Racking up the profits

Leveraging plating simulation technology to optimize rack and tooling design

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Where Technique Meets Technology

Smart Manufacturing

Smart Manufacturing

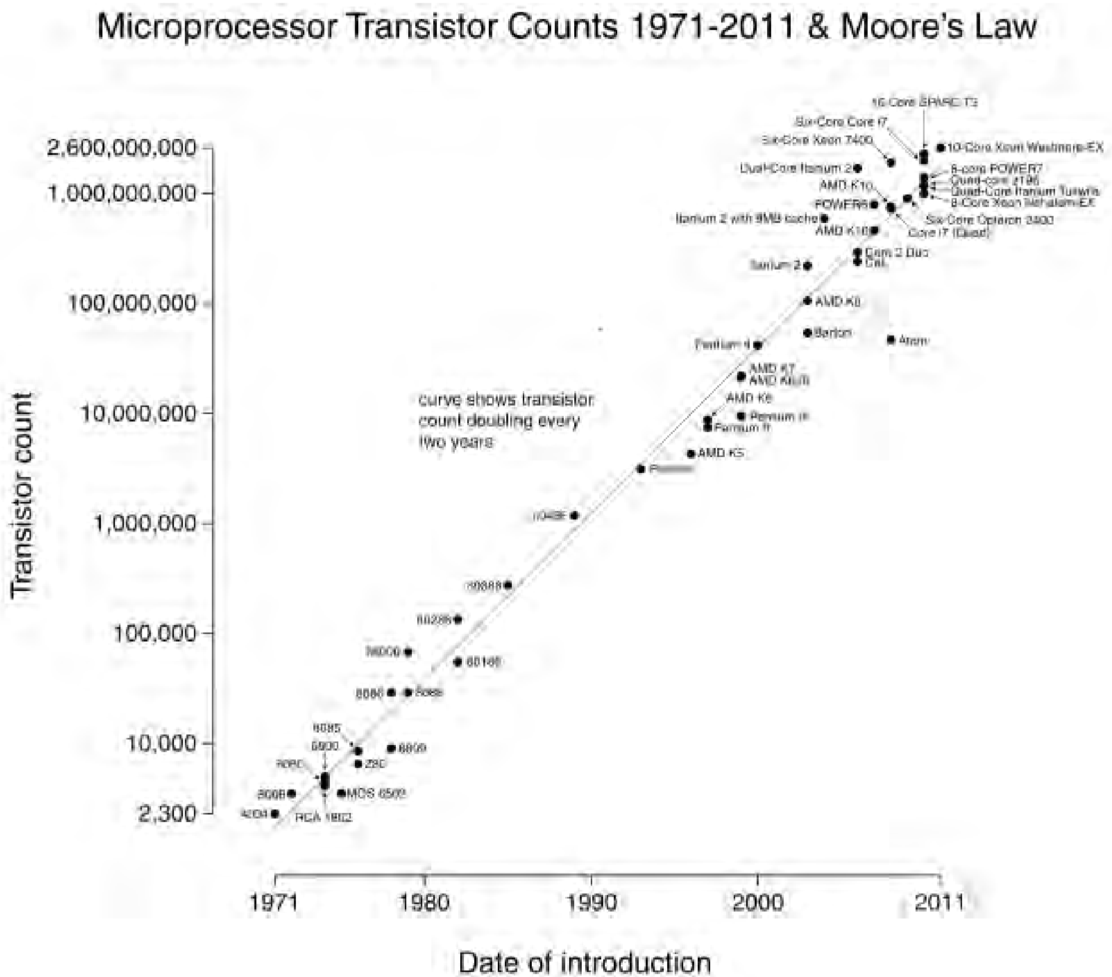
- *Smart Manufacturing is revolutionizing process and product innovation, productivity and resource efficiency by combining the* ***physical*** *and* ***virtual*** *worlds.*

"In short, at the company and plant level, we are seeing tremendous improvement potentials in productivity and efficiency thanks to software technology." Helmuth Ludwig, CEO Siemens

Moore’s Law and Computing Power

The law is named after Intel co-founder Gordon E. Moore, who described the trend in his 1965 paper. The paper noted that the number of components in integrated circuits had doubled every year from the invention of the integrated circuit in 1958 until 1965 and predicted that the trend would continue "for at least ten years".

The period often quoted as "18 months" is due to David House, an Intel executive.



Everyday Engineering Analysis…

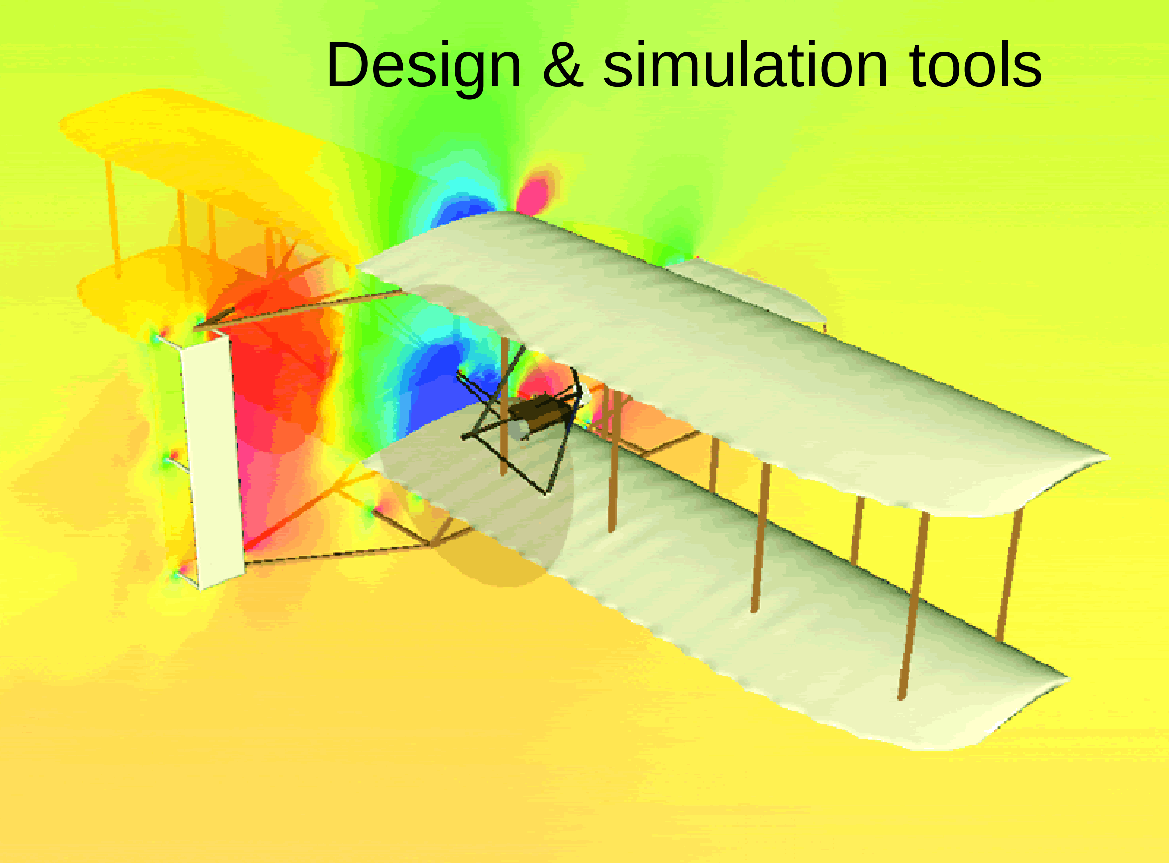
- Stress analysis
- Thermal analysis
- Fluid flow
- Seismic
- Crash dynamics… simulate or trial & error?

