attitude: I did not see much blaming during the hard times. I saw much support and hard work from most members.

Negatives:

We did not do exceptionally in ANY dynamic events (but we did perform acceptably in autocross). None of these are due to driver fault, as I see it. Acceleration and skidpad did not go well because of two reasons: The engine mapping was unacceptable and the team squandered the one opportunity it had to drive in the rain. We knew that skidpad and accel would likely be in the rain when we were testing at Auburn, yet when the rain started during our testing, the call was made to have one driver do engine tuning in the rain rather than have 4 drivers figure out the car dynamics in the rain. This produced poor accel and skidpad results, and did not result in a drivable engine map. In endurance, we ran out of gas. I do not know the full reason why, but I think it is a combination of a gas tank that would not fill to capacity on the first try and poor engine mapping.

Not everyone helped when they could. I noticed a couple team members doing nothing during key work times more often than I noticed them doing anything constructive. In future years I will advocate examining who is going to competition before we get there. If you do not carry your weight, your presence becomes a liability rather than an asset.

Knowledge of the rules:
The time to realize rules is not 3 hours before tech closes on day 1. It is when you are designing the system. The only things that should be fixed during tech inspection are things that the judges are being overly picky about. We should have no quick fixes on the car for things that are blatantly in the rules.

Tech inspection: Whoever receives the important tech documents at registration should either be held responsible for them during the rest of the competition or should give them to somebody else to be responsible for them. We should know where structural equivalency forms are prior to being asked for them. We should not have to go searching for the tech inspection documents.

Design presentation: Prepare for it. What happened this year was unacceptable. We need to be ready for questions, know the right answers, and pay attention to what the judges want. When they tell you that your introduction has been too long already, don't continue it, hand it over to them so that they can ask questions. The tent should not be used as an easel. It was the best solution that morning, but was still completely unacceptable, especially considering how long we had to think of a solution (2 years).

Preparedness: It is an atrocity that after 2 years we still did not have a car that was complete when we arrived at competition.

#4 Student Report
After Action Report Detroit 2006

Things We Did Well:

- Under extreme pressure, we worked quickly and efficiently, (example: making chassis changes to pass tech.
- Split up responsibilities, creating a more efficient team.
- Got to the competition on time every day.
- Car looked good visually
- Loading the trailer
- Preparation for the endurance (bolt check etc.)
- Uniforms and jackets were perfect
- Bringing everything we thought we could need, we only had to request a couple of things.
- Competing in all of the events

Things That Need Improvement:

- We were not properly prepared for the design and presentation events.
- Our car's chassis did not pass the tech inspection.
- Go over the entire car before competition, and find the obvious things that do not pass tech. (2nd throttle spring)
- The car should be ready to go to tech upon arrival
- Many members of the team were not interested in working.
- Need more engine tuning prior to the event, and should make use of the "practice time" if at all possible for overall trims to match the competition fuel.
- Make use of practice time before autocross to scrub in tires.
- The car is much too heavy. 4 more pounds and we would not have had any chance at design finals.
- Need to test on the fuel that we will be given at comp.
- Presentation should be prepared months in advance
- Design boards/ dry runs should be done months in advance.
- Team meetings every week!

- Get a sound meter, so that we can find out what muffler is going to pass before competition, and tune on that one.
- Don't lose the trailer keys
- Organize the trailer far in advance, so that everyone knows where things are.
- Plan ahead for lunches, so that everyone who has been working hard all morning can eat
- Replace/clean fuel system components prior to competition. (hours and hours of testing, yet we still ran out of gas due to a FPR failure)
- ORGANIZATION (too many things were lost leading up to competition, and during competition.)
- Reports, it is my feeling that every time some critical findings or research is done on any section of the car, it should be written and documented. This will make design boards, preparation for design, and design of cars in the future much easier.

#5 Student Report

Things done properly:

- The paddock and trailer were both kept free of trash and debris, in addition to being properly organized so that tools and supplies could be readily found and given to runners to meet the needs of the track crew.
- All of the necessary materials were packed to deal with a failure of the major components.

Things to change:

- All presentations need to be finished prior to the Detroit competition and practiced. Additionally, the content of the presentations needs to be exactly what the judges are asking for in terms of content, delivery, etc.
- Both the muffler and the headers need to be reevaluated so that they pass tech inspection on the first try. A sound meter test needs to be done prior to traveling to Detroit and a lighter muffler needs to be found.
- The trailer needs to be checked for flat tires, stripped lugs, loose lugs, etc. prior to leaving Atlanta (this should all be fixed by the new trailer.)
- The schedule for the week of competition needs to be sent out at least a week before the date the team leaves to ensure everyone knows what's going on and when to be where (no more of this assuming people will look stuff up.)
- In the new trailer there need to be system specific cabinets that are labeled on the outside so that everyone can find all of the items that are necessary.
- Team members need to be reminded to bring a camera, binoculars for watching the dynamic events, and a stop watch or two among the team for timing the cars.
- Subsystem leaders need to choose an apprentice at the beginning of their senior year to train for the following year so that we don't have most of the senior management on the team graduating and leaving none of the knowledge behind.
- New drivers need to be trained for next year. Using 51 for driving and tuning practice could be helpful.
- More time needs to be spent tuning effectively. Maps for the different dynamic events specifically could also be helpful. Maybe a program could be written for the endurance event using the 2 way telemetry system to automatically adjust the amount of fuel injected to the amount of fuel used and the amount remaining.
- All paperwork and forms for tech inspection, waivers, and the like need to be printed and kept in a folder to avoid misplacing them.
- If a projector is going to be used for the business presentation, it needs to be borrowed and tested prior to leaving Atlanta.
- More detailed records of purchases need to be kept (use of a standard purchasing form could be useful.)
- Hotel reservations need to be made with actual dates of travel in mind, not just the dates of the competition.

#6 STERLING SKINNER
A summary of the 2006 Formula SAE event at the Ford Proving Grounds from Sterling Skinner's perspective. This year is the 20th competition from when GTMS first started competing in 1987 when Sterling Skinner was a freshman.

Preparing the Race Car in the Student Competition Center

The Bad: The gtms team has been the largest contributor to the mess in the Student Competition Center. The party to honor Paul Allen had more than one school administrator walking away wondering why the place was such a mess. It was the GTMS area that was in the worst condition.

The Good: The team has made improvement in having an ethnic and gender diverse team this year over some previous years.

Trip up to Detroit

The Bad: The trailer must be prepared early and well. Two flat tires could have been disastrous. This even goes for a brand new trailer. It can't be overloaded and expected to roll smoothly all the way to Detroit. New trailers are notorious for having the cheapest tires on the market on them when they roll off the assembly line. Maybe it is time to buy smaller generators and lighter welding equipment to not overload the trailer. Maybe two slightly smaller trailers (one for the car and spare parts and the other for the tools) would be the way to go. The trailer breakage has been a problem for many years and I don't think that will completely change with a new trailer if we continue to load it the way we have been.

The Good: The team worked hard to get to the competition DESPITE the two flat tires. The team had prepared and were resourceful enough to have the spare tires even though the new trailer wasn't available as it was thought. Someone could say that the welders and heavy equipment aren't needed, but they were certainly used this year in getting the front tubes re-welded to meet the judges' wishes.

Cost Event

The Bad: We typically have a sophisticated car, so we often give up points on this… however look at the winning car's score. They won Endurance/Fuel Economy AND did well in the cost analysis because their car was simple. So, they have proven that you don't have to do well in either the dynamic events or the cost event. A well designed car can and must do well in both. Cheap cars aren't necessarily slow, and expensive cars aren't necessarily fast!!!! The cost event is not an event that should have only one or two people working on it, it needs a complete system approach from the beginning design of the car (just as in real life).

The Good: The cost report preparation is one of the somewhat unglamorous portions of the competition, and yet certain members of the team stepped forward and got it done and defended it. As far as I know it was on-time and wasn't neglected.

Design Presentation

The Bad: I heard that the projector didn't work well because it was borrowed and we weren't trained to set it up well. So, next time check out the projector EARLY and practice everything the night before in the hotel room so that it is working perfectly. For more than one year the team has called me at ~8pm the night that the team leaves in order to check out a projector. I drive back down to work so that they can get a projector for the competition. This year it was completely forgotten, I suppose. I had several projectors sitting near my office that could have been used.

The Good: I heard that the presenters quickly smoothed over the technical difficulties and continued with the presentation on the laptop screen without panicking. The emphasis was kept on the presentation of a great race car and not the technical difficulties.

Design Event

The Bad: The only way to get our design score back in line is to listen to the judges discuss the 5 design finalists cars and to take lots of notes. I was there this year at the GM tech center early on Sunday morning and was very humbled by the detail of what the judges were looking for in methodology and systematic design. We weren't even CLOSE to getting into the design finals. We missed it by 10 miles. The top 5 team's design boards were huge and amazing!! They had aerodynamic models of how the brakes would be cooled, they have in-depth engineering studies of just about everything, they had spare parts and rapid prototype models of so many things to show the judges. They had a history of how the mass of certain components on their cars have continued to decrease from year to year. A team in the design finals has been preparing for that for years, not just a few weeks. The design boards must be started months ahead of time so they can be refined and refined based on feedback from team alumni, not days ahead of the competition. The GM tech center was packed with the other teams and everyone was taking notes and making videos of the judge's comments. There was not ONE GTMS team member there. I would suggest that somebody get on the fsae.com forum and ask to purchase the video from another team. There were many video recorders running the entire time. It seemed that so many other teams were HUNGRY to do better in design for 2007 and it showed by their taking notes and video taping and hanging on the judges' words and asking the judges more and more questions about what they didn't understand. All the while, the gt motorsports team was trying to get to the correct location. This was the biggest and most avoidable mistake of the entire weekend, in my opinion.

The Good: The car is well designed as it has been for some time. The judges have always liked our designs *when we have been prepared to answer their questions with design methodology and proof through various visual aids.*

Static Tech Inspection

The Bad: Apparently there were 5 areas in which we didn't pass the static tech inspection. Firewall, fuel line too close exhaust, safety wire on some nuts, crush zone not braced correctly, maybe a leak?, etc. I wasn't at the competition at that point so I am not sure. Getting through tech inspection early is a very very important thing that sets the tone for the entire event. If we don't pass on Wednesday, then we are already behind and have never caught up in the past. The years we have done well have been years in which the car went through static tech easily. The car is not finished until it is prepared for going into the static tech inspection. Therefore, it was clear that our GTMS entry this year was not finished until the night before leaving for the competition when the push-bar and the fuel rail anchors and other such items were being added. The "Idiots Guide" says over and over…"Finish the car early"…. This wording should be changed in every instance to something like: *The car's success at the competition is correlated most directly to how early it is completed in a competition ready configuration, i.e. ready for entering the tech inspection. The car is not "finished" in any sense until it is ready to easily pass all sections of the technical inspection, both static and dynamic.*

The Good: The team was flexible and prepared for last minute alterations on the car due to the judges' interpretations. The front tubes were cut and re-welded to the judges' liking without looking for a welder. The team was self-sufficient and prepared for the unexpected.

