The background of the slide is a vibrant, abstract bokeh light tunnel. It consists of a dense stream of out-of-focus light points in various colors, including bright yellow, orange, red, and white, set against a dark blue and black background. The lights appear to be moving away from the viewer, creating a sense of depth and motion.

Altium[®]

ALTUMLIVE:

WIND TUNNEL RACE CAR MODELS
CUSTOM PROTOTYPE DEVICES DESIGN:
ALTIUM AS IMPROVEMENT TOOL TO GAIN
EFFICIENCY

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TMG, Principal Engineer

Munich
Tuesday, January 17

Topics

- 1 Introduction
- 2 Wind Tunnel Testing Overview
- 3 Prototyping Design Process
- 4 Our experience using Altium Designer
- 5 Mechanical Integration and Documentation
- 6 Conclusion – Questions ?

Welcome everybody,

we would like to share with you part of our experience when designing electronic prototype devices using Altium.

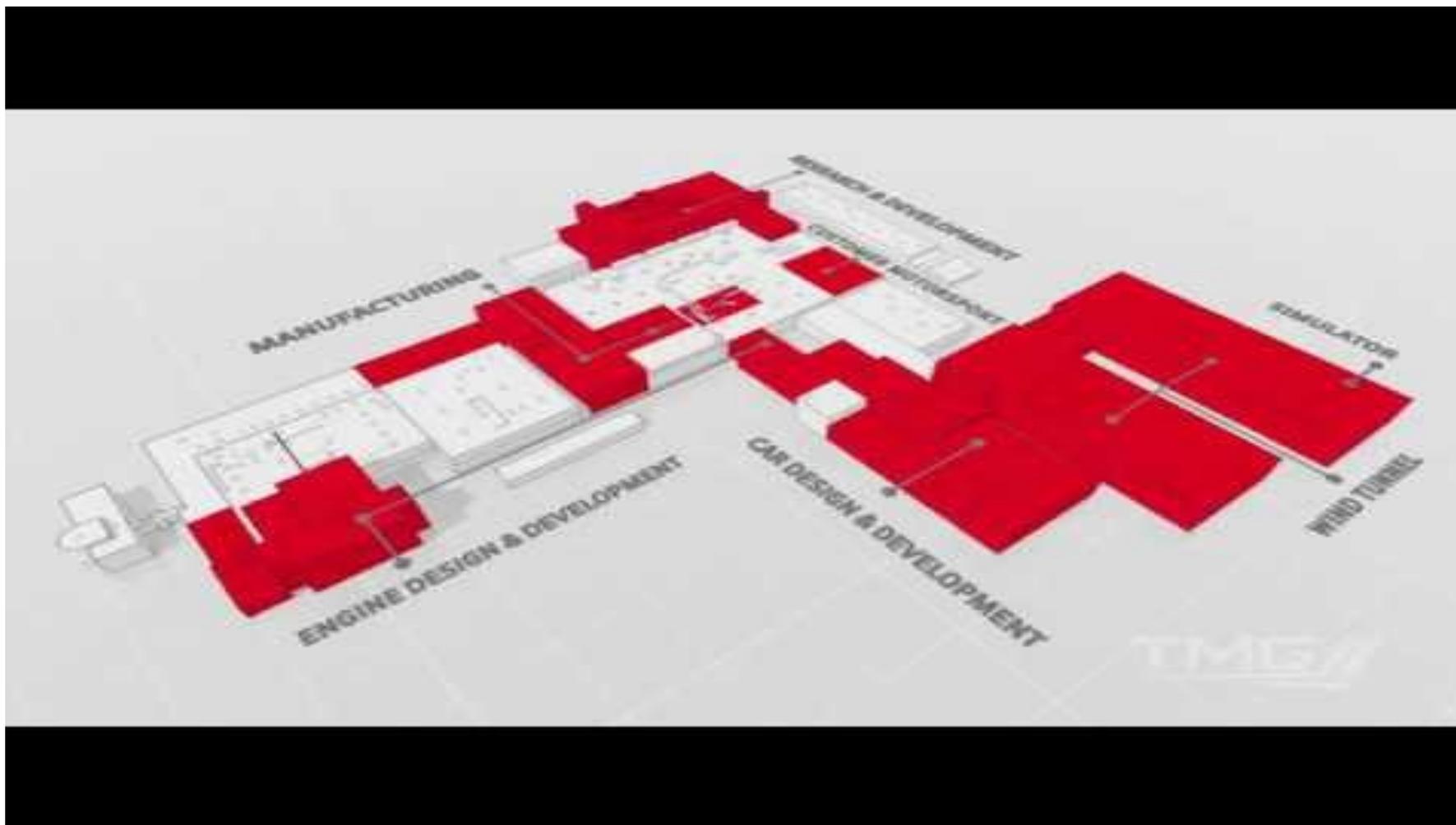
We introduced Altium Design in TMG Wind Tunnel Department in 2011.

