CALLAS PROSPER Philosophy : Targets and Specificities

Gilles.schaefer@car-d.fr www.car-d.fr

CALLAS PROSPER philosophy

- History
- Design targets
- Specific philosophy
- Goals achieved & Future Road Map

Some steps of the history

- V 1 & 2 (1994-1996) : Thanks to the first customers (ETAS, Renault Sport, Nissan…) for trusting me and thanks for their patience…
- v2.3 : intensive validation with Peugeot 607 and 306,
- v3 : sensitivity check with a « wrong setting »
- v3.1 (1998) = first Real Time
- v4 : CALLAS Motorsport (F3, F3000, BTCC, JTCC F1, Le Mans)
- v4.3 (2002) opening towards external user modules, allowing namely HIL with the ETAS engine test bench
- A real time simulator inside a running car to make real time car model validation and external identification (grip, road profile, …) research program ARCOS with PSA & INRETS.

Three main design targets

- To deal with any vehicle, with the various 3D aspects of vehicle dynamics, at different Level of Detail (complexity)
- To be an assistant of expert design engineers, allowing them to establish the link between design parameters and performance with an unmatched productivity,
- To link design phase and tuning phase, design experts and tuning experts

1 - Any vehicle in 3D and different LoD

- To deal with any vehicle
- To deal with the various 3D aspects of vehicle dynamics
- To work at different Level of Detail (complexity) according data availability, which is a real problem to handle
- To work at different Level of Detail according design phase,
  - at preliminary design, you have a A4 paper sheet of data
  - The vehicle wizard utilises these data to build a model not so simplified providing some typical values according the vehicle category
  - With the design progress, the model is refined
- The huge variety of vehicles modelled is the strongest insurance about the serious of modelisation because of the zoom of their specialisation:
  - Any approximate or bug in aerodynamics will be seen in a racing Formula
  - Any wrong tire coupling will be seen with a military vehicle doing a pivot (45° side slip, 100% slip ratio)

2 - Design expert assistant

- To bring simulation to the expert, rather than trying to learn car dynamics to simulation expert ; this requires:
  - To speak the professional language and units
  - To simulate the professional tests
  - To have a user friendly interface (no text file to edit…)
- To have ultra quick way of helping design :
  - Functional modelisation by-pass the technological details and is multi-domain, multi-engineering
  - Braking with the perfect ABS to define the right brake balance in one sim
  - Vmax/radius in steady state (all speeds and all steering in 30 s)
  - Vmax on obstacle : simulation increases the speed by small steps till failing, so the last result in the computer is the best possible
- To provide all the details possible to promote understanding which is a must in design with innovations

3 - Linking design experts and track experts

- Same tool in design phase and track tuning, To have a Common references, To build a common database of simulation and track test data acquisitions (which are rarely managed and rarely sustainable)
- Some examples :
  - the 4 wheel loads are accurately set on track because it affects handling, and you can go-up to the CoG location, but not the reverse way
  - Ride height is also very important, and also very easy to check on a real vehicle; so the CALLAS PROSPER model ask you for it and will build the model to respect it ; this seems me better than assembling spring height
  - Load condition can be change easily from a well-known “reference” situation, … as in a real test, without resetting RH, aero, static wheel setting, tire radii…
  - It is easy to process CoG accelerations to virtual accelerometers on any point in sim, but very heavy to make in the reverse way
- Validation feature : the real driver commands are pushed in the software, providing an accurate back to back comparison sim/track in the same Excel sheet, even if the driver do not succeed to perfectly stabilise its speed during the chicane or draw the right SW ramp; many “play-it-again-Sam” saved.

CALLAS PROSPER philosophy

- To learn from the real life :
  - The main purpose of a model is to play « what-if », so the model is ahead the prototype building
  - In our field, a model is only a simplified image of the real life, because in the model we put only our present knowledge, so knowledge-wise, the model is behind the real life
  - In this meaning, the model has to modestly learn from the real life, and we have to observe, analyse, criticize, imagine,
  - To track the « simulation misleading», see the two following slides
- To be open to allow to simulate the not-yet-invented sub-system :
  - A must for the very mechatronic modern car
  - with the build-in functional modelisation
  - With User-external modules

Tracking some misleading of simulation

- Let's break a taboo : yes, a simulation model can be relatively accurate AND providing wrong sensitivities and « misleading » conclusions
- Example 1 : response to suspension total roll stiffness
- Sometimes model suggest no suspension would be quicker
- Track tests find an optimum
- One possible bias is to make the simulation on a perfectly flat area, instead of the real good quality area with a given PSD

- Example 2 : front axle LSA, rear axle rigid
- A loot of understeer in test track with an « optimized » version
- One possible reason is that the camber effect (differential from front to rear) is not correctly simulated, sometime by lack of tire data with significative camber

Improving tire model

- The basic point of view « tire is a black box, no need to understand inside, just trust and utilise an embedded model »
- When « misleading » simulation, the trust in the Tire model becomes OFF
- A bad tire (or car) model is a model with correct matching but bad parameter response ; car engineering is dealing with dynamic load repartition we have to verify that the tire model has realistic tendencies in the major fields :
  - Load range has to be wide (at max cornering a tourism car is near on its external wheels, i.e vertical load 2 times the static load, but the standard at tire manufacturer is to test at static load +/-25% or +/-50%
  - Cornering stiffness and Grip vs load need to have the right shape, namely the optimum point, that is the main reason for the change in handling vs load condition
  - Forces vs. angles
- Improvements are very often incremental, so with deference, we can try to improve some of the Pacejka drawbacks:
  - Parabolic is a dangerous tool when extrapolation is needed
  - Too much math and not enough physics can give strange result (ex. load extrapolation transforms the shape of Mu-Curve and can switch to negative the tire trail).

Goals achieved & Future Road Map

- All these goals have not been achieved yet
- You are here to write the wish-list and set the future Road Map, thanks to the OKTAL organisation.
- I hope you appreciated the CALLAS PROSPER software and also will keep-on appreciating it.
- Keep-on providing us your knowledge and feedback. Thank you