Dynamic Tech Inspection, Brake and Noise

The Bad: Over and over again this team has not passed the noise portion of the brake and noise test. We registered 120 dB when we needed to be under 110 dB. We weren't even close. Adjusting the car and then getting back in line put the team more into a frenzy and used more nervous energy. This makes everyone tired, and tired people don't drive and think well. It wears the whole team out to keep going back to the tech inspection. That is precious energy!

The Good: The team had a backup muffler that was very quiet handy. Preparedness got the team through re-tech inspection with minimum delay without having to fabricate or re-assemble the muffler as

in previous years. I noticed that extra muffler packing was brought to the competition, …which was another level of preparedness.

Skid Pad

The Bad: The car wasn't running well. I am not sure if that was because we really got E85 in our tank, or because the 100 octane at the competition was nothing like the 100 octane that we buy in Georgia. The team should investigate this issue well. However, at least one driver got confused and went the wrong way during the event, so more driver practice (or a more rested mind) would have helped this event.

The Good: The team got in line in time and got times despite some horrible weather conditions. The team had both rain tires and slicks mounted and ready to go depending on what the weather did.

Acceleration Event

Similar to Skid Pad.

AutoX Event

The Bad: The car was running better with the new tank of fuel and the fuel lines flushed out. We were still only 25th place (Southern Tech was 6th!). Why weren't we faster?? Maybe it was driver practice, and maybe the fuel map was very rich because it had been changed after the morning events. The team must investigate this. The car's times in the Endurance event were very good, so it wasn't the design of the car. The tires may have taken especially long to warm up which really hurts in the AutoX event but not in the endurance event as much.

The Good: The team worked to quickly change the fuel pump, make a diagnosis of the erratic running of the car, and get new fuel so that the AutoX event wouldn't be affected. The team was on time and got into the faster run group of the endurance event which is SO important to doing well in the endurance event. In other years the team has really messed up the AutoX event and then been in the SLOW running of the endurance event. This year the team was in the faster run group.

Endurance/Fuel Economy

The Bad: The car ran out of gas. The engine was just running too rich for some reason. It is certainly possible to pass the fuel economy run with a 600 cc engine. But somehow we were injecting too much fuel. My only ideas on this are that the fuel map had been changed to try to make the car run better after the problems on Friday morning, or that changing the muffler system in order to pass brake and noise made the engine map no longer correct. I suspect the former. It just shows that everything keeps adding up and that level, clear-thinking, rested brains are absolutely necessary. Was the oxygen sensor checked after the AutoX event to see if the engine was running well? This is not the first time that the fuel map was changed at the competition, and it has gotten us in trouble before.

The Good: Just before the car ran out of gas it was FAST. We were right on the University of Florida's tail for many many laps until they finished their run. They weren't pulling away at all, and they took SECOND place in the endurance event. One driver spun the car once and yet kept the engine running and lost VERY little time getting the car back on course.

Design Finals

The Bad: The biggest mistake and the most easily avoidable mistake of the entire competition was that the team was not present at the design finals on Sunday morning. It was there that I knew that the team was not hungry for victory at the California competition.

Awards Banquet

The Bad: The team wasn't mentioned one single time at the award's banquet. The team didn't place in any event or any of the special awards such as the composites, cooling, brake, suspension design, etc. This shows that the team didn't loose first place at the competition because of some small problem outside the team's control such as getting some bad fuel or even because the engine didn't have 3 more horsepower or because the chassis needed to be a little stiffer.

The Good: The team arrived for the banquet and was there to cheer on the other teams which squarely beat us in so many events. Not showing would have been as a sore-looser.

Overall Comments

When does the next competition begin? May of 2007? Nope, it already began at the closing of the awards banquet a few weeks ago. There are only so many hours in everyone's day between now and presenting the car to the technical inspectors next May. The team can't work harder than it has been working after January 1st of every year. In fact, it must work a little less during the spring to keep everyone's grades and health in a better situation. The only time that the team can work harder is during the summer, during the fall semester, and during Christmas break. I can tell you how the team will do in May just by looking at the status when returning from Christmas break. The spring must be used for driver practice, refining the design boards, getting all the bugs out of the car, practicing the presentation, and having a big unveiling celebration. The spring is NOT for furiously trying to layup the competition-spec intake manifold, or waiting for the brake calipers to come back from DeKalb Tech, or making 100 phone calls to the supplier of the axles hoping to push them to finally ship them, or panicking when the newly ceramic-coated pistons are damaged in shipping.

Simple cars can be built quickly, and cars that are finished early can be finely-tuned. Those are the cars that will win. Would we have done any worse without the air-shifter or better with the dynamic intake?

Luck favors the mind that is prepared. -- Louis Pasteur 1822

8. 2004-2005 After-Action Reports

The Student-contributed 2004-2005 After Action reports will be available to the team at large once all current and former members who were part of that team have graduated.

The best lesson from that year (and ’03-’04) is contained within the “Ethical conduct when you disagree with GTMS team leadership, or, the “one shot” rule” section. The following is a take in the year that I’d sent the team.

Some Brief Thoughts From Dr. C.
My thoughts on this past year reflect a frustration with the events over the entire course of the year, and my hope for the future. For all of the sound and fury of the team after the 2004 event, that idealism, that drive “to do it right” faded over the year, and we ended up as well you know.

Things that struck me over the year:
1) The leadership repeatedly accepted less than responsible conduct from its own members. Individuals would repeatedly make commitments for completion of a task, but that task would not be completed, and the cycle would repeat again and again. **Leaders must lead**. If you’re in that leadership meeting, you’re not just a mere member; you’re a **leader**; act like one. If you take on a responsibility, discharge it to the best of your ability. If you come up short, be forthright and ask for assistance; don’t dissemble, make excuses, or shirk what you have taken on.

2) Design activities seemed ill-focused, and coordination between design and fabrication activities, particularly with DeKalb Tech, seemed almost lacking in any sort of coordination. If the leadership doesn’t know where design and fabrication stands, how can you ever reasonably manage your schedule and resources?

3) The team didn’t drive; too many members have never felt the outright thrill of one of these fine cars coming alive around them, felt what 0-60 in 3.5 does to your heart rate, felt the addiction that this experience conveys to those fortunate enough to have lived it. **DRIVE THE CARS MORE!**

As always, I am hopeful for the future. GTMotorsports is a learning, evolving entity, and its members will take from this past year the experience that, if properly applied, will return the team to the pinnacle it has scaled in the past. The alumni in the area are available to help the team as much as they can; they’re an incredible resource, and I encourage you to involve them in some active way with the team.

I can’t add much more than what I’ve written up in the past in the “Idiot’s Guide”; it’s your team, it’s your responsibility, it’s your passion, it’s in your hands.

9. 2003-2004 After-Action Reports

#1

Competition this year had many good parts and some bad things.
Bad: The car was untested. We only had about 4 hours of drive time before competition, so little that I had never been in the car before we got to Detroit. That is really bad, but was the harsh reality we had to deal with. No checklists this year, it didn't hurt us, but that could be because of luck and or a lot of experience at previous competitions which is a luxury we won't always have. The only major problem which all of these items go back to is not getting the car done early enough. That coupled with this years pre-comp drama caused a lot of time to be wasted that could have been spent testing and preparing for comp.

We need to fix the tool cart and actually use it. Also bad was not checking the lugs on the trailer, maybe we should make a checklist for the trailer, torque them with a torque wrench (75 ft-lbs). Also need to fix the electrical as there is still a grounding issue w/ the new wiring, it was fixed at one time, but the new additions have caused another problem. Also, bringing bags of dry cement was not the best idea ever.

Good: The team performed quite well as a whole at competition this year. Everyone worked well together, and I was able to find people when I needed them. The paddock was beautiful, trailer was nice to work out of, the new shelving was great, as was reducing the number of gray bins we bring. After the good packing job of Australia this year we reanalyzed what we actually use at comp and had everything we needed, the packing lists were updated and well documented. Not bringing the welder, generator, and old car was a good idea, I would also recommend always bringing the tire mounter, unless the team has 3 sets of rims in which they can have their wets mounted on rims ready to go. If that is the case then I would not bring the tire mounter because it is a bit of a hassle.

Although the car was behind in development it came to comp ready to go. There were not any nights where anybody had to stay overnight to work on the car. Everyone got a lot of sleep, that was a great improvement over previous years. I don't ever remember using the hotels this much, we do need to try and get out of the paddock earlier in the day if possible, but still a great improvement over years previous.

Another long term problem we have always had with pre-comp preparation is that we always wait until the last minute to work on the trailer. The team should focus on the trailer preparation and comp equipment preparation in the Fall. Here is a quick list of things that should be done this Fall before the next comp:

Trailer Maintenance: Wiring issues, paint it, install new axles w/ higher load rating, or look at buying a new trailer, maybe share the cost w/ Baja or get the ME school to go for it, but get a good trailer w/ high load capacity. Currently those axles have 750 lb ratings each, bringing the entire load capacity of the trailer to 1500 lbs, w/ about 1100 lbs of trailer that leaves only 400 lbs of payload capacity with a 450 lb car that means any tools or supplies we bring are overloading the axles. (I'm not sure I buy this weight capacity on the trailer. Dr. C.)

Build a new tent for the side of the trailer, or do a permanent rig for the new white tent we have. Get buckets and fill them w/ concrete and just throw them in the back of the diesel as it has all the payload capacity in the world.

Also, fix the tool cart and test it, drag it around for a long time to make sure it is durable and reliable.

#2

What was done right:

1. Team organization at comp. With runners in both the paddock and with the car, along with a number of other people about, it never seemed to take any longer to get something to the car from paddock than it took to find it. I would like the team run the same way at comp next time.

2. General team dedication. Everybody busted their butts to get this car done. The car's lateness was due to different reasons.
3.

What went wrong:

1. Design. To the best of my knowledge, the only parts that were designed were what's in "the whole package" Autocad file in the office. Basically, the steering rack, frame, suspension points, uprights, rotors, calipers, motor, and differential were the only things that we had planned for placement on the car. Although these things make up the basis of the car, there are many other things that had to merely be rigged on there however they were found to fit. They often had to be done several times over to boot. Preventing this sort of thing from happening again is my personal goal for the team.
2. Passage of knowledge of the car onto new team members. Maybe it was just me, although I was more than just barely involved in team, but although I did often express interest in seeing what sort of engineering analysis was done on the car, I don't ever recall having even 5 minutes of time given to showing new members how we decide what goes on the car. It is also possible that I missed most of the design part, as I started in the fall. To be honest, from what I've seen and heard, it would take a significant amount of demonstration to convince me that the people who designed this car have a significantly deeper understanding of the car than I do. Last I heard was that the suspension geometry is exactly the same as 21's. The brake system is the exact same one as last years, despite hearing how we've known it doesn't work for some time. I could go on and on, but I'll just cut it off and say that I have been very confused and disappointed about the design work that has gone into the car.