Since then it has become our electronic devices reference design CAD

The work and the development in a Wind Tunnel Environment is not a standard one, the key factors are:

- ✓ Clever Ideas
- ✓ Short delivery time
- ✓ Reliability
- ✓ Customization
- ✓ High level of technologies

We will present who we are playing the following short movie,



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General Description

TMG has two Wind Tunnel designed for Aerodynamic development of race cars. The Wind Tunnels are subsonic closed loop, and can have slotted or closed wall. The usual model scale is 60%. In one of the two it is possible to test full scale car. The maximum wind speed is 70m/s (252 Km/h, $\approx 2.2 \cdot 10^7 Re$, $Mach < 0.21$).

Typical wind speed test 50 m/s.

Overhead six component main balance

Model motion system pitch, yaw roll

Boundary layers reduction devices

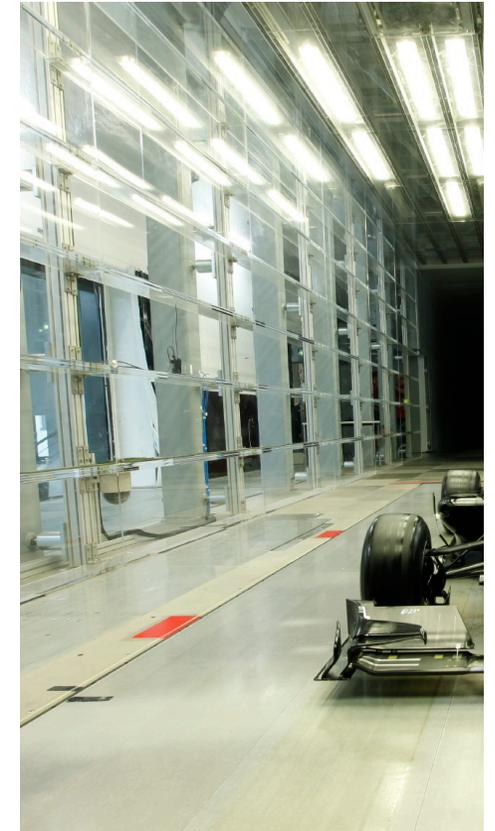
Rolling road (70 m/s)