Why not surface finishing?

Technique – honing your skill

Technology – upfront analysis

Stress the concept



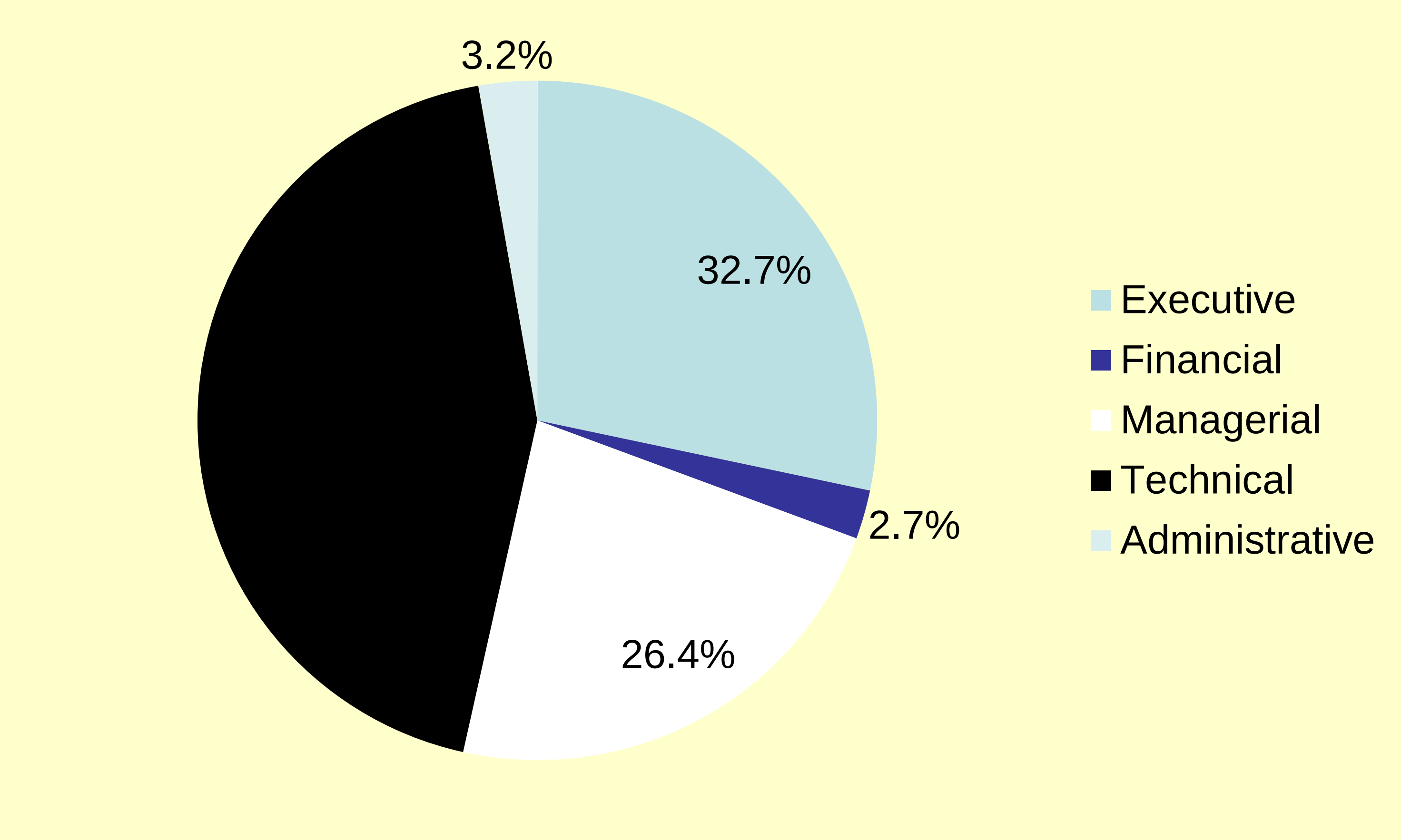
First four flights Kitty Hawk 17 December 1903 – from concept to flight 5 years

CAE Awareness in Surface Finishing

How do Surface Finishing Manufacturing Executives Make & Qualify Investment Decisions?

In 2012 we surveyed 9000 individuals connected to the SF sector, of which 300 (and growing) responded in full (3.3%).

Who’s viewpoint



Challenges

Rate the business challenges	Exec	Tech	OEM	Supplier
Costs	1	2	3	1
Productivity	2	3	2	2
Capacity				
Quality	3	1	1	3
Regs compliance				
Project lead times				
Supplier capability				

Threats

Rate the threats	Exec	Tech	OEM	Supplier
Competition domestic				
Competition international		3	3	3
Lack of trained staff	1	1	1	1
Lack of resources & investment	3			
Regulations	2	2	2	2