What needs to be changed:

1. Design, design, design, design!! Or perhaps more accurately, planning. I firmly believe that all components of the car should be fit in BEFORE we start cutting and drilling. A sharpie and a ruler will get the job done eventually, but it'll be messy and less than optimal.
2. New members need to be guided, not dismissed for not knowing. Give them the engineering reason for the design, and tell them that they need to do a bit of research to prove that it should be done their way. They don't see the older members do the research, so they don't assume that they need to research their suggestion.
3. Keep an open mind. One of the things I've always hated about motorsports in general is that more than any other pastime I'm aware of, the people involved are know-it-alls. Yes you might have designed the XXX (fill in your personal favorite design component for XXX), but that doesn't mean you are the final word on the system, or that you haven't missed something. A new person might be on the right track, even though they may not be fully able to explain why.

#3

I will begin by saying that I believe we built a great car this year. It is disappointing to see that she was not used to her full potential due to the extremely late finish. Also, before I continue I would like to note that disassembling 4 might need to be reconsidered. While this would be a great opportunity to learn, it will only put us behind on starting our new car. Correct me if I am wrong, but all the knowledge from disassembling her can be gained from building and designing the new car. Also, if she is pulled then she is more likely to end up on the floor like previous cars.

<u>Pre-Detroit</u>

- As a part of the union, there were many, many nights were we finished a small set of tasks and then did not know what else needed to be accomplished. It is obvious that there was plenty to do, but due to the lack of organization from leadership or maybe just a lack of to do lists, there was a labor force as well as work to be done, but no one to connect the two.
- I cannot begin to count how many times "we did it in the past" was the answer to "why?" If it works, then great, but do we know why it works? I seem to remember a phrase "an inherited evolution." We are capable of much better than this and can "out engineer" the other teams, so why are we settling for what used to work?

- If you start building a system and someone else for some reason finishes it, make sure you talk to them. You might think they know what you were planning, but more than likely parts will be remade and it will end up nothing like it was originally planned. This can also help people to understand systems more thoroughly.
- The leadership who took new people and showed them how to complete tasks or help out, they were irreplaceable. For those who were the "only ones" who could do their work, new people learned nothing and your work was completed inefficiently and slowly.
- If there are a limited number of people who have a particular skill and no one else is allowed to perform this particular skill to the car, then maybe those who are allowed to perform this particular task should be there! There were many nights that work came to a standstill because everything was waiting on a certain piece to be finished.
- If we are going to run Wiggins clamps, then can we please buy the all the parts. Saving money only works if your machined part is exactly the same as the one you should have bought.
- If you want the head machinist to make a part, give him a properly dimensioned drawing. This goes for word of mouth parts too (even though we should design everything to begin with). Way too many parts were made multiple times due to a lack of communication or inaccuracy.
- I thought there was a team meeting at 5 on Fridays? This would have really helped in knowing what was going on, where we stood, what needed to be done, etc.

Detroit

- The team works very well together in general. After the issues that arose just weeks before Detroit, I was very happy to see us work well together. It made things run easier. You could watch other teams and tell there were issues between people that thankfully we did not have to deal with.
- Check list would be a great idea. Although people seemed to be fairly informed at comp, list would have still made things more efficient.
- Better communication about meeting times is needed. It should be obvious to announce to EVERYONE what time we should meet, but I guess not.

Final Notes

- We need more communication in every circumstance from leadership to new people. It isn't always obvious to us. If there had of been more communication, all of the new people might have a better idea of what was going on, what was going wrong and what needs to be fixed for next year. I know I asked many questions, but was still in the dark about things, because people weren't talking. New people are the future of this team.
- I believe that more non-shop activities could help bring this team closer and help the new people get to know leadership at the beginning of the year. Especially at the beginning when leadership is running around like crazy trying to find something for people to do. A more laid back environment would be much better to get to know your leadership and team members in.
- Through everything that happened this year, I believe the team held together very well in Detroit and even in 31st place, I was proud to be a part of this team.

#4

This year the team had a hard time and the final position reflected that fact.

Things that we did well:

Tech inspection-

The team displayed its experience in competing by getting to tech early and getting out early as well. The few changes that were needed (ie. Muffler mounting position) were finished quickly so that our time in the tech tent was short. Brake and noise was completed on the first try although we barely skimmed through with a reading of 110.5 dB. Nevertheless this prepared us for a good start because we could focus on competing and not just fixing things we should have done right the first time.

Early to queue-

For once the car was actually in line for every event before each event opened. This simple task is paramount to a good finish because the weather in Detroit sucks and it will always rain when you try

and get to an event right before it closes. Our decent finish in autocross can be credited to this as we had the luxury of running on a dry track unlike many other teams.

The paddock-

The pit area was very well maintained which made it easy to get work done and also showed the professionalism of the team. The nicely laid croco-tile, decently sturdy awning, and overall state of cleanliness made the pit look like that of a real race team and both our competitors and the judges noticed.

Teamwork-

Although the team tried to eat itself before comp, we were still able to pull together during comp. It was good to see how well everyone worked together, completed their tasks, and were always standing ready for the next assignment. This is a criterion that cannot be taken lightly and I am glad to say that although it wasn't perfect, it was good.

Things that we did badly:

Preparation-

We went in knowing that we had problems and we didn't place well because of it. The cooling system, charging system, suspension setup, lack of practice time, the organization of those in the hot area, and nearly everything else that comes from driving time and testing was inadequate and unacceptable. We had problems that we knew about and that had not been fixed and it is impossible to make it through endurance or even lay down competitive times when the car is not absolutely sound. The team processes some of the greatest engineering talent in the world and once we cross this barrier we are unbeatable (e.g., Australia and England, twice).

This is a hard goal to meet. It requires steadfast determination and many long nights. For the team to be prepared enough to compete successfully we must have a car engineered to the fullest of our capability that runs as soon as possible. We need to know what is going to break, where it's going to break, and the easiest way to fix it before the car goes in the trailer. So we just got to get it done.

Design-

We didn't even make design semifinals and that is not due to a mysterious grudge or any other conspiracy theory. The judges said that we inherited a good design and now don't understand it. They were right. So many of the design decisions were based on the fact that "we did this in the past and it works" and this is unacceptable. Before anything is implemented on the car it is imperative that we must know why it is being implemented. When asked questions pertaining to the design of the car and a simple "I don't know" is given it appears to the judges that we didn't consider that topic and didn't design the car with those goals in mind. This is an occurrence that happens way too often.

To fix this we need real engineering. We need to use all of the stuff we learned in class and build this racecar as if we were real race car engineers. Then after all the numbers have been crunched it, we test it, and we test it again and again until we know that it is bulletproof and then it goes on the car. Then we organize and annotate all the data we collected and take it to the judges. We also archive it and give to future teams so that they know why we did it like that. This is not even as difficult as it sounds as we have the database to support it and the knowledge to conceive it.

Things to do for next year:

Analysis-

We need to apply our engineering knowledge to make sure that our car is designed to the best of our capabilities. The calculations and application of theorems how you bridge the gap between close enough and correct and that is what we need to start doing. Before a part goes on the car or even goes into consideration we must have done the work to make sure that it will be as strong as needed and as light as possible.

Comp practice-

One of the things that would help greatly at competition is having practiced fielding a car. The experience gained from working on the car in a hot pit setting is invaluable at comp (e.g., less running

back and forth to get things that should have already been in the tool box). The best ways to gain this experience is at SCCA autocrosses and by working out of the trailer during testing before comp. We handled the last competition experience well, but it could have been better.

Driver Training-

Now more than ever we are at a huge deficit of driving experience. For the betterment of team morale and to make sure we can drive these cars as fast as possible we need to get seat time. In other words, we need a place to drive. Now that comp is over and the driver time trials issue has been sedated it does not mean that a place to drive isn't still an imperative topic.

Checklists:

Just a minor detail that we really to use next year at comp. The use of checklists help to make everyone clear of their responsibilities and also makes sure that the preventative maintenance (e.g., empty catch cans, bolt check, CHARGE BATTERY) gets done and is done consistently. Its always the little things that can make or break us at comp.

#5

-Presentation Event

-Sales and Marketing (*Note from Dr. C: the presentation event judges may more closely adhere to the actual rules next year, such that some of the comments in this report may not be valid next year)*

The judges made a big deal about focusing on selling the car. The entire business aspect was what they cared about. They commented on knowing who the judges are and being able to convince them that that is the best design. They want you to be able to understand your design, as well as the cost of it and the manufacturing process(detailed manufacturing, pictures of our setup would be nice for carbon fiber bodies and such). They want floor space needed, how much you would sell the design for, prospective customers, how many units you would need to sell to break even, how many units they could actually sell.

-Content, Organization

Outlines are good, that say OUTLINE. As well as a conclusion that concludes stuff. They were really big into this aspect saying they want good outlines that tell them what they are going to see. it is a good idea to have an outline at the top showing the progress of the presentation so they know where they are in the presentation, i.e. what info they have seen, and what they will soon know.

-Delivery

They want you to introduce the presenters(chief engineer, presenter etc, you can actually say that this person here is solely here to answer questions.) Person presenting should be confident, as well as answers given should be confident answers, they don't even have to be right, just confident. ALWAYS give a rough answer (Numbers are not important), it is better than saying you don't know. A quick, convincing and persuasive answer is best. To get to the top: Use time wisely. i.e. Pass out brochures/flyers/visual aids/parts while setting up so they have time to look at it and are distracted from seeing you set it up. However, do not give them really complicated things that they will be distracted from the presentation with so they can hear what you say. Good idea is to have specs on the sheet so they can refer back to it while they are grading you and quick facts on the flyer so they remember things they may have missed when they were writing info down.(or bored because they hear 130 other teams saying similar things) MAKE SURE: To comment on the handout, and run through it with them, or tell them its there or what it is for. The official ten minutes doesn't start when you are passing out materials. You want to relax judges. USE ALL TEN minutes. There will be a minimum of 6 questions: 2 on each subject, take about 1 minute to answer each question. -Practice the entire set up, including setting up the design boards if assembly is required, and passing out flyers etc.

It is good idea to have a picture of the car in the background so they will know what it looks like.

-Design

Have a basic description of the car, don't get too technical. Good idea is to basically only say what makes your design different/unique. Use a pamphlet to tell them exact numbers so they can refer to it if they wanted.

-Manufacturing and Cost
Tell them what Proposed selling price is. As well as the tooling and equipment needed. The inventory needed. The size of the plant and the layout that would work well. A good idea is to actually say the number of different size tubes used in the chassis. A good estimate of the initial cost, and a cost flow analysis explaining the marketing side. Explain what was needed to manufacture. A Royalty percentage is acceptable for cost.

-Conclusion
Explain why to use your design, and explain who we are, what we are, what we got, explain it as if this is your only car.

During competition:
Why did we wait to run autocross? 5 cars ahead of us were plenty enough. In reality we only needed 5 max because if you calculate it out, the benefits from getting rid of the junk on the track are not extreme. 5 cars run 2 laps for each driver, which is 4 laps per car, with 5 cars running is 20 runs ahead of you. If there is ANY possibility of rain, you should be the 5th car and get an acceptable SAFE run in, and then with second driver, being the 20th lap on the track you will have a clean track to run before it rains.