Vertical wheel force measurement

Exhaust simulation system

Measurement probe arm

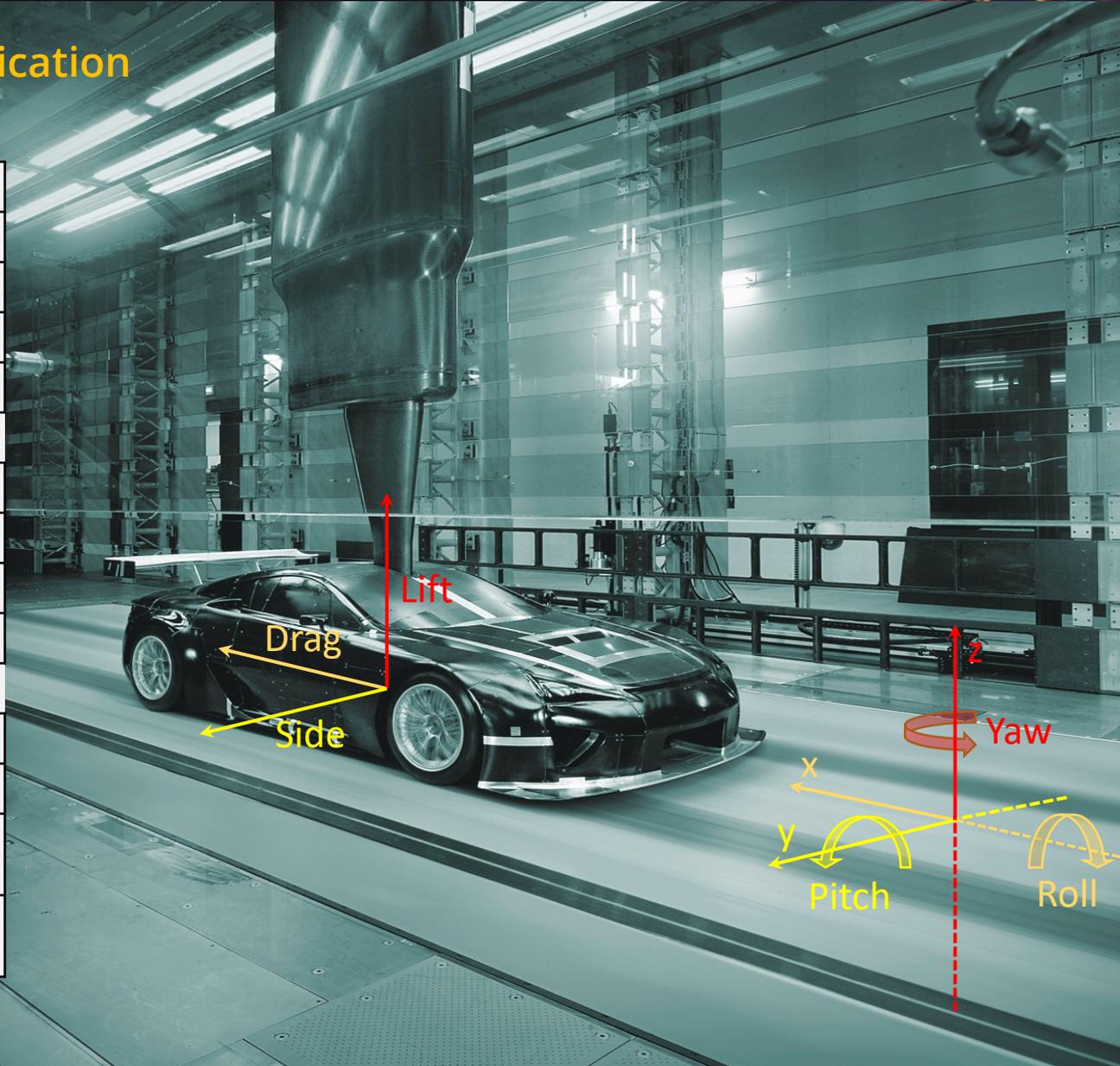
Particle Image Velocimetry system (PIV)



Wind Tunnel Testing Overview

Some WT Technical Specification

Dimensions	63 x 26 x 13m
Test Section	15 x 4.1 x 3.7m
Max. Wind Speed	70m/s
Fan Diameter	6.3m
Fan Power	2.3MW
Rolling Road	
Max. Speed	70m/s (252kph)
Width	2.4m
Length	7m
Vertical Wheel Force Measurement	
Load Range (model)	30-300N
Load Range (full-size, front)	50-500kg
Load Range (full-size, rear)	70-700kg



Overhead Balance	
Drag	1800N
Side Force	1400N
Lift	5200N
Roll Moment	1100Nm
Pitch Moment	2600Nm
Yaw Moment	1100Nm
Accuracy	±0.04% FS
Repeatability	±0.02% FS
Model Motion System	
Drag	1500N
Side Force	±750N
Lift	5200N
Roll Moment	±200Nm
Pitch Moment	±2600Nm
Yaw Moment	±250Nm

Aerodynamic development for race car - basic concept

The main purpose of the Aerodynamic development for a race car in a Wind Tunnel, is to maximize the efficiency in term of maximum „grip“ and minimum resistance.