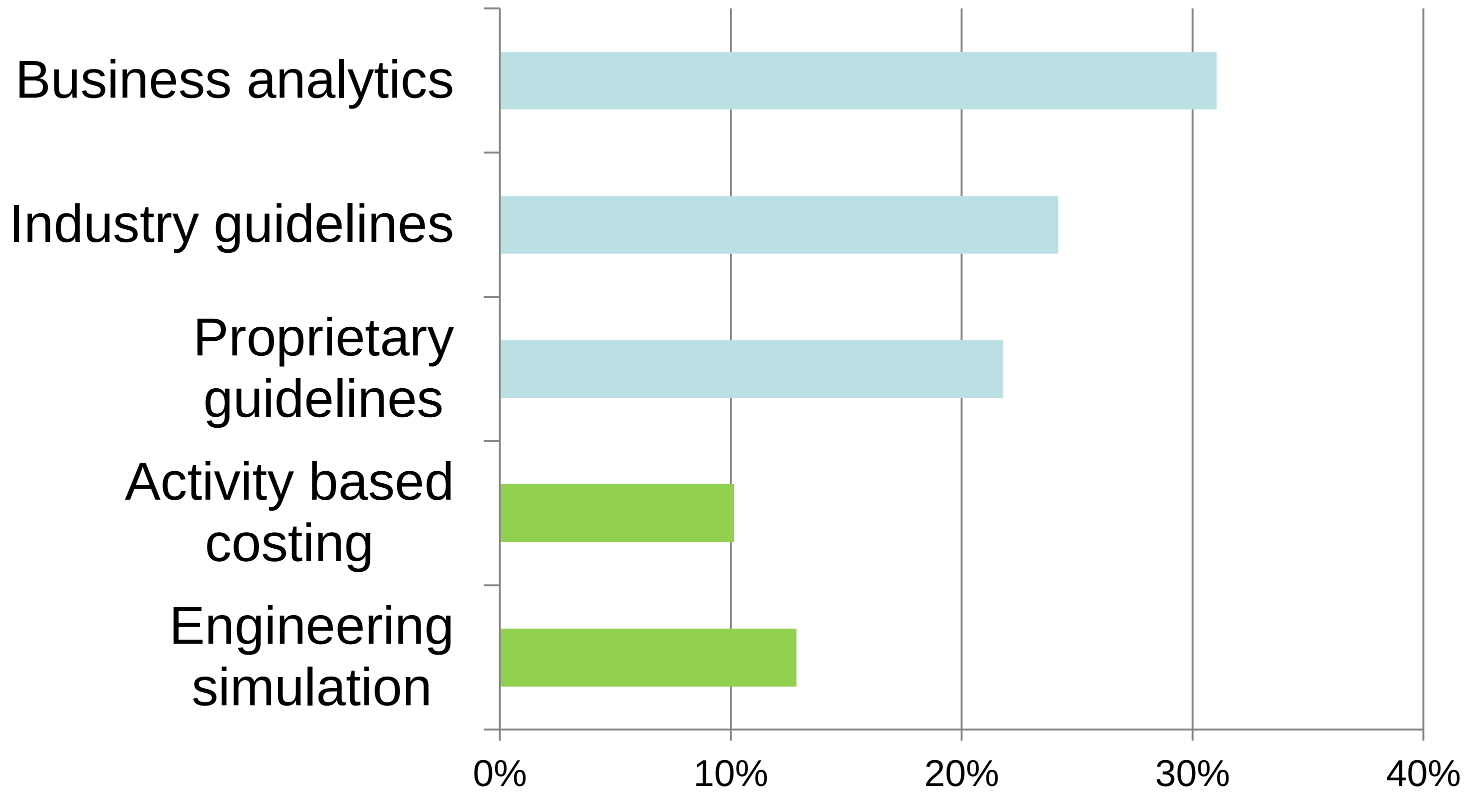
Costs

Rank the costs	Exec	Tech	OEM	Supplier
Labor	2	3		2
Scrap, rework		3	3	3
Energy				3
Materials, commodities	1	1	1	1
Plant, equipment			2	
Transportation				
Environmental	3	2	2	

How do you Quantify the Impact of Technical Decisions on Business Investments?

- Business Analytics/Statistics,
- Industry Guidelines/Practices,
- Proprietary Guidelines/Practices,
- Activity based costing (ABC) tools (e.g. Plato),
- Engineering Simulation Tools (e.g. PlatingMaster, Plato, FlexTime, FEA, CFD)

Tools to assess business decisions

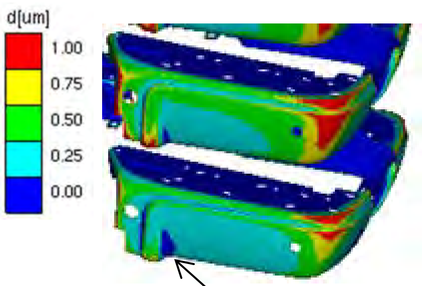


What are the limits of traditional rule of thumb methods in process design and improvement decision making?

What can we learn from a virtual plating line?

Plating Challenges

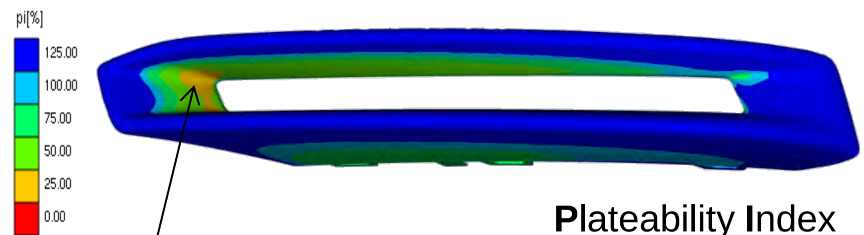
Quality



Q-specs defined to ensure in-field service – no corrosion,

Up-front plating manufacture simulation shows part **will** fail, due to under-spec chrome thickness

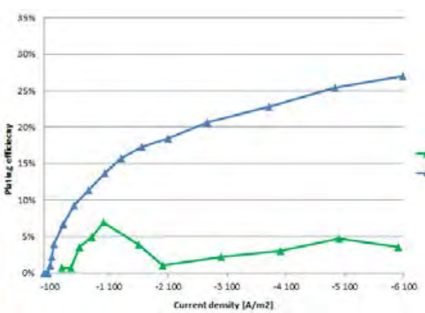
Cost

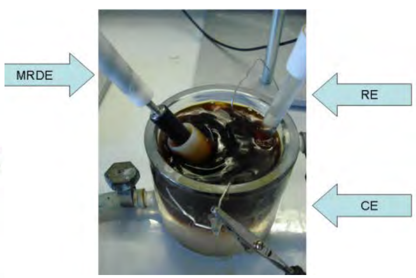


Plateability **I**ndex (PI) mapping

Rapid PI calculation in design studio, immediately identifies costly Design-Manufacture issue

Compliance





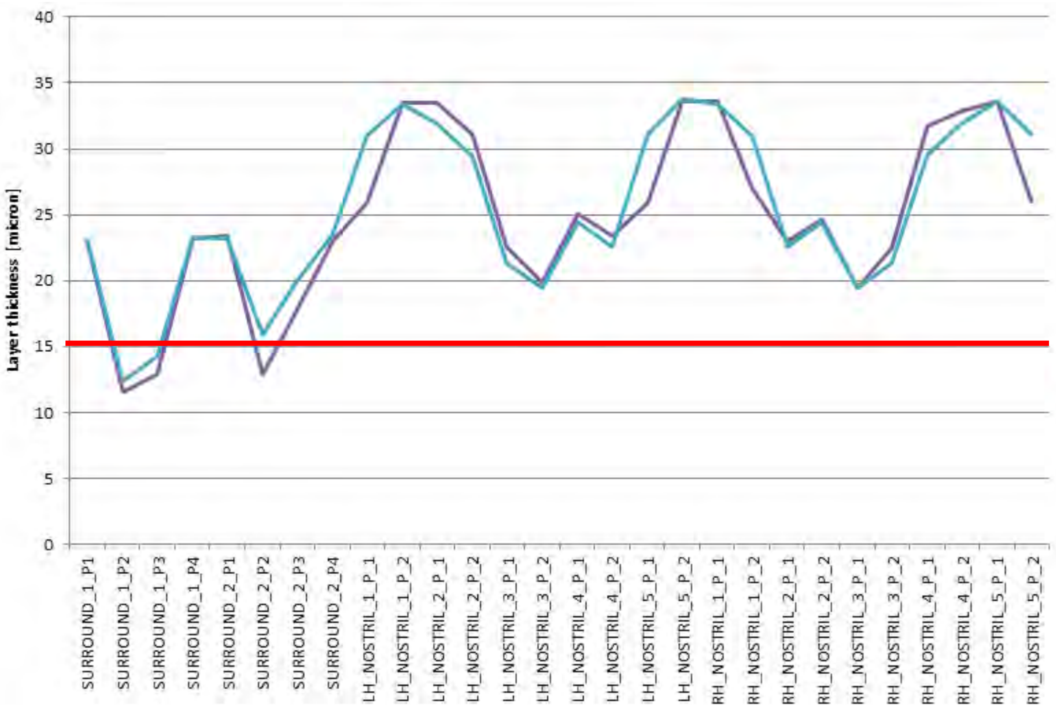
EPA/OSHA Eliminate hazardous materials. Lab. characterization of proposed coating=> Simulation quantifies technical risk of scale-up