Hard Lines-
I must emphasize that hard lines are really not a good idea. If anything has to be changed or checked, especially with our enormous cooling problems you can not effectively squeeze the tubes to get rid of air, or exchange tubes quickly to put clear ones on for testing, and when reassembling it makes it rather hard when in such tight spaces. Components have to be taken out at times just to fit a hard line in. There is no worth in hardlines taking all the other factors into account. Also the tubes when welded do not provide smooth surfaces on the interior possibly causing buildup (just a thought, I do not know).

The Judge speaking to us:
-Last years car does not matter was emphasized more than anything. It is a new year with a new car, so we need to know the basic vehicle dynamics, evolutions are ok if we know the basics behind it and FULLY understand the systems.
-Judges see you, ARRIVE RACE READY, even small changes do not look good. As well as zip ties hanging loose, or unheatshrinked wiring. All these things should be done at home, no exception. –
His personal opinion is that you need the fundamentals, and reasoning should not be because the FDA, or CDA says.
-Tire reads tell everything, perhaps we should take good photos of tires after we do mock enduro for design. Or bring in an actual used tire we tested.
-The little things are what set you apart, they are very important.
-Having a hard brake pedal, and not heavy steering is crucial.
-Explain our throttle response, it is a key phrase with design judges(or him only).
-Know what compromises we took with rear rotors, axle lengths, etc so we explain the engineering aspect of our design, what we did and why.
Damper curves would be very nice to show.

During Enduro-
Better communication is a must. The headset people inside the track should constantly be watching the flaggers and the car so that when a Passing flag is shown the driver immediately gets in the passing lane. Also each group of people watching need to have a walkie talkie so information can be passed more efficiently. More walkie-talkies next year, with batteries that work! (I might suggest the team buy its own radios, instead of relying on mine! Dr. C.)

Setting up/packing-
I believe we should set up as a team, and pack as a team. The more people that know where things are make life easier. I say this in the essence that if the person is not doing anything, they should be helping to pack or unpack. If you are busy with anything by all means use your time wisely and with common sense. The more people helping to put things in and out of the trailer really help save time and energy

and make this more of a team effort rather than a master/slave relationship between the team members. More than one person should know how to pack/unpack the trailer.

-Food
More food more often. Perhaps more of a snack situation rather than meals. None of us ever seemed to be starving entirely, but at times were rather hungry in between meals, especially before lunch. Maybe nutrigrain bars or something similar would really help that situation.

-Heading Home
When driving do not hit deer on the highway traveling at 80+mph. Deers explode and cars hit rails and then you have to sit there and have a million people stop and ask you if you are alive, even after the car is pushed into the median off the highway, and the deer is disposed of. Dead animals are not pretty. And being a 3 hours drive from home (6 hours total for the ones picking you up) and having a flight in 8 hours is not fun, time is not your friend. :)

#6
Things we did well;

- The team worked well together in a quick manner
- Utilized good strategy (getting on to the autocross before the rain. We were 2 hours early for the queue)
- Passed sound the first time though
- Did not work on the car 24/7 while there
- Paddock was clean and orderly
- Knew were and when we needed to be places
- Got through tech early
- Sealing the electrical system to prevent damage due to water

Things that need to improve;

- WE WERE NOT PREPARED (hence the 31st)
- Car was not done until the week before comp
- Presentation (how the car looks and design board setup) is half of getting to design finals
- The other half of getting into design finals is knowing your stuff
- Explanation of what is going on and why to the new team members
- Official driver trials to give the team a chance to drive and search for much needed talent (the points aren't only in static events)
- Work to task and not to schedule
- Team outings to increase the level of friendship between team members
- **Team** meetings every week to give every one a task and not have anyone idle at the shop
- Start working on design boards ASAP
- Start working on presentation ASAP
- Have important parts of the car designed early and made before they have to be on the car or sub-assembly
- Test all components before putting them on the car in Detroit (evaporative cooling)
- Make sure battery is charged before each event

#7

- The effort to load the trailer was poor. The effort was well organized and lead, but few seemed willing to physically carry the stuff from the shop to the trailer.
- The team handled the wheel-falling-off-the-trailer problem very well, although I still think it would have been easier to tighten the lug nuts before leaving Atlanta.
- There should be a list of all the team's hotel room numbers and who occupies each room printed and displayed in each room. We might as well keep a copy in the vans and posted in the trailer too.

- Arrived early, paddock set up quickly. The team was immediately separated into two groups – one set up the paddock, the others gave a final check to the car to prepare for tech inspection. Ideally, the final check should have been done before leaving Atlanta.
- Tech inspection. Getting in line early and quick correction of the problems are to be commended. The team was always professional when dealing with the inspector.
- We are almost there with the muffler. We "passed" but let's not forget by what margin.
- Design:
    - Boards and display were awesome.
    - The car was not cleaned and polished enough (almost not at all). Be sure to pack Simple Green, Never Dull, etc…
    - Tighten all jam nuts
    - More physical testing on the car – chassis rigidity before and after carbon panels, moments of inertia, and **compliance in the suspension.**
    - This year, the judging was just a series of questions with almost no opportunity to lead the judges to the good aspects of the car. Although no opportunity was given between questions, try to make the time at (almost) any cost. Some judges say they walk in with a set of prepared set of questions. Some say that it is up to us to give them a presentation (and then walk in with a set of questions and don't stop asking them for the entire 20 mins). Be prepared for either style of judging.
    - PRACTICE. There was absolutely no formal practice for the design event. This can NOT be the case for an event worth 150 points (nor should it be the case if the event were worth 3 points).
- Skid Pad
    - More practice for drivers (this applies to all events, especially next year)
    - Actually use, or at least test, the second Ackerman point.
    - Test for skid pad specific setup
- Acceleration
    - Well executed, but little practice for drivers.
- Autocross
    - 1st in line! Well done. Let's be first in line for everything next year.
    - In all, the autocross was well executed and the car performed well.
- Endurance
    - Poor planning for the evaporative cooling system. It should have been installed and tested in Atlanta. There was the entire night before the event to install it, which isn't a good thing, but much better than a few minutes before we are scheduled to run. See Idiot's Guide no. 7 (cliffs notes: never delay preparing the car for the next event).
    - Aside from the evaporative cooling, the effort to run the car at the event was good. The preparation of the car before coming to competition, however, was certainly not.
    - I know everyone has heard it before, but the car was running WAY to late. Failing the endurance event was entirely predictable. See Idiot's Guide tip numbers 1,3,8,15, and 19 (cliffs notes shouldn't be necessary). We didn't even have time for a mock endurance event. That is not acceptable. This year, the team as a whole did much more complaining and much less work than 3's year. That is the reason the car was finished late, plain and simple. No use pointing fingers or placing blame, we all were at fault.

Other stuff

- No checklists
    - Both routine maintenance checklists and between-event checklists should be made and assigned.
- Although the car was finished late, it was competition ready when it arrived (at least more so than in previous years). This was the most laid back competition the team has been to. Did anyone even stay at the track for 24 hours straight? That is a step in the right direction.
- A whiteboard on the side of the trailer would be nice.
- Let's keep up with the van keys next year (Idiot's Guide #22).
- More people should attend the design review. Especially if this is your first competition.

- Hobbs meter. On car. Good.
- People were late to leave the hotel. Some by only 2 or 3 minutes, but remember you are holding up the entire team. Well, next year you won't be. Be on time if you want a ride. Be a few minutes late if you want to walk. We NEED to be in line for each event early.

#8

Although I had no strict affiliation with any system on the car, in general, I do have comments on this last year. This past year, we took on an ambitious challenge - to work on, improve, and compete 3, while at the same time building a Detroit winning car 4. We set many ambitious and important goals for the completion of 4. Many of these goals were not met. If they had been met, car 4 probably would have had an impressive finish in Detroit.

At the end of last year (3's year), as leaders and as team members, almost everyone had something to say about the structure of the team and they way we were doing things. We all had aspects of the team we wanted to improve upon, yet really nothing seems different now. In some ways, our team has taken a step backwards from where it was in 3's year. The main thing we have lost is sense of being a team. Having been in the shop many hours, just like everyone else, I really got a sense of what was going on. The team didn't feel like a team. I believe this separation and this feeling is what really held our team back this year.

I'm not going to point any fingers or state any names, but the main issue was the way the leadership and team were separated. The leadership skills of some leaders just didn't match up with the personalities and work ethics of many of the team members. This is something that really should have been noticed and cleared up in the beginning of the year.

Last year, the sense of team was much different. We all met at the shop at the same time, ate dinner at the same time, and went home at the same time. Many times after leaving the shop we would go eat, watch tv, or just have fun at someone's apartment. This year, people came and went as they pleased. Although there is nothing saying you shouldn't be able to come and go as you want, the social aspects of the team are what really hold us together. Quite often, we were too tired, stressed out, or didn't have the time to just have fun. Motorsports is something we do because we enjoy it. It is something we do with our spare time; we all make the decision to come down to the shop every night. Some leadership members didn't realize this; they made many of the team members feel like employees getting pushed around by their boss who doesn't care.

In terms of building the car, I have a few comments. First, I think we should have some process of evaluating/checking/approving designs. Currently, it seems as if we waste a lot time creating a concept, building it, then being told it won't work. I think that major design ideas should be discussed by a group of leaders (maybe 6-7 leaders?), then presented to the team to really evaluate the design. Why is this design better than the next idea? How will it benefit or hurt the car to use this design? Catch can boxes…hard water lines…quick release fasteners…when speaking of these ideas, no one could tell me why we were using them. I really think this is a problem. Smaller design issues should still be discussed, but maybe not as formal of a process as with larger designs is needed.

Second, this has been discussed before but I still think it is important, we need to get into the process of building a car, not bunches of systems. Currently, our car is created by subsystems – composites, power train, chassis, suspension…However, there are not many relationships between the systems. Each of the them are different and separate; this allows for the many interference and packaging issues that arise. Although it would be quite difficult, I believe a full modeling of the car in 3D would really help our understanding of how the car works, how it fits together, and how we can package it. We need to really analyze why we are putting things where they are and why we are doing what we do. We need to be open to trying something new and different – not to just copy what we did on last year's car. Also, with better packaging possibly through this method, we probably could eliminate a lot of unnecessary weight.

Our team has a lot of potential to be great; we have done it before, maybe next year will be our year for first place. I'll be back there to help out as much as I can.

10. 2002-2003 After-Action Reports

Dr. C's

Areas for improvement

1) I think it time for a major design change. Loss of commonality, or inability to use spares from a previous years' car, are sad engineering justifications for THIS year's car. We're hearing "this is a design evolution from last year" rather more persistently now. When the head design judge during the finals debrief opens his remarks with this statement, you know that they are well aware that the car is similar to previous years'.

2) The design judges have slammed us for years about the wheel position and leg/foot access. We should not continue to ignore them. Question to the drivers: did wheel position and its small size lead to fatigue during enduro?

3) We need to set, and manage to, a design freeze date.