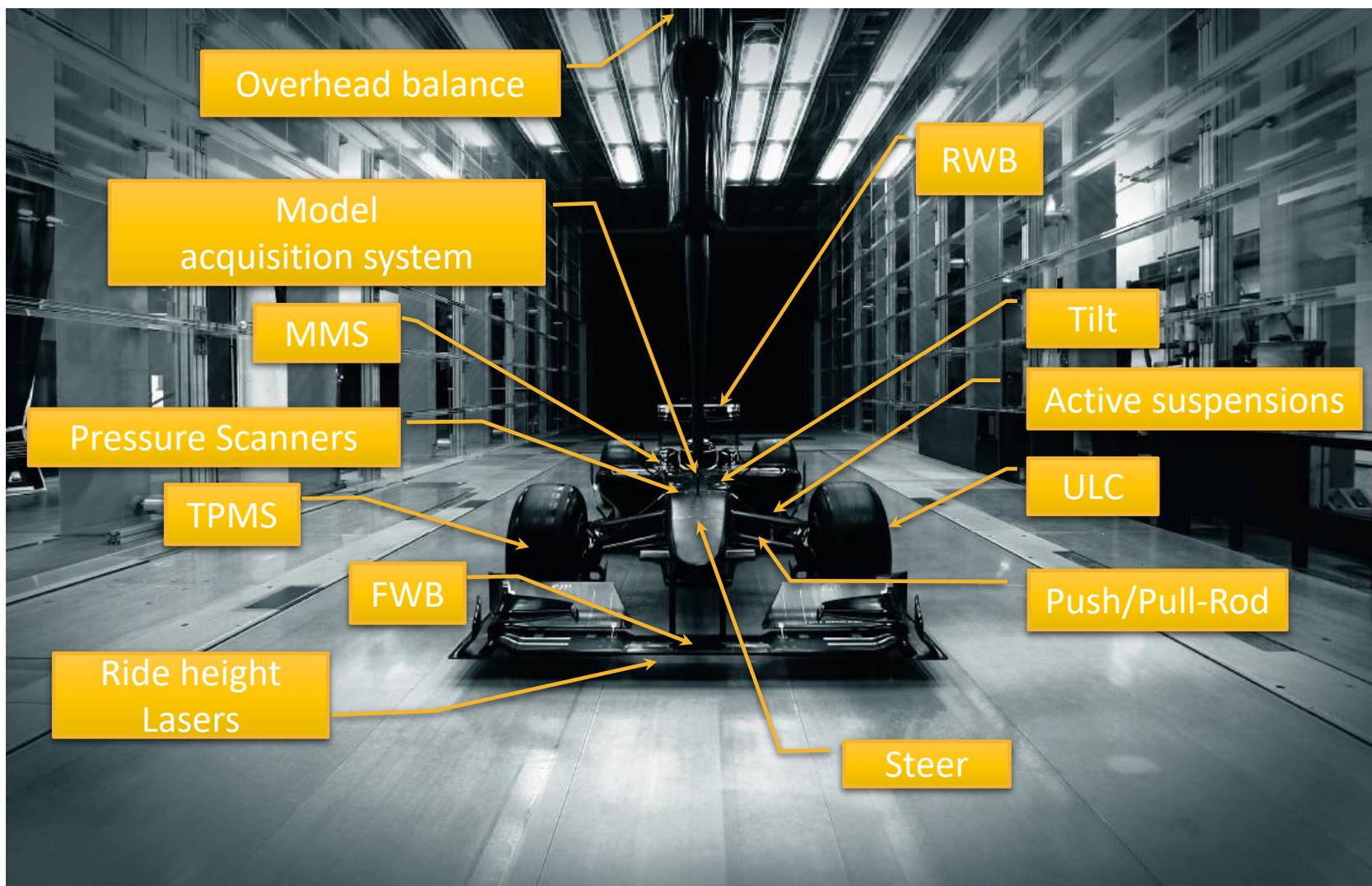
The friction / „grip“ on the tyres is proportional to the vertical force acting on them therefore one of the goal is to increase the aero down force (C_z).