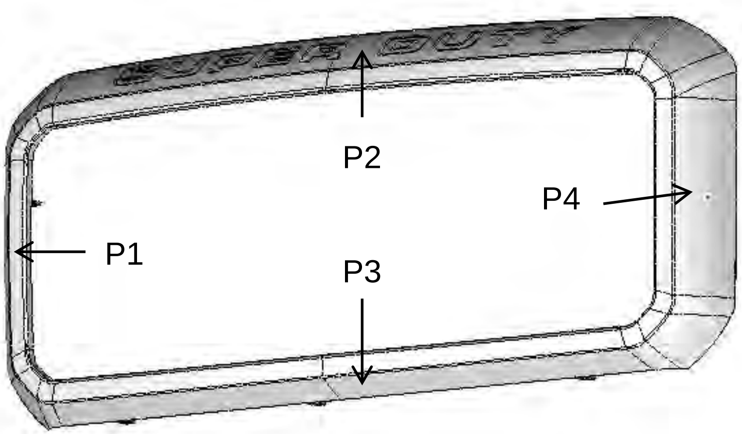
Productivity

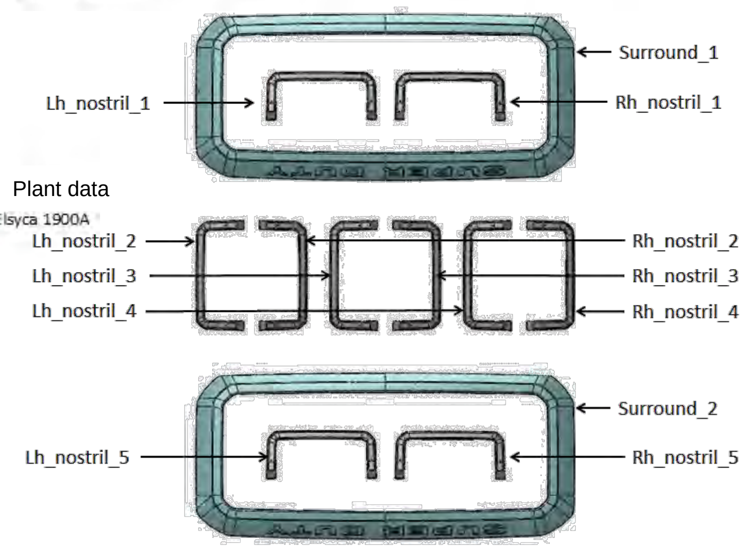
Optimize rack configuration and tooling for maximum in-spec productivity

Productivty - Rack optimization – starting point

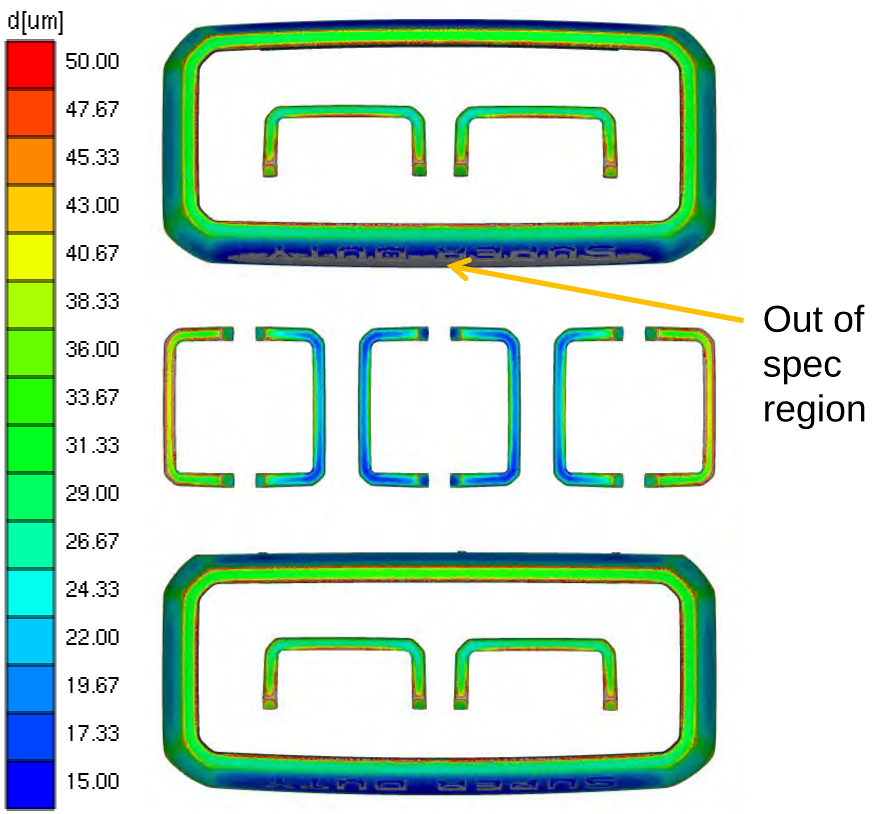
- Under spec at points on both surround grills on physical tests
- Simulations follows very closely - maximum deviation is 3 micron
- Plating time is fixed



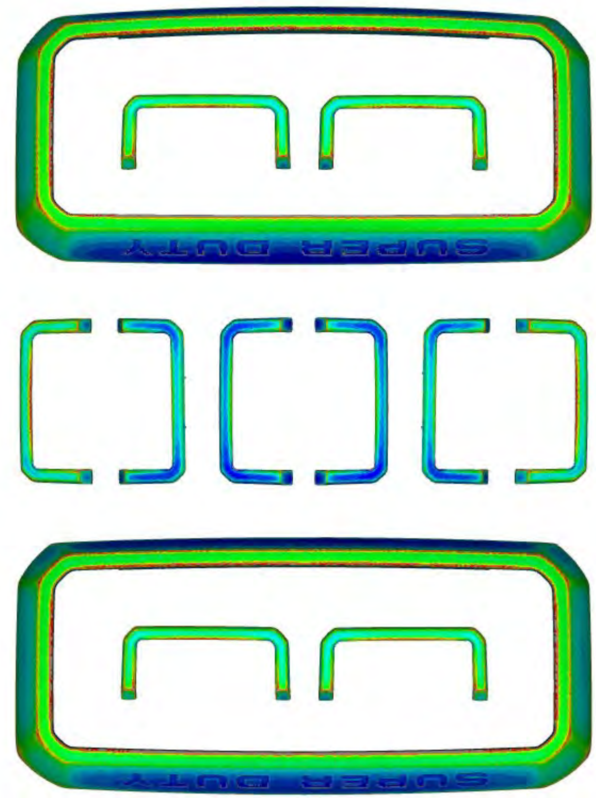




Rack optimization – comparison (v5)