4) We won't be #1 in design until we are able to show the *predictive* analysis that justifies our design. Yes, the test data proves that it's a good design, and that we've developed the car appropriately. However, the judges want to see that we're predicting certain performance or behavior, and our testing should be to confirm and refine those predictions. How do we improve here? Possibilities include use of GMTS projects in the capstone design class, and in the CAD class. We need a full CFD analysis of the inlet, etc. Top 5 in design is great, but we have to show that we're engineers if we hope to take #1: engineers predict, technicians test.

5) Our weight has crept up to 475#: why? Other teams that use more traditional full tube frame chassis and unstressed engines are lighter. We need to understand where the weight is in the car (does anyone have a component-by-component, system-by-system weight breakdown?), and set design goals to manage the weight.

6) Our fuel economy needs to get to the same level as Wollongong: running the same size engine, and whipping our tails on the track, they still burned only 60% of the fuel that we did. Wollongong placed first in both enduro AND fuel economy: that's no fluke. Of the top 10 teams in the enduro, we were 9th in fuel economy. We cannot afford to break the limit on fuel economy, and we can certainly help our selves by actually scoring points.

7) Invest in a hand-held GPS for the drivers to walk the track. There are only 5 or so track layouts that FSAE uses, and if we get them mapped, so much the better. As one might have noticed from one of Bob Woods' postings, other teams are building such maps.

8) We have a real opportunity to gain experience and assistance using the machining resources at DeKalb Tech (Richard Egge). Let's develop and nurture that relationship.

Done well:

1) Chassis finished early.
2) Excellent pre-comp prep for the boards and presentation.
3) Trailer logistics ensuring that we would not have on-the-road failures.
4) Excellent paddock organization and appearance
5) Excellent presentation and use of design boards.
6) Not ready for tech, but, early on site

Done less than well:

1) Team disorganization at comp led to time pressures. Car would push out late to events, without proper support crew and tools. Organization and execution improved throughout the competition, though.
2) Drivers MUST be responsible for their gear, and ensure that it follows the car.
3) Car not tested for fuel economy earlier enough during development. Stopping in Kentucky to test fuel economy? Oh please.
4) Car not in comp-ready form until 1 week before event.
5) Brake light not wired when arrived at site.
6) Seat belt covers lost

7) Merit switch didn't kill the engine: this is the second year this has happened, AND SHOULD BE THE FIRST SYSTEM TESTED AFTER LIGHTING THE ENGINE THE FIRST TIME.
8) Too much setup/prep/fixing inside enduro fence.
9) No sponsor boards, recognition of individual donors.
10) Failed to submit information for program: FIX THIS NEXT YEAR.
11) Lack of prep on Friday morning cost us a dry track. The car should always be ready to fuel first thing in the morning, with no adjustment, such that we can be first in queue once it opens. This means that all necessary prep and setup are completed the night before.

Report #1
I might suggest to leaders before next years comp printing out copies of GTMS10years.doc, the competition schedule, the rules, packing lists, etc. and giving everyone a personal copy which must be read cover to cover before leaving for Detroit.

-Always debrief as a group after every event, including tech insp. and take notes ELECTRONICALLY and make sure the file name is descriptive and then put it on ALL of the computers.
-Make sure every computer for design not only has the design software loaded, but properly configured, without screen savers, etc.
-Before leaving for Detroit, tune the car so that you have tested setup options that are available, and make LINEAR, QUANTIFIABLE, and REPEATABLE changes in balance from ridiculous understeer, to ridiculous oversteer, in both wet/cold and hot/dry conditions, on both bumpy and smooth surfaces.
-ALWAYS test with nitrogen in the tires.
-The paddock organization was impeccable; I don't practically expect it to improve too much.
-Put a white board on the side of the trailer!!! It would have made things so much easier, and people would actually write things down, also tie a marker to the board, so it can't get lost.
-Buy a case of boxed lunches and leave it accessible to the team members (Phil's mom wont be there every year)
-Safety wire the spring perches in place (it won't matter on the new shocks...). Buy the necessary hardware to safety wire every single bolt on the car, no matter what, no matter how long its been since that bolt failed, no matter how much of a pain in the ass it is, DO IT!!!
-Never trust anything on the car to an adhesive or threadlocker that was applied after the part was used on the car; the grease is too hard to remove without a proper agitated solvent bath, and the adhesive wont bond.
-PASS SOUND
-Have a backup muffler
-Even if you have all the spare parts in the world, take last year's car with you. Take note from the professionals in this case, they usually take 3 cars per driver. What if we broke the long piece of brake hard-line: we didn't have enough spare hard line, and the only option would have been the spare car. It happened 33's year. Having said that, KEEP LAST YEARS CAR OUT OF SIGHT. Maybe the hotel parking lot, it doesn't matter, just out of sight.
-If the key leaders need to make a critical decision such as waiting an extra day before leaving, let them do it, they should be able to prioritize testing vs. leaving early, it saved us this year, and last year.

Report #2
Pre-Competition – Things for next year
-Find a freaking tire testing machine for our Avons and Hoosier
-Get our cars on a shaker rig
-Refuse to take shortcuts during manufacturing process just to meet powdercoat date, e.g. heat treatment.
-Package more around driver rather than last year's car
-Make every panel on the car stressed by adhesive bonding and fasteners
-Installed torsional stiffness with and without a structural seat
-Lateral and Longitudinal Stiffness of chassis
-Accurately measure CG, I's, Roll and Pitch Centers.
-Destructively Test wheel tethers on MTS

-just use 50” rock climbing slings
-Get accurate 500lb load cell from Lynch to use on MTS for shock dyno.
-Analyze velocity variation on steering u-joint
-Audible shift tones
-Make our own sawhorses from STEEL

At Competition
-MUFFLER NEEDS TO WORK
-We have to be the first in line for every event to get at least one run in.
-Top teams like Cornell and UTA do it every year and consistently beat us in accel, skidpad, and autox because of weather.
-Even if you are right and have calculations to support it, don’t be a smart ass to the tech inspection judges.
-If ANY design judge asks you how you would design ANYTHING regarding the vehicle dynamics for ANY car except your own, your answer will be the following; “Show me the rules and your tire curves, then I’ll tell you what to do.” While being a smart-assed response, it really shows understanding of the design process.
-Drivers Need Checklists for driving gear etc
-Safety Wire Spring perches on FOX’s no matter how much it’s a pain in the ass with all your spring changes.
-Buy four ~20” diameter rubber fan belts instead of using plastic wrap on tires
-Test for fuel economy first and foremost as it is essentially worth 40% of the points.
-Refuse driving the car until comp electrical\data acquisition is installed\calibrated. Any time “lost” will be made up tenfold by the testing efficiency allowed for by the data-aq.
-Wire the merit switch so it functions correctly and we don’t have to unplug the alternator
-This happened 2 years in a row
-Screw the digital Hobbs hours meter because it is susceptible to water damage
-Buy Dr. C more scotches at Big Bucks, however, next year, more conspicuously.

Report #3
After Action Report- Team Leader Scott Flanagan

As most people would agree not being prepared is almost always our biggest problem, the real question is how do we achieve that. This year we took some major steps forward, but also some steps backwards.

Steps in the wrong direction:
We did not have the suspension tuned in, being a primarily handling competition this is crucial. We have still time and again faced the problem of an understeering car, no matter how the car is set up when we put it in the trailer it always seems to push when we get to Detroit. We need to determine why and correct that problem. We have been wasting all of this time and effort on a rear anti-roll system each year never to use it because we say we are always too good for it, that we can tune suspension without it. I say we suck it up and start using it, actually test on it and see its effects, and then tune the car without it, but we need to know how it works so if we get to comp. and the car pushes we can quickly remedy the problem with the rear anti-roll. Also, more suspension parameters should be driver adjustable, at least those which directly affect whether or not the car pushes, so that between runs when the support crew cannot get to the car the driver could make a quick change.

Fuel economy was a major issue, we need to determine why and test various theories on how to improve. That means running lots of mock enduros on 3, not waiting until 4 is done. Also, the powertrain should be developed on 3 as a test mule. Swapping the motor and everything, an engine swap is something we say we can do quickly and we should in the case of an emergency so swapping the comp motor to 3 for acceleration development and then into 4 for the final running should be standard practice from here on out. The
powertrain is independent of suspension enough that we can take it out of the picture, develop it offline and then when 4 runs concentrate 100% on suspension. That means we need to be done with the final manifold/headers/engine build before Christmas break. Calibrate it at EPP over the break and then

spend the next month properly integrating it into car 4. For all of that to happen development must happen over the summer!

Steps in the right direction:
Comp ready car, while we didn't have as many hours on 3 as we would have liked, they were 95% in comp form, we made sure to focus on that and it paid off with no failures at comp. Design boards were ready and the static judging went well from a presentation/delivery side of things. We do need to investigate why we scored so low in design (similarities between this car and previous cars never came up during the final discussion of design finals). The trailer was ready and a pleasure to work out of this year, as was the paddock and placing the toolbox on a cart and having it outside the trailer at all times was a godsend when supporting the vehicle. Next year the car needs to be up on a cart or something so the tires can stay clean w/out the possibility of people calling them tire warmers.

Production Issues:
One of the biggest problems I witnessed this year was jobs being done more than once. We need to do a better job of inventory and storage of newly manufactured parts. I would propose that the green monster bins get changed around, no longer shall people be assigned personal storage space, but rather boxes will be assigned to subsystems. Maybe we should even go as far as keeping an inventory of what is in each box (use the MP3 computer and Excel for that). Also, something we need to do as leaders and make clear to new guys is that when you are given a job it needs to be completed, if it is not completed you need to report to whomever assigned you the job and tell them why you were not able to complete the task. There needs to be a better job done on seeing a project to completion. Also, leaders, when you see someone doing a job that has been assigned by someone else, if you want them to do that job in a different manner, or if you want to change the design of that bracket or whatever it is they are working on you need to consult with the leader that assigned the job. Too many times this year someone was assigned a job, and then some leader told them a different way it should be done only for that not to work and the job had to be redone as it was assigned the first time. We also need to figure out how to get new members to take more initiative, break down that intimidation (question the most recent new members on how to improve that)

If we can fix those problems while still bringing the team closer together we should do extremely well and have fun doing it. We do need to plan more social/fun events and drive a lot more although we still need to meet production deadlines. And, leaders need to be at the shop early and set the example, mainly by not sitting around in the office. All of the new guys on the team look up to the leaders, if the leaders are sitting on their ass in the office then why should the other people do any work, people need to be a leader and set the example.

Report #4

Overall, I feel that the team was very successful this year in Detroit. It may not have been our highest placing, but I think it was the best I have seen in terms of preparedness and execution, and everyone should be commended for that. Collectively, the team was very much on the same page this year, and everyone was pushing in the same direction without dissention. Even though, it was a tough year because everyone was working so hard to finish the car earlier. The car was in fact finished earlier, but it cost us a little in terms of people not having quite as much fun as in the past. Unfortunately, that may just be the price to be paid.
Of course, there are still improvements that can be made in the coming year. To that end, here are a few thoughts about what could be done better:

1. Meeting a deadline is not as important as doing the job right. Case in point: No, the chassis was not finished early this year. It was well into spring semester before the subframe was finally powder coated. The chassis was not done until late because it wasn’t done right the first time. One good theory is that everyone was too tired to notice some flaws in the fabrication that were otherwise easy to spot. In order to meet a deadline properly, a thorough checklist could be referred to in order to ensure that the part is made correctly.