The maximum speed of a race car is inversely proportional to the drag (C_x).

The ratio in between C_z and C_x provide the efficiency of the car: maximum grip and maximum speed.

WT Model and electronic devices

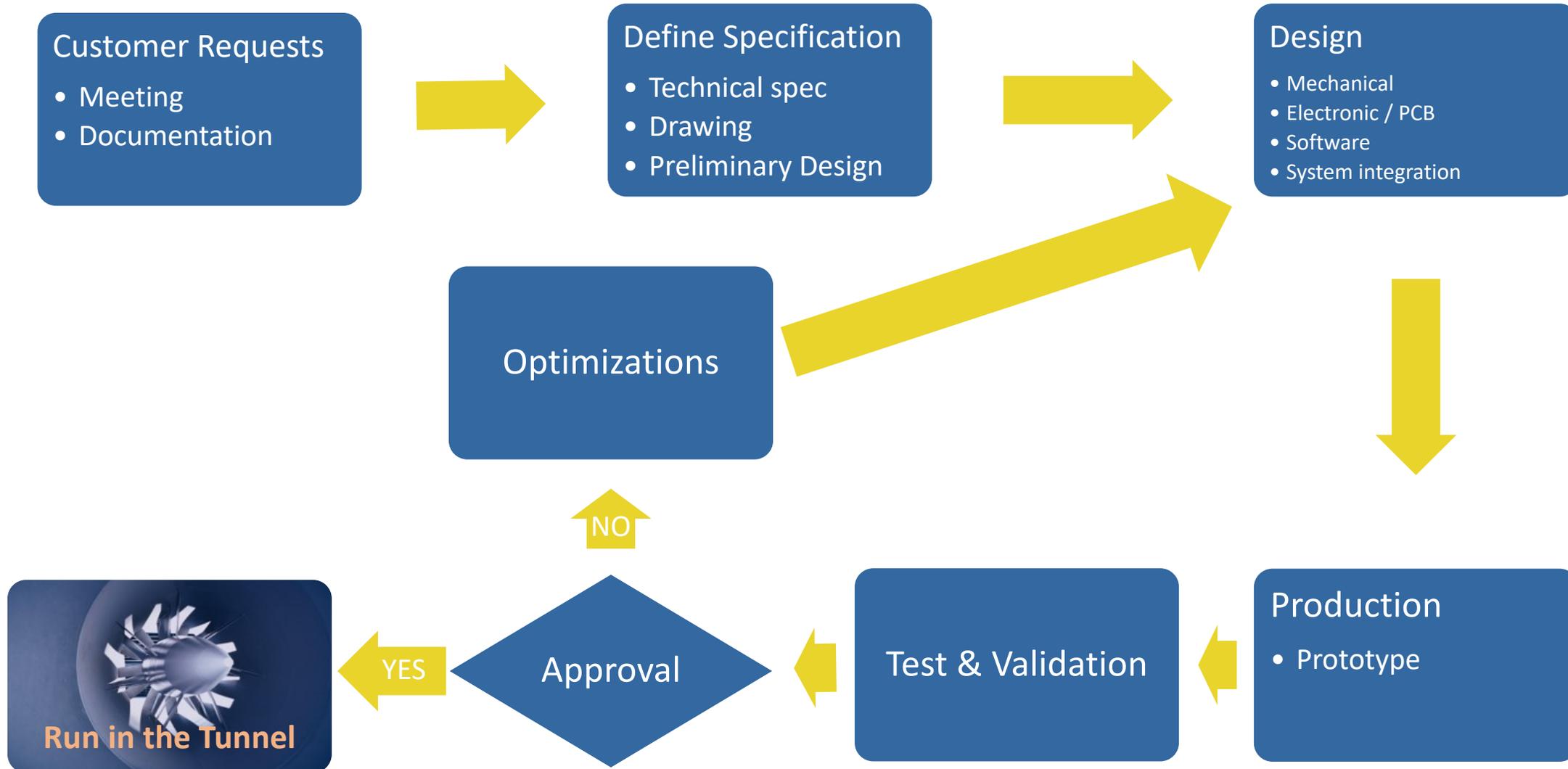
What is it installed inside a wind tunnel model ?