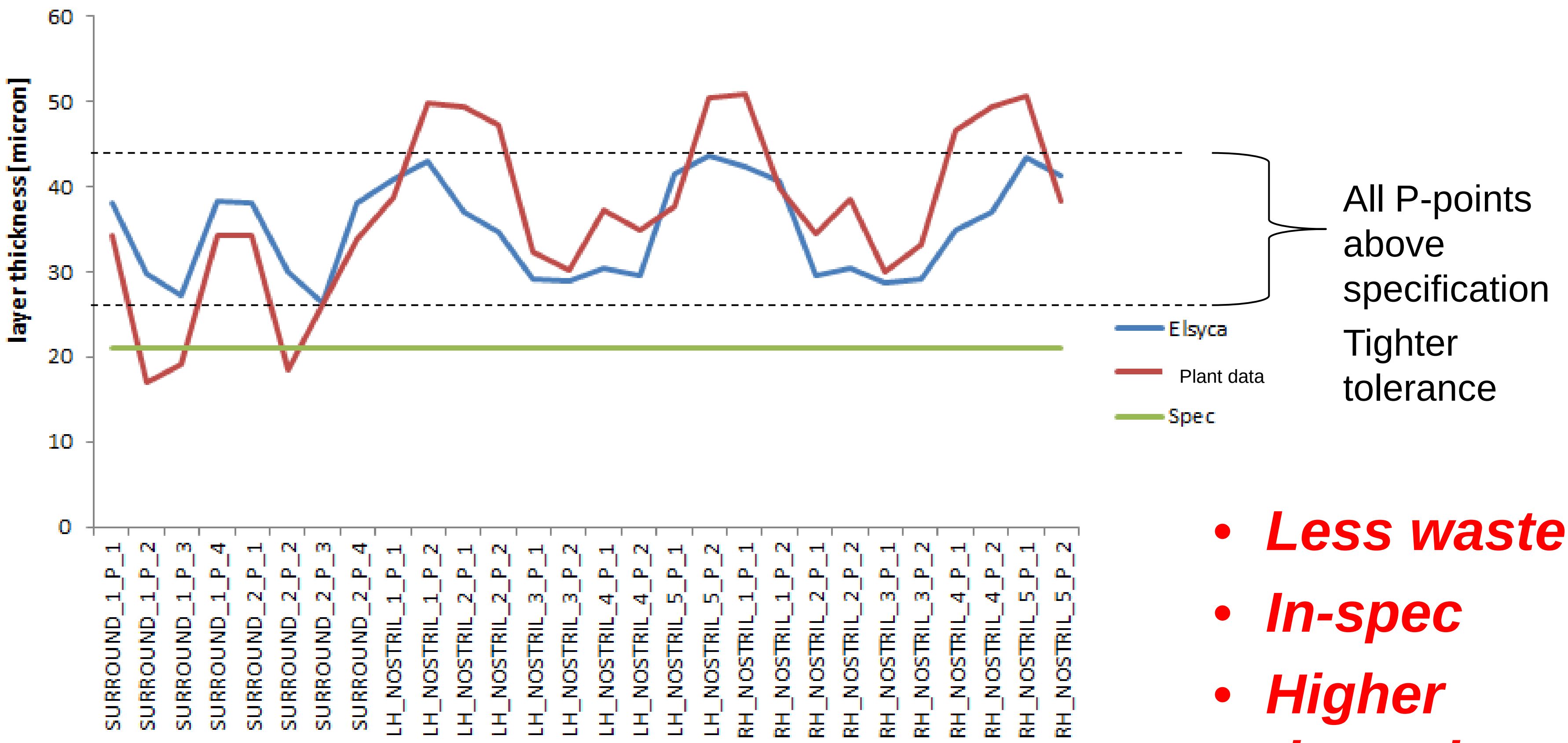


Original case



Optimization case

Production result



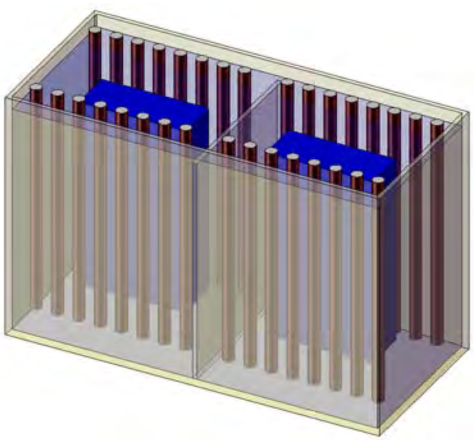
- ***Less waste***
- ***In-spec***
- ***Higher throughput***

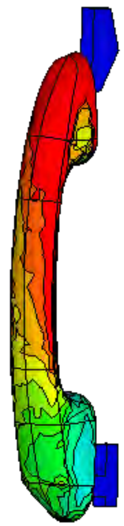
Modeling Process

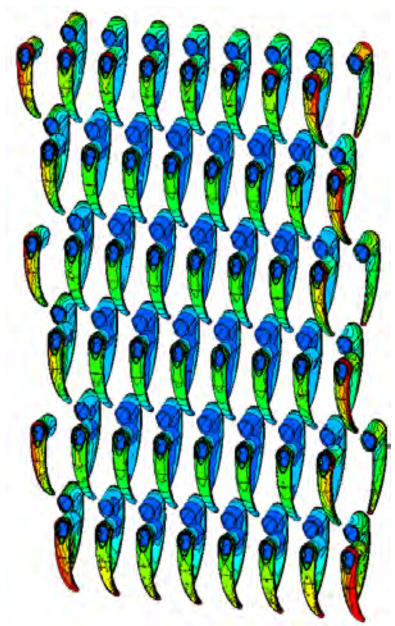
Model

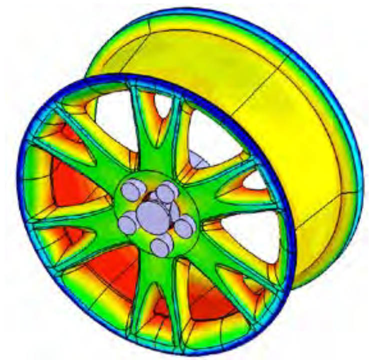
Predict

Optimize



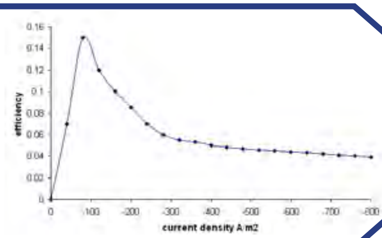




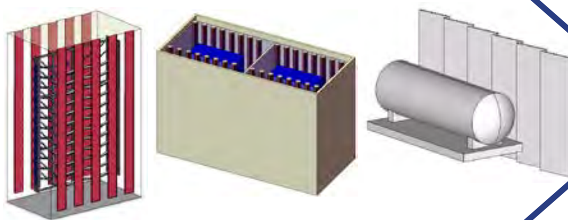


Technology – key ingredients

Physico-chemical data gathering



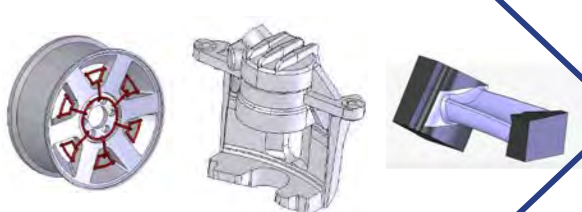
Infrastructure configuration (CAD)



Process parameters

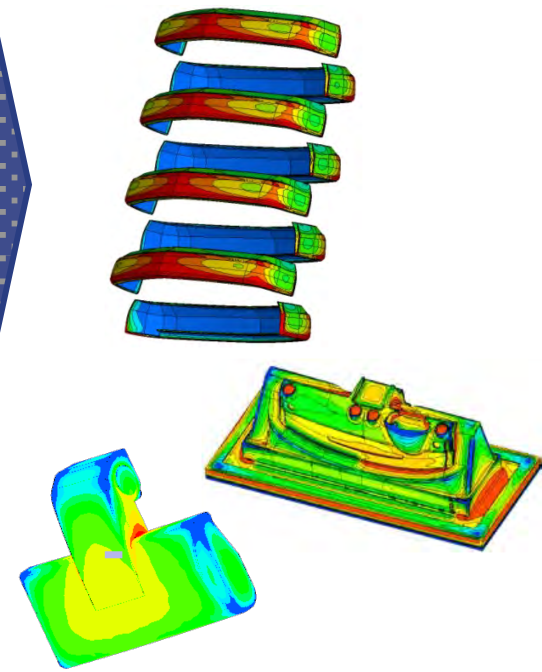
Imposed potential or current, plating times, etc.