2. The leaders/designers/planners need a master list of goals (prioritized) that can be referred to over the course of the year. Many times, ideas have come up that may not benefit the team very much, yet they will receive a lot of attention. Someone needs to compare such ideas against the list of goals and have the wherewithal to say, "That's not a high priority item, we don't have the time to devote to it, and therefore we should abandon it."

The truth is, we're engineers, and engineers have the tendency to get caught up in a cool concept, idea, or technology, which may not meet other project objectives of cost, time, and complexity. Also, the value of an idea should be quantified before it goes on the car. Just because it's theoretically a good idea doesn't mean that it will work at all. Know how much faster it will make the car and how many points it will be worth. A simple car that is race proven is much more valuable than a cool car which may not finish endurance. This idea has been shared many times before, and it's time that the team took it to heart. Don't put anything on the car at the last minute in the hopes that it will work correctly. It's better to leave a proven setup alone.

3. We racked up in the static events, and we know what we need to do to succeed in those. As far as the dynamics go:

I. Acceleration - We can't do anything about the weather. We just have to accept that. However, we could have been better prepared so we could have run in the dry.

II. Skidpad/Autocross - I think we just got beat.

III. Endurance - Yes, better car prep would have benefited us, but I don't expect a group of people operating on 2 hours sleep for a week to do anything properly. I think the best route is better planning so the same demands won’t be made on people next year.

IV. Fuel Economy - I don't need to repeat the fact that we did poorly. A lot more foresight about this will help nicely.

What to do about all this? Well, certainly more testing. The car was finished, although not in comp form, relatively early. The "not comp form" part of that really hurt us in our fuel economy situation. Preparation can’t be stressed enough.

4. Finally, the team needs to find an effective way to blow off steam. Towards the end of the year, well before comp, people were getting very frustrated and fed up. The team is much more effective when its members want to show up and work, rather than feeling like they have to.

11. 2001-2002 After-Action Reports

(A sad year for after action reports: only one submitted)

After Action Report: Powertrain

There are a few main things that should always be remembered when dealing with these engines and trying to diagnose their problems. First, whenever something is running wrong always start with the basics. Put thermocouples on each cylinder so you can quickly verify that all cylinders are running because at idle, which is high for these motors, they run so smooth it is hard to hear a cylinder missing. Also, when tuning engines in for drivability etc, the engine will not go from good to bad in a short period of time unless you have really messed things up, which is hard to do. Dont always blame the map for a bad running engine; it is only a small part of the whole picture. When there are drivability issues that drivers are complaining of and are having a hard time putting into words either put in a driver who can give lots of good Powertrain feedback (not always the same driver that can give suspension feedback), or get in the car yourself. It takes a good knowledge of how the maps work to understand what inputs affect the drivability issues, and when in doubt take a crappy laptop in the car with you and tune on the fly. Design Judging: The main thing is to be prepared with both boards and mainly a notebook. In both competitions this year I never once used a design board, but you still need to have one, because there are some times when a judge comes around and you cant answer their answers because you arent there and the boards will hopefully do that for you. Make sure your notebook is logically laid out and for each test you define your testing parameters, have torque, HP, and VE plots for every comparison. The main thing you should do is always be leading the judge, tell them what you tested, why you decided to test and then the results. Throughout that they will ask you why do you think that power increase is there, so be ready for it that happens with almost every comparison. Always be prepared to answer questions about the intake, restrictor, and header design. Also stress how we do tuning on both the engine dyno and the chassis dyno for transient tuning. Above all, make it reliable, 4hp is not worth any cost in reliability, you can do just fine on 3 cylinders and 45 hp, it won us 2nd in enduro and 3rd overall, not too shabby,

12. 2000-2001 After-Action Reports

This is the year that led to the writing of the Idiot's Guide, and the implementation of the After Action reports from team leaders.

Detroit

1. Without saying, design boards need to be done before hand so the design presentation team can sleep.
2. During events, I would like to see a few people stationed at evenly from our paddock to the dynamic area entrance to run items or communicate if necessary.
3. A team curfew, such as 10pm at England, might be a good idea, as it would cause the team to organize\prioritize its time more efficiently.
    a. We really need to set a **specific** Lunch break for at least 30 mins where food is ready to eat for people working at a set time. Similar issue for dinner.
4. Too many people just standing around the paddock.
    a. We had discussed this issue before comp, as it was an issue '01. Our plan was to have set people who took care of food, took pictures, recorded times, ran errands, etc. Due to lack of time to prepare extra tasks, 4 resulted.
    b. Another result of this problem was that people randomly walked back to the hotel because they were bored.

England

1. Miscommunication about the tire swapping with Yokohama. We basically just needed to have a meeting that morning with the necessary people to set things straight.
    a. To generalize, I think morning or evening meetings are necessary.
2. A few times people ran off that we needed and could not find until they returned on their own. Setup a signout board.
3. Food again was an issue. Specific times need to be allotted.

4. Since the event was spread out much more, runners stationed every while would have been nice to transport heavy objects such as tires.
5. Car left paddock without fire extinguisher numerous times. I don't know what happened because that was on someone's checklist.
6. Need to cover design boards with Plexiglas or laminate for rain.

General Issues to stress

1. Team curfew to leave competition site is necessary. Team curfew to return to hotel is also necessary.
2. Double sided papers with specific daily schedules and personal checklists need to be distributed.
3. Food issue.
4. In Det. and Eng. We had design debriefs discussing questions asked and our responses. This discussion needs to be recorded and published so future teams can reference it.

Electrical Systems Car 21

PROBLEMS ENCOUNTERED:

- Alternator power was bound to the wrong post on the Merit switch, resulting in 21 not passing a tech inspection for not having a working kill switch.
- Failure of coil driver circuit resulted in dead cylinder.
- Failure of coil driver circuit damaged ignition coils

SOLUTIONS IMPLEMENTED

- The alternator line was simply switched onto the correct merit post after the event.
- Coil Driver circuit was replaced with spare.
- The damaged coils were not replaced during the competition resulting in the cylinder remaining dead.

LESSONS LEARNED

- COMPLETE Tech inspections should be performed prior to leaving for competition and should be repeated before entering tech inspection areas.
- In the event of a coil driver failure (obvious destruction of the circuit) all cylinders should be tested for functionality and as a last resort the entire set of 4 should be replaced.
- ALWAYS have a spare set of ignition coils and a spare coil driver circuit.
- A diagnostic circuit would be simple to implement using thermocouples to generate a voltage based on the temperature; these voltages could be used to activate an array of transistors and LEDs to indicate to either the driver or pit crew whether all 4 cylinders were at an operating temperature.

Business Manager

1. A fulltime PR person is a necessity. Our sponsor relations this year fell off sharply, and need to be improved.
2. Shirts need to be ordered earlier
3. The team needs to be held to greater accountability when using the p-card. It was abused a lot this year, and that can't continue into the next year at the risk of having it revoked.

General Notes

1. Yes, the car does need to be done sooner. But just saying so won't get it built any faster. Each leader needs a detailed plan of action, list of materials needed, and manpower needed. Also, it's just as important to develop a way to keep leaders accountable to that plan. When a project gets behind, the entire car will be held up, and "Get the car done sooner" will be just another good idea. There has to be a method to keep projects on track, and put them back on track when they fall behind.

2. A little more emphasis needs to be placed on the concept of the competition. We need to be sure that we're giving the judges what they want, and not just our idea of the fastest possible car. I saw this happen in all three of the static events this year.
3. During the entire year, more of our manpower needs to be used more effectively. Fortunately, I see this as an area for tremendous improvement, since there are so many returning team members that can bring experience with them. Obviously, just a few of the leaders can't get everything done, even in their own areas.
4. Sleep is more important than most of us are willing to admit. A leader doesn't do anyone any good by being at the shop when he/she is tired but not properly functioning. (It's also dangerous when operating equipment/vehicles) Granted, finishing a project requires late nights at times, but a continued lack of sleep reduces productivity so much that it renders leaders ineffective. Lack of sleep also lowered morale and enthusiasm to very low levels just before comp. I think it would be very difficult for an unhappy and unmotivated team to win FSAE.
5. Better organization and communication before and during comp are MUSTS. I feel that a firm schedule and clear expectations of each team member are necessary in order for the team and all its members to function at full capacity. It would also help utilize the manpower available to us.
6. Around comp, the leadership must be able and willing to make quick, firm decisions about little details such as who needs to be where and when.
7. The team needs more decisiveness sooner. Sure, it sounds good to put a decision off until there's more time to think about it, or to wait on someone's opinion, but I think that many decisions need to be acted on sooner in order to get the car completed on time.

Chassis:

I completely agree with everyone who has said what a great car we can build, but our planning is somewhat lacking. Our execution is great (2nd in autocross) but the planning leaves something to be desired and needs to be improved on. As far as the chassis goes, having it finished sooner is the most important goal to have. (Cornell finished their entire car by February!)

To that end, here's my take on what can be done on the chassis next year to better prepare the team for success:

First, having necessary materials is important. Having the tube bender and not waiting on it will be a big help. Also, being sure that all tubes are ordered and in the shop before we begin is vitally important.

Secondly, doing things at the same time, rather than serially will also help. By this I mean that the suspension tubes that need to be machined can be made while the jig table is being set up. Also, tabs and inserts can be attached as soon as the tube is in place, without having to wait until the chassis is off the jig.

Besides all of this, I'll say one thing about suspension. Obviously, the earlier the suspension points are set, the earlier work can begin on the chassis. Also, it won't do any good to have the chassis finished early and not the suspension, since they go to the powder coater at the same time, so both need to be finished quickly.

I'm sure there are a few other similar things that would help the cause, but I think this is a good start to building next year's first place car.

Composites 2000-2001:

Successes:

The sidepods were completed much earlier than previous efforts. Both the nose and the sidepods were well styled, pleasing to the eye, and carried well the GTMS tradition of subdued, chassis-hugging bodywork (according to current team members). One team member was solely responsible for painting the car. The paint was very good, and gave the vehicle a more presentable, professional appearance. Except for sidepod ride height and a slight lateral misalignment with the nose, the bodywork fit pretty well. The seat, while of poor quality and surface finish, drew positive feedback from drivers and probably was ergonomically better than previous efforts. The intake system's design revision solved last year's problems with the intake blowing itself free from the engine block.

Reasons:
More team members were available for menial work. More team members provided skilled assistance to mold and buck fabrication and finishing. A change in seat methodology resulted in a superior seat. Drivers were used as models in a female buck (pour around driver) approach and their feedback was a part of seat fabrication from the very beginning.

Failures/Deficiencies:
Bad scheduling delayed nose completion. Poor quality of layup due to lack of experience. These two problems increased the work needed for paint preparation, which prevented a full, striped paint job from being applied to the car. It also did not give the painter sufficient time to clear-coat the stickers.