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Prototyping Design Process



General Requirements

In both wind tunnels we are running different project for several Customers.

The time schedule is very taut.

Each session is 4-10 days and the running time is from 16 to 24 h/day

Therefore is very important to have reliable devices capable to run for long time without issues.

Another aspect is the installation time. In between one session and the next one the test section preparation and the model installation have to be as quick as possible.

Typical installation time is less than two hours

Key points

The collection of all the information related to the specific project/requirement involves different branches and departments.

It is mandatory define, after a preliminary meeting, a proper time schedule.

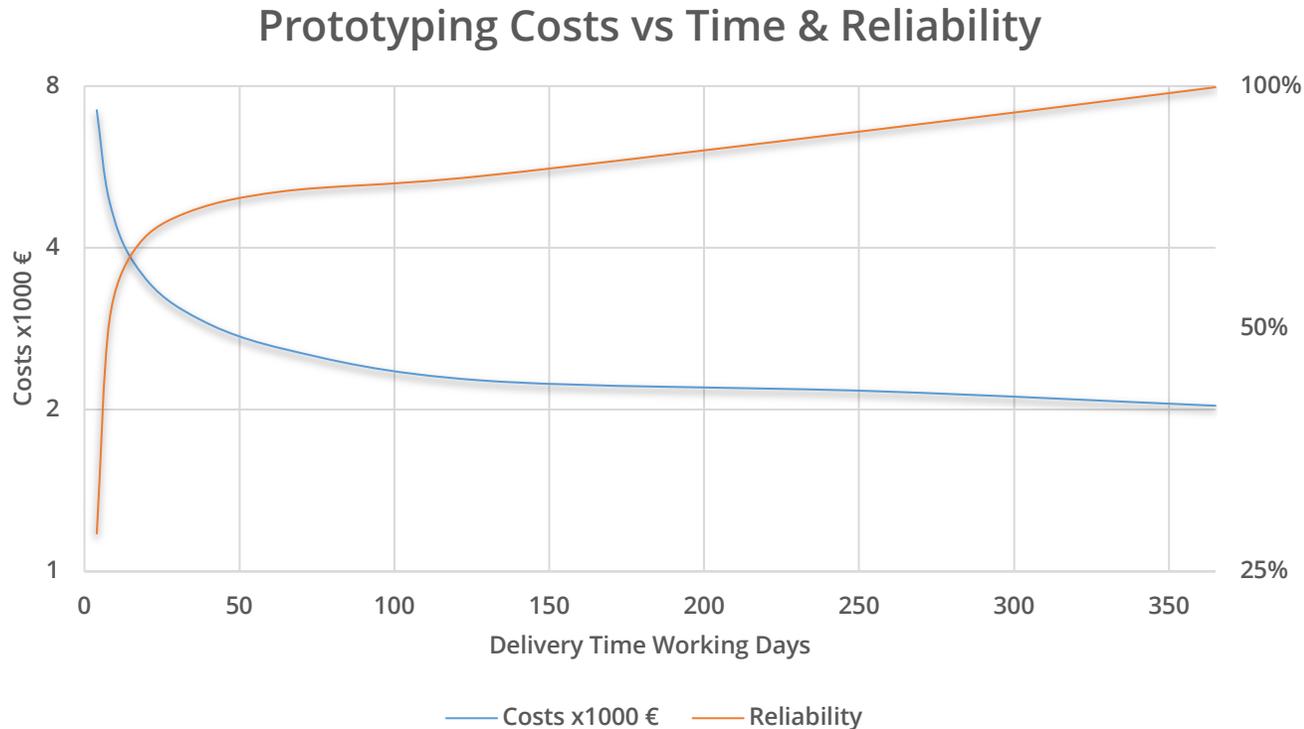
It is important identify clear and „measurable“ target.