Part/structure model (CAD)



Elsyca proprietary meshing and solving (FEM)

Simulated current density distribution and deposited layer thickness



Rack Optimiation of VW Steering Wheel Bezel

Gerd Reineck, TRW
Robrecht Belis, Elsyca

Automotive trends for interior parts

simple geometries

complex geometries

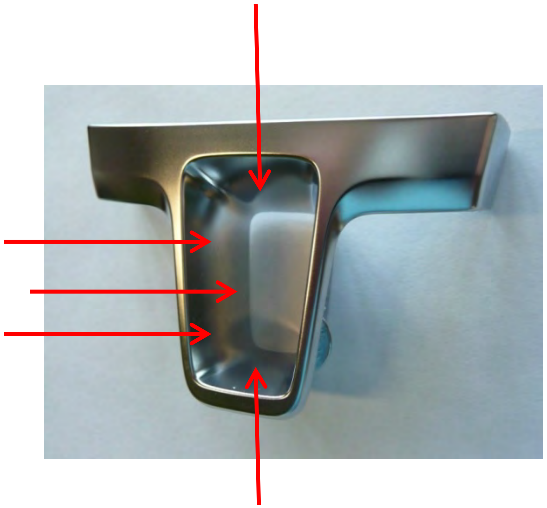
Comparison of plating processes

Conventional electroplating process:

- thickness of visible internal surface of the parts not successful – **Faraday cage**
- numbers of parts are limited
- color deviation on the bezel due to thickness variations
- high scrap rate

Electroplating process with auxiliary anodes:

- thickness all internal surface within customer specification
- reduction of scrap rate
- increasing of numbers of parts on the racks
- uniform color of all areas on the bezel



Faraday cage - poor macro throwing power

Project description

- Project description (outsourced to Elsyca)
  - Chrome plate steering wheel bezel
  - Define optimal rack load/part orientation
  - Define optimal process conditions
  - Design rack
  - Identify potential suppliers

- Challenges
  - Geometry with recessed area
  - Geometry with sharp edges
  - No design changes allowed
  - Very short time window (5-6 weeks)

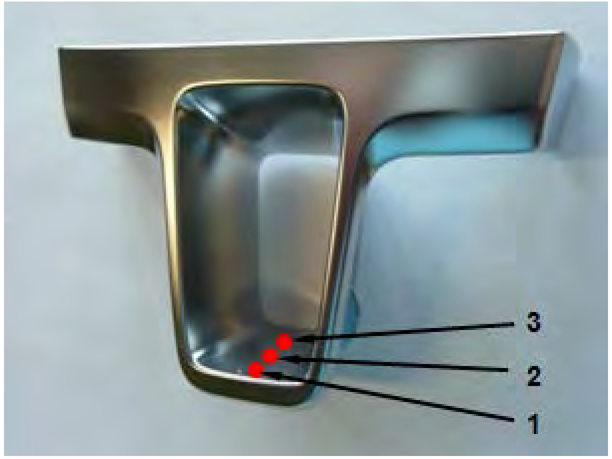
Project steps

- Requirement definition
- ‘As-is’ simulation
- Optimization based on simulations
- Design auxiliary anodes
- Design technical drawing rack
- Build physical rack
- First prototype run
- Electroplating in practice
- Further optimization by simulation/trial
- Performance auxiliary anodes