How to fix it:
Start earlier: the mock chassis was not completed until the end of the Christmas break. Investigate vacuum bagging for improved exterior surface finish and stricter scheduling. Investigate alternative release agents (other waxes, Waterloo's packing tape idea). Cytec offered free prepregs that we did not use because we did not investigate finding an autoclave. Look into that. Investigate more precise, innovative and less time consuming buck fabrication methods than pouring foam and covering it with Bondo.

From a Team Leader
My list to add to the lists of things that can be improved upon for future competitions.

1. Organization. There should be a specified individual who is responsible for the following basic tasks.
   a. ensuring that all team members know where their room is.
   b. ensuring that all team members know when each event is.
   c. ensuring that all team members get a wake up call.
   d. ensuring that no team members have to get meals on their own.
   e. providing drinking water/soda in the paddocks.
   f. providing sun tan lotion, and maybe a spare sweatshirt
   g. knowing who has which set of car keys.
   h. knowing the hotel phone number
   i. providing fresh hot coffee 24-7
   ...we are all adults, but have too much on our minds to worry about basic necessities...

2. In the paddocks:
   a. keeping the paddock area clean and free of people who are doing nothing other than taking up space. (e.g., those who were reading the newspaper in the trailer immediately before the endurance event made things difficult, especially justifying their travel expenses, and checking the setup on the car is difficult with five occupied lawn chairs blocking the path)
   b. using organizing trays/bins with multiple compartments for things such as brake line parts, cable accessories, etc.
   c. having a label on the outside of each bin which details all of the items inside
   d. having a specified labeled location for every bin/case/toolbox.
   e. always having more than one spool of safety wire, electrical tape, speed tape, etc.

3. Before an event:
   a. an assigned person to carry the extinguisher, starting battery, umbrella, driver toolbox, etc.
   b. a person responsible for strapping in the driver.
   c. a person responsible for double checking tire pressures, spring rates, and damping rates
   d. a person responsible for tasks such as checking the fuel cap torque, the pedal assembly position, merit switch position, etc.

4. Attitude

It is my position that anyone who displays an outward negative attitude to a degree that it becomes detrimental to the morale of the team is no longer welcome. Personality, personal relationships, past performance, and seniority should have no bearing whatsoever. If an individual does not enjoy GTMS, then they should leave. A bad attitude is detrimental to motivation, and thus the success of the team

The 'Good' Comments from Dr. C. immediately after the FSAE event

Folks:

Yesterday's messages from Sterling and me may leave you the impression that we have nothing but a negative impression of the team's performance: not so. Our intent was, and still is, to provide all team members objective assessment of how the team might be able to improve for future campaigns. Indeed, just as there most definitely areas of improvement, there are many more areas where the team may be justifiably proud of its performance. You need to hear both sides of the story.

From my point of view, what were the key achievements that deserve due credit and lend pride to the team and its leadership?

The car:

- Brandon's diff is a MASTERPIECE. Had we used any of the previous diff designs, we probably would have been black flagged at the first sign of fluid on the back of the car. Brandon's design beat a problem that has plagued the team for years, and it looks good, too.

- The brake system is killer. Floating rotors and custom calipers with oval pistons? Awesome.

- Overall fit and finish continues to climb.

- Body work was almost ready for comp, and certainly had an excellent finish and paint job. As compared to previous years, body work completion was a major improvement.

- Electrical system design was excellent: well packaged, well laid out, well implemented.

- The team continued its tradition of innovative, well executed designs.

- Steering radius was significantly reduced (Ira was constantly drooling over the handling improvement).

The event:

- We had what was probably our best placement ever in skid pad and cost.

- We were, indeed, on track for a top 10, possibly top 5, finish at comp.

The Team

- Acquisition of driving rights at Lockheed, and keeping them happy about it, is a significant advance for the team. The team well exercised this opportunity for driver training and vehicle testing.

- The team is increasing its use of comparative testing to assist in design decisions and substantiation.

- The team identified the competition drivers early, and made efforts to improve their fitness.

- The team implemented an improved dyno setup for engine testing.

- The unveiling was a MAJOR step forward, and very well done.

- Sponsor relations are carefully and conscientiously handled, as are contacts with the corporate development officers at Tech.

- The team's membership is large and stable.

- The team continues to maintain excellent safety consciousness in the shop.

The above list is by no means comprehensive, and don't feel slighted if I left out your piece of the puzzle.

Indeed, there is much to like about 32 and this year's efforts.

Comments from Sterling, and endorsed by Dr. C., immediately after Detroit
Dr. C and Team--

I don't mean to pour salt into wounds or point fingers, but I thought I would list out some of my notes from the competition while it was still fresh:

Here is my list of most blatant errors at the competition.

1) Didn't practice the presentation early enough or in front of others such as Dr. Winer, Dr Vito, Jeff Donnell etc. This practice needs to be done in time to make changes and then practice the changes.

2) Didn't have good preparation for the design event. No "display", some SLA parts were left at our paddock, didn't bring any dyno plots to the competition, didn't have a list of specifics to show the judges.

3) Car NOT FINISHED or legal for comp when arriving in Detroit. Bodywork not mounted, seat not finished, fuel rail not secured, roll bar padding not on, no mirrors even purchased, damaged crank position sensor on car, etc.

4) Team members often didn't know who was supposed to do what or what the schedule was. Not enough "team meetings" at the competition.

5) Car not driven in comp form enough before the competition Electrical system installed just before leaving for comp, competition engine installed at the last min, oil leak noticed but not fixed correctly, bodywork didn't work well on its mounts, seat didn't work well-no mounts, new diff not installed until the last min. The 25 hours on the car before the comp was not done in competition form.

Here is my list of possible ideas to do before next competition in Detroit. Most won't be possible before England.

1) Get more EE, IE, ID, Mgt, and other major students on the team!! Cornell had 39 team members at the comp. Ohio State had more.

2) Get the paddock better designed with tool chests in a better place, table and chairs, Georgia Tech on the tent, better sponsor boards, "crocotile flooring" etc.

3) Have design reviews regularly with visiting professors to listen in.

4) Host the unveiling much earlier and invite all alumni, sponsors, entire campus! Have the presentation practiced for then with SLA parts on hand. Pay attention to prominently displaying the stickers that have reps at the unveiling. Make sure we invite all to the competition in Detroit.

5) Develop a database with all alumni addresses so all alumni will receive newsletters about the progress of the team.

6) Do more A-B testing on as many parts as possible, especially on the engine. Get the engine dyno more instrumented.

7) Be ready to compete for ALL awards that are given away at the competition including best braking system award, computer usage award, etc. Be ready with posters. A different person should be selected as the person responsible for each one of these awards. That person then discusses the car with the judge that comes around.

8) VERY IMPORTANT Have one person on the team who is not the team captain responsible for making sure every RULE is met on the car and that the car passes through tech inspection on the first try!!! This person should be selected BEFORE the car is designed. Mirrors must be designed into the car's chassis or bodywork from the beginning.

9) Work on solving the crank position sensor problems that the FI system has. Maybe, switch to another system entirely that has more data acquisition capability.

10) Maybe go to a different style of team shirt for next year that is button-down and short sleeve? Have team jackets or sponsor jackets for every team member!

11) Keep increasing the fit and finish of the car. Maybe, have one body for show and another for driving. Polish the crush zone better.

12) Have crash data on the car by test crashing a crush zone in a special built fixture?

13) Do an emission test on the car to show that it is environmentally friendly?

14) Have Gas Chromatagraph diagrams of engine exhaust output to show the judges.

With those things said, I am very proud to be associated with this team. The competition is so tough now. You may very well have won the competition if you had taken #23 a few years ago…even with the oil leak. I look forward to following all of your careers because, based on what I have seen you do, they will certainly be varied and exciting and successful!

13. From Paul Allen, GTMS Founder

Way back in 1986/87 when we built the first car, it became very obvious that meeting deadlines and goals that we set for ourselves was more difficult than meeting those that involved individuals or groups outside our team. When we committed to a presentation of the car to the Atlanta SAE chapter, we had our first "external" evaluation of our efforts and progress. This caused a very high level of effort that would not have been expended otherwise. A subsequent presentation to supporters both on and off campus yielded similar results. I realize, however, that if this type of presentation becomes routine over the years, it can loose its effectiveness.

I think the most valuable lesson was...
1. The team leader's head should not be down inside the car tightening bolts: the team leader should keep an eye on the big picture and that's hard to do when narrowly focused on car preparation. Also, the leader is constantly distracted in such situations, and a fatal oversight might occur due to such a distraction.

I struggled with this in 1987 and still do today. I enjoy the hands on work and I can loose sight of the big picture. However, I find that if I step back and use my time to leverage the time and tallent of several others, my team will accomplish much more.

I am very proud to be associated with gtms and I am very thankful that the team has the type of support and input that you and Sterling are providing. I hope to be of more support going forward as well.

14. From a 'Concerned Alumnus'

Car Design

The GT team is awesome! Once again they improve on a great design. But it was not sold properly this year. Supply backing data and be salesmen on all facets of the design. Visual aids are a necessity.

Rules

Read the rules. Read them again. Look at what has changed, and what has apparently not changed. Read the rules again. Small changes sometimes happen without any notice. This happened to some of the rules that I wrote.

Be sure you understand the rules. Get a clarification if anything you are doing does not comply EXACTLY with the written rule. This will prevent a lot of issues at tech inspection.

Read the rules again. Recall that one of this year's design finalists could not have completed the endurance event because they did not take notice of a rule change.

Put the car through a mock tech inspection before you leave. Go through the rules individually and verify that each one is met. Invite some outsiders to be tech inspectors. You could draw on team alumni, or maybe locate a racer who has done SCCA tech inspections. If you still go to the autocrosses, I'm sure you can find someone who will come to the shop on Saturday morning and go over your car in exchange for a team T-shirt.

Leaks

Be sure that there are no leaks of any kind. There already is a "zero tolerance" policy for endurance, and I can foresee this policy enforced for all events in the future. So design properly, and assemble everything correctly to ensure zero leaks. Also, be sure to test properly so that leaks can be identified early.

Car Completion

Get the car done. The winning car this year was first driven on Feb 1. The same team did not first drive until late April last year. Compare their finishing results.

Get the car done sooner so that it may be fully developed and tested. Go through your troubles at home before you show up in Detroit or England.

Set your unveiling sooner. Should be at least 2 weeks before you leave for Detroit. A month ahead is better. The car must be competition ready at that time. This means the engine package, the bodywork, and decals all ready.

There are teams that are completing their cars in the paddock, but those aren't the teams that are winning the event.

Presentation

I agree with giving the presentation before the event. Practice the presentation in front of your advisor and a few others. Have them immediately grade you and provide a feedback session (both good and bad items). Then, give the presentation again after the discussion, incorporating any feedback possible. Keep an open mind and be willing to listen to the audience.

Practice the presentation several times before the event in front of different people. The car unveiling would be another good opportunity for a practice presentation.