All the involved party have to follow the planned scheduled time (internal departments and external suppliers) in order to deliver in time the devices to be used in the wind tunnel.

Reliability is also one of key point. We test all the devices on a test bench for minimum 24 hours. This is avoiding to install devices that can be affected of early failure.

Since 2011 we designed more than forty devices using Altium Design.

We have improved the reaction time and we have decreased the average time to produce a prototype. We are able to produce a new prototype in an average time of four week. The design time drop down to a couple of days accordingly to the complexity of the devices or improvements.



The time constraints are against the cost of the project and in particular of the PCB production. Short delivery time can increase the price of the PCB production from four to ten times of the basis price (typical base price considering 8 -10 working days).

The cost increases also when the amount of parts to be produced is small (1 to 5 pieces) that is a typical case for the prototypes.

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Preliminary process

Altium design is a complete environment where you can configure your project and take care all of the aspects of your systems/devices.

When we started to use it, quite big preliminary work has taken place.

We have prepared several templates, tools and configurations in Altium and we have defined our way to use and work with it.

A continuous population work of our shared components library for the schematic and for the PCB is always in progress. At the beginning it was very challenging prepare our own libraries.

We decided to fill the library with all the components/parts that have been used in the past and with the ones selected for their reliability and functionality accordingly to our needs.

We also attended to several Altium trainings in order to improve our knowledge and improve our efficiency when using it.

The possibility to have a complete overview of the project in terms of schematic, PCB, bill of materials, mechanical enclosure give us the possibility to reduce the probability of mistake.

Steer Optic limit switches improvement

In one of our project we had to improve the limit switches functionality on the steering assembly.

On one side it was necessary to replace the limit switches devices and on the other side it was necessary to improve the interconnection of the unit with the other systems.

The travel of the mechanical carriage of the steer has two type of safety devices:

1. Electrical limit switches
2. Mechanical stopper

These are avoiding that the steering assembly can be damaged if, due to an issue, it has driven over the maximum range.

In our previous assembly it have been used limit switches with a mechanical lever and push button: DG13-B1

This limit switches are capable to carry up to 2A.



Steer Optic limit switches improvement

It is obvious that the electrical limit switches have to be engaged before the mechanical stop.

Unfortunately the need to move the steer up to the maximum travel range becomes critical for this kind of limit switches.

This for three main reasons:

1. Accuracy of the position and of the operation/switch point; the accuracy requested is around 0.2mm
2. Repeatability of the engaging point
3. Mechanical damage

Therefore another family of limit switches has been selected; we opted for the optical limit switches Omron EE-SX1106.

In this way we were able to increase the accuracy and the repeatability of the detecting point. It has a high resolution with a 0.4-mm-wide aperture.

The delivery time was very tight; we had only two weeks to produce the first prototype.

Design

The design of the schematic and the PCB took one day.

The PCB became very compact and it includes also all the interconnection to the steer motor and feedback sensor. It also became like a sort of junction board in between the steer assembly and the controller.



It has been checked and integrate in the mechanical assembly in CAD using the 3D Altium tool.

The PCB board has been order with a delivery time of two days.

All the component have been purchased with two day delivery time

The assembly of the PCB board took less than one day.

A 24 hours test follow and we were able to install it in the model two days before the session.

Last model functionality check and setup took few hours in our model shop

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Steer project and Documentation

The Steer improvement requested the mechanical integration on the steering assembly itself and the final revision before the approval.

Using the PCB design and the 3D functionality of Altium it was very quick and easy check the mechanical integration of our new board on the steer mechanical assembly.

A proper documentation have been prepared: one of the function that it is very useful and quick in this case is the „Smart PDF“. This function allow to create also the „Output Job“ that will became part of the Project (PrjPCB).

Altium Design have been used not only for design PCB but also for other application like acquisition and motion cabinet. We defined our way in order to create schematic documentation for most of the projects, devices and instrumentations installed in our Wind tunnels

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Questions ?

Open Session

Thank you for your attention.