Requirements - ‘As-is’ simulation

Requirements by customer

Requirement of …	Thickness
… copper	> 20 µm
… nickel	> 10 µm
… chrome	0,3 µm

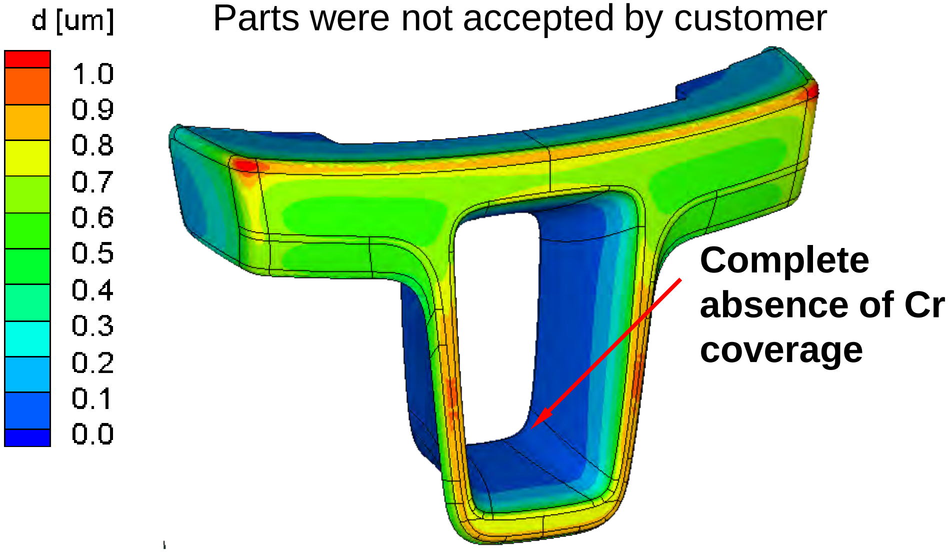


Measuring points according to drawing

Average simulated thickness by Elsyca

Measuring point	1	2	3
copper	13	6	10
nickel	5	2	3
chrome	0.19	0.08	0.13

Parts were not accepted by customer



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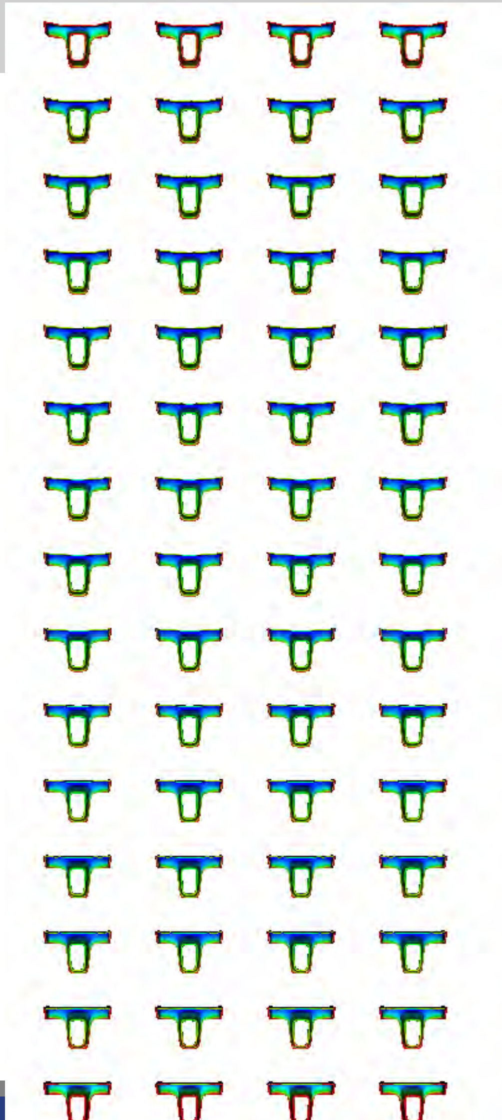
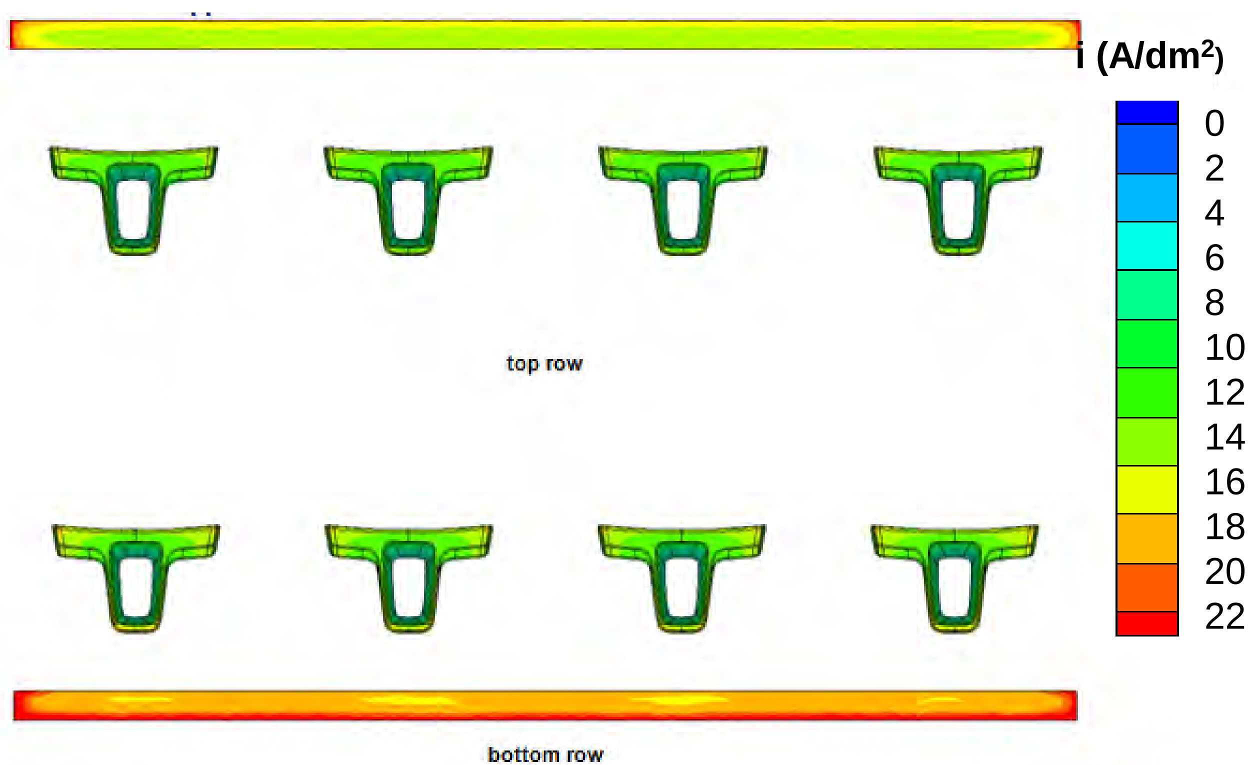
Optimization based on simulations

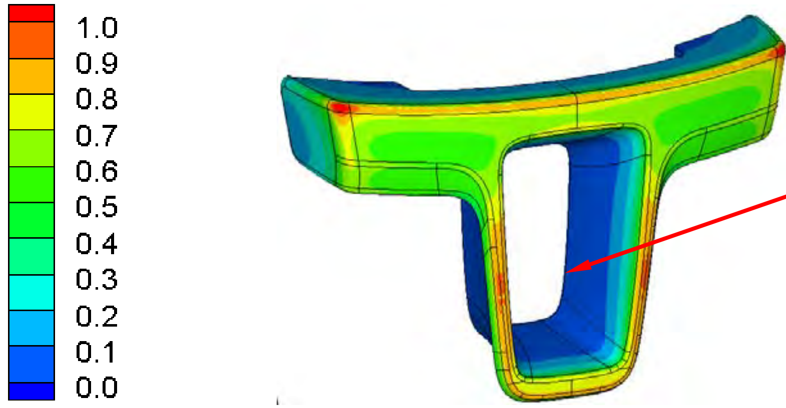




→Design and validate current robbers
→Rack load and part orientation
→Process parameter

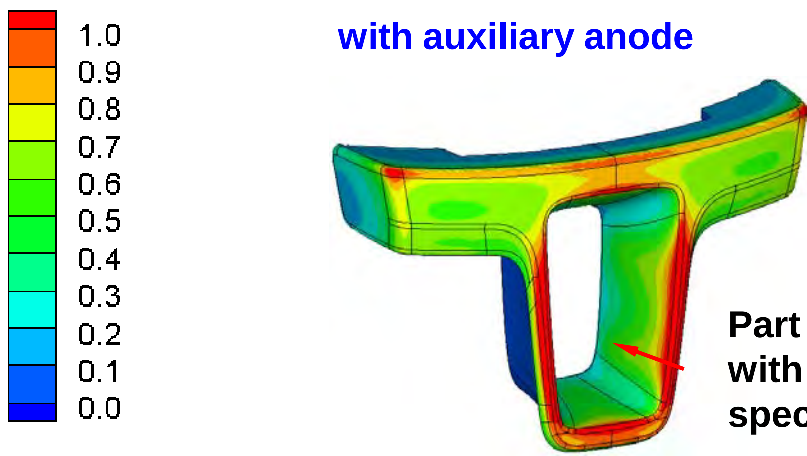
Design auxiliary anodes

without auxiliary anode



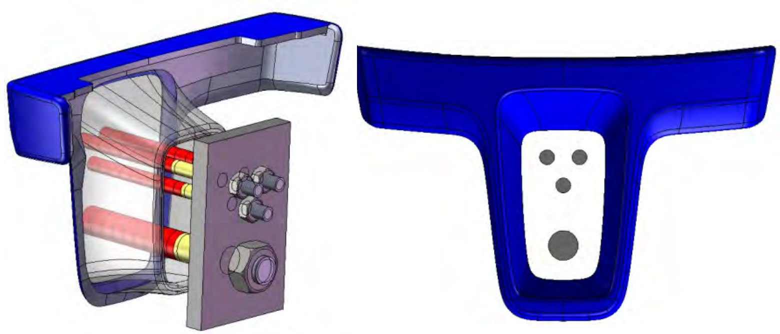
Complete absence of Cr coverage

with auxiliary anode



Part entirely with specification

4 auxiliary anodes – platinized Titanium
3 x 3 mm diameter pens
1 x 6 mm diameter pen