Planning

Prior planning prevents poor performance. Many of the issues from Sterling and Dr. C could have been prevented by better planning. I know it is a huge issue to design and build a car in a matter of months, I have been there myself. Things like sponsor showings, the unveiling, testing sessions, and such are firm deadlines that helped us with car completion.

15. Annual Judge's Perspective

From: Dick Golembiewski (Dick was a long-term, and influential, design judge)
Date: Thu, 23 Aug 2001 15:06:56

For those of you beginning your projects for the coming year, I would offer what is now becoming my annual design judge's perspective:

When a number of us meet to discuss the competitions, there are common threads. A number have come out in Carroll's briefings, but I will reiterate my thoughts here:

First, none of us are gods. We are however charged with making subjective judgements of your cars. In FSAE, the first round is extremely difficult, as we have approximately 20 minutes before spending the few remaining assigning scores. All we can really do is decide who moves up to the semi-finals while trying to rank the remainder in groups. It is virtually impossible to assign any other meaningful numeric totals. There just isn't sufficient time.

Carroll wanders around getting an overall impression. Since there are both easy and hard graders, he tries to ensure that a team which deserves to get into the semi-finals is not excluded. In this year's FSAE finals, I thought one school did not deserve to get into the finals (see remarks below), while two others did. Unfortunately, those things happen.

Prepare accordingly. Have your act together. We want to see/hear a 4-5 minute overall summary, followed by our breaking into individual areas. While you're speaking, many of us are examining.

The semi-finals in FSAE and/or F. Student are different in that we have fewer cars, and as a consequence more time to spend with you.

Areas for improvement:

Almost no one tells us that they started by reading the rules, and formulated an overall strategy for winning. We then want to hear/see SOMEONE articulate an OVERALL DESIGN PERSPECTIVE.

Almost no one in their discussion of suspension geometry starts by telling us that they looked at tire characteristics.

There are some of you who have built great cars (BIG example this year) who based your designs on previous years' WITHOUT FULLY UNDERSTANDING THEM. Our charge is to not necessarily AGREE with your designs (although we do have to subjectively rank them), but we are looking for at least some logic as to why you did what you did. When you can't answer basic questions - and I gave one guy the answers the previous year - it strikes us as poor design. There is nothing wrong in keeping some design features from year-to-year, but you must understand the pro's and con's, as well as articulate why you chose to keep them. "It worked in the past" is not good enough.

All of us who stay the entire weekend are more than happy to give you an individual critique. You need to ask. Not all do.

We see lots of people watching cars on the track, but the same problems come up each year. Do you know what to look for? If not, ask. If not, you're not learning.

No one reads their tires. I read your tires throughout the weekend. We may require the finalists to show up with the tires they ran during the endurance race. Someone asked me what I was doing, and I explained. This was a top team, which had never done it before! This is fundamental.

There are some very good drivers, who have driven around some problematic chassis - the most common being corner entry or mid-corner understeer. We see lots of drivers pitching the car and/or using the throttle to compensate, but that points to a chassis problem.

The top cars are getting marginally better each year. We see differential, damper, engine, brake, and other development programs. The mid-level teams have also raised the bar.

I'm sure I'll think of more, but these are the big ones we see every year. I'll hang around the list until 1 September in case of questions. Please, unless you need to discuss something privately with me, send your post to the list, so all can benefit.

Good luck with your projects this year!

- Dick Golembiewski

16. Carroll Smith's All You Ever Wanted To Know About Design Judging And Waited Until Too Late To Ask

FSAE design judging is meant to be a co-operative experience between the students and the judges. The judging experience is:

1) An opportunity for the students to explain their concept(s) and to show the results of their efforts to a group of practicing engineers experienced in both passenger and race car engineering and development.
2) An opportunity to receive constructive criticism from the judges.
3) An opportunity to score points in the competition
4) An opportunity for the judges to meet some bright and dedicated young engineers and restore our faith in the educational system

Time constraints limit the judging and scoring envelope to an inadequate 30 minutes for each team. Therefore your design presentation should be as carefully planned, organized and orchestrated as your cost presentation. There is no other way to ensure that the judges get a complete overview of your car, do not miss any of your clever details and, of course, that you end up with the maximum deserved point score.

Design judging starts with the submission of your design review. The review will be read by at least two of the judges prior to the event and will be familiar to at least one of the judges in your judging line. It is often said that you only get one chance to make a first impression. This is it. Too many of the reviews tell us how hard the team worked and how clever they are. We know that! We want to know about your design - and we want to know about it in detail. Statements like, "We maximized the suspension geometry." Don't get it done. We want to know how you maximized the suspension geometry etc. etc. etc. We ask for three view drawings. We expect to see proper detailed engineering drawings – not a crude sketch or a solid works rendering. It is a challenge to completely describe the design of a complex vehicle in four pages – but it can be done. Every year we receive at least four outstanding design reviews. The judges are favorably pre-disposed toward these teams. Make sure that you are among them.

In design judging you get a second chance to make a first impression. The team that arrives with neatly done story boards and complete and indexed documentation has a big advantage going in – as does the team with a neat and tidy race car. While aesthetics is assigned only five points on the scorecard not only are the judges human, but the overall appearance and detail preparation of the car is a strong indication of the quality of the engineering that went into it.

You will be given 5 minutes at the beginning of the period to describe your design. The judges are divided into two groups: power train and chassis/ suspension. You should have an articulate and informed team member address each group. Describe your design philosophy, your goals and how you met them. Make sure that any innovations or particularly clever solutions are pointed out. The judges will then examine the car in detail. They will ask a lot of questions. Your team members had better have answers. "I don't understand the question; would you please re-phrase it" is a legitimate answer. So is, "I'm sorry; I don't know." You are not going to snow the judges. Don't try. This is also not the time to argue with the judges.

The cars must be presented for design judging in "ready to race" condition. In 2003, for the first time, we will refuse to judge cars that are presented in an incomplete state. We will critique them, but they will receive no score. In a similar vein significant points will be deducted for loose nuts and bolts, rod end bearings without jam nuts, etc.

Every one of the judges is fully aware of the value computer driven design aids. CAD, CAD/CAM, FEA, CFD etc. We are also aware of their potential shortcomings. The team that performs physical testing to validate their computer analyses will impress us. The team that does not will not.

Engineers are practical people. We design stuff and we build stuff. We have to learn to manage resources, time, money, parts and people. There is an old saying in racing, “The race starts at one o’clock on Sunday afternoon. If you are there, fine. If you are not there, the race starts at one o’clock on Sunday afternoon”. A brilliant design that is not finished on time is useless. Success in engineering owes as much to development as it does to design. That is why the OEMs have test tracks, the bird works employ test pilots, and professional racing teams have separate test teams. The brilliant design that is not finished in time to test is doomed to failure in the contest. A simple design that has been properly developed is a better exercise in engineering.

Every year there are teams who feel that they have been unfairly judged. As lead design judge I do not judge the initial round. I am available to hear complaints about the judging. Over the years I have heard a great many. The usual complaint is, “The judges didn’t notice our brilliant and innovative widget”. It is not the judges’ responsibility to notice your widgets. It is your responsibility to bring them to the judges’ attention. While I have considered most of the complaints to be unjustified, in a few cases I have agreed with the teams and, after consulting with the relevant judges, have adjusted scores. The morning after design judging is too late!

The teams’ opportunities do not end with design judging. For the length of the contest, design judges are wandering the paddock ready and willing to discuss the details of each and every car. This is a priceless learning opportunity that far too many teams fail to take advantage of. The judges will probably not come to you. We are easy to spot. Stop us and ask us to look at your car – we will all enjoy the experience.

17. Team Member Commitment Profiles

Paul Johnson, Sterling Skinner, 8/30/2005

While discussing the new member rush for this year, Sterling came up the following commitment personalities. Please review the following to become more aware of your current position on the team and what is expected of you. I found it amazingly accurate and somewhat humorous.

Ways to be involved with GTMS in order of decreasing time commitment (but not decreasing importance):

5) Team leader, chief engineer, composites leader, business manager, fund raiser, chief machinist, shop manager, etc. At this level the team member is expected to spend some all-nighters if necessary to make sure the projects that they are leading are on schedule and not holding the team up. Also, a member at this level is expected to be in the Student Competition Center over Christmas and Spring Break unless it is well communicated well ahead of time that they will not be there. These members take the full responsibility that the car is built on schedule. This level may require some level of mental illness.

4) Full team member.....goes to competition and is fully involved in the team's activities both in committing to projects and socially to some degree. goes to competition and gets to drive the car when it is appropriate and even drive in the competition if the skill and commitment to that responsibility is there. Helps prepare the car for driving, builds parts, and is fully involved with representing the team on campus. These members will spend some all-nighters with the team and are strongly encouraged to be in the shop over Christmas and Spring Break. This is the heart and soul of the team. The leaders will never be successful by themselves. We have already tried that.

3) Specialist.....some members can participate on the team by just doing one well-defined project or specializing in one specific skill that they master. This usually requires previous experience in something like welding, engine assembly, machining, painting/bodywork, computer programming, server maintenance, etc. This type of member usually does not socialize with the team too much due to involvement with fraternity, marriage, grad-school, or work, but is very valuable none-the-less. Often this type of team member trains others in the skill that they have such as welding or composites lay- up. Often this person will not go to every competition with the team. (Don’t expect to be the specialist-driver unless you just won the WKA championship last year.)

2) On list and pays dues.....some members like to keep up with what the team is doing but are not able to put much time or sporadic time into the team. These are encouraged to participate at the level they can, but not take on responsibilities that the team is counting on. Just come and help clean up or setup cones or assemble parts of the car when your schedule allows. Keeping these members on the list helps to show that there is a broad range of student interest to our sponsors such as GM and SGA, etc.

1) Doing a project for credit..... Some students who are not on the GTMS member list can pick a project to incorporate into their CAD (ME 4041), senior design (ME 4182), Mechatronics (ME4447) or special topics credit (ME 4699) classes. This can be a significant contribution to the team by investigating topics such as 4-wheel steering or traction control or home-built fuel injection that may be used in future years by the team. Typically this type is not on the team rolls, but communicates directly with the team leadership. This involvement with the team often does not add any time to the person's schedule because the project is completely inside the time already allocated for classwork.

These levels are listed only to give some examples and are not TAGs for people to define some sort of "rank". Members often move between levels of commitment. Please communicate with the team leaders if you desire to take on more responsibility OR less with the team. Members who disappear without communicating really hurt the team significantly. For example...If you are about to go on probation or something, tell the team leaders that you need to scale back your involvement so they can re-delegate your projects....then go study....or make-up with your girlfriend, etc. The key is communicating with the team leaders.

Here are four ways NOT to be a member in good standing with the team:

1) I want to be on the rolls but won't pay dues, BUT I want to list GTMS all over my resume.

2) Takes on projects and responsibility but then disappears without communication or warning. Deserter!!

3) Only shows up when the car is running well and wants to drive (rock- star wannabe)

4) Only shows up at PR or recruiting events AFTER the shop has been cleaned up by the other team members.