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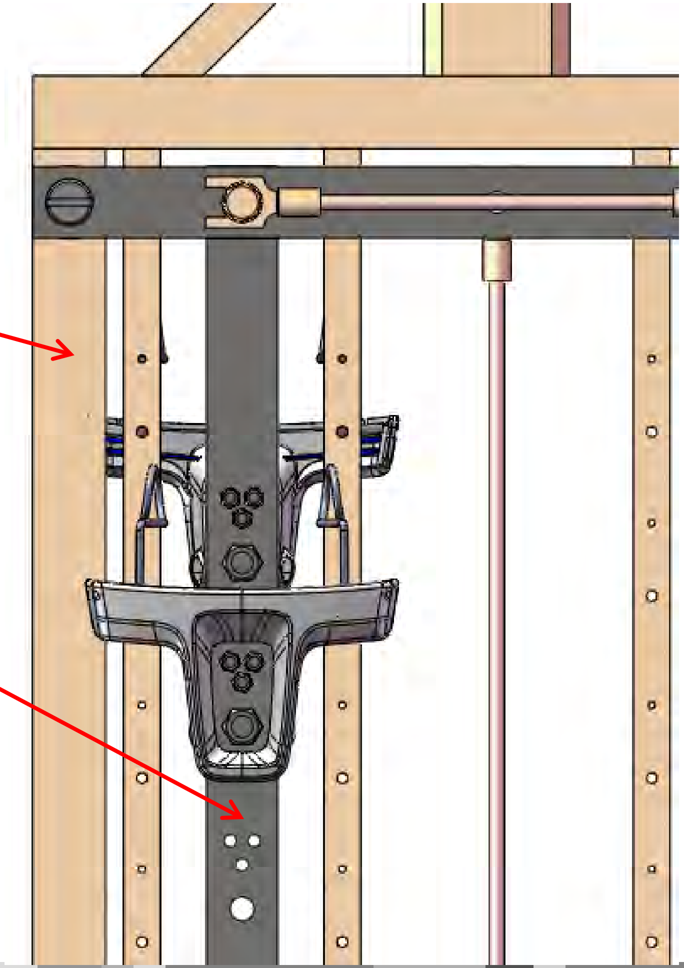
Design technical drawing rack

Cathode frame

Anode frame



The frames are isolated to prevent short circuit

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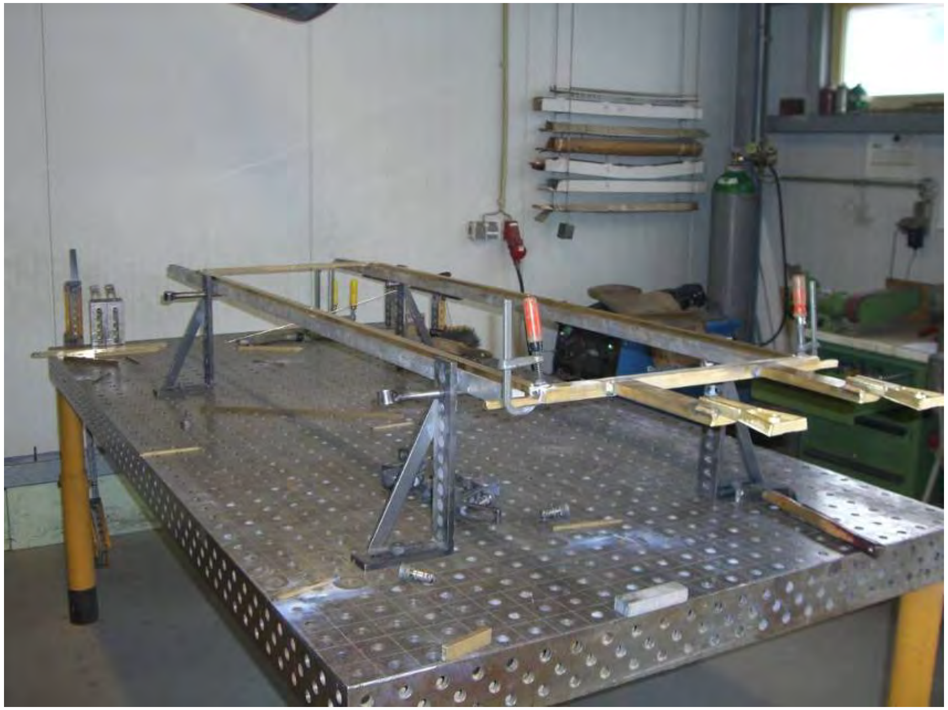
Build physical rack

Rack production from builder Leukel, Hünstetten, Germany



Rack preparation based on simulation for the first trial

Coated rack

Rack manufacturer LEUKEL has in the complicated processing of racks with auxiliary anodes sufficient experience

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First prototype run

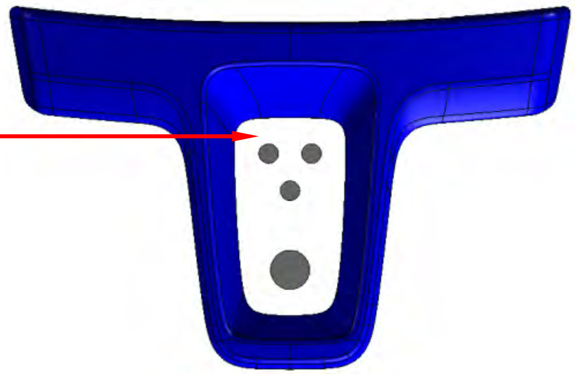
- All parts are within specification
- Time from start to first production run was 5 weeks

- Auxiliary anodes are very powerful, but
  - Requires excellent rack production (exact dimensions as simulation)
  - Requires more care to load/unload the part
  - See next slide

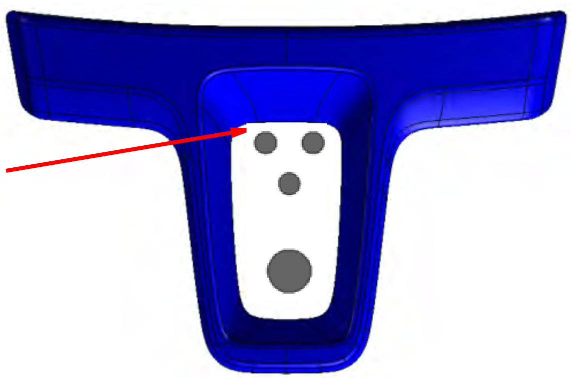
- Iteration to further improve production robustness on auxiliary anode design

Electroplating in practice

distance o.k.



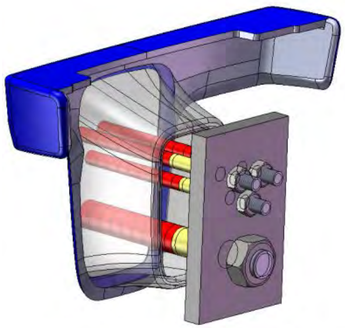
distance not o.k.



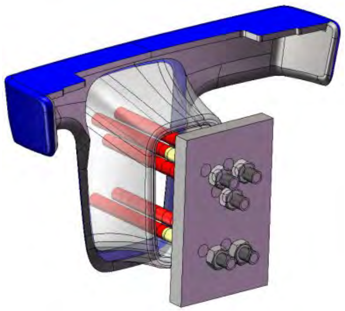
burn marks

Further optimization by simulation/trial

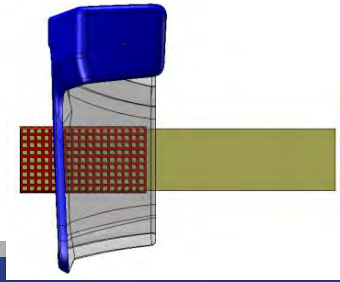
Variances



4 auxiliary anodes – platinized Titanium
3 x 3 mm diameter pens
1 x 6 mm diameter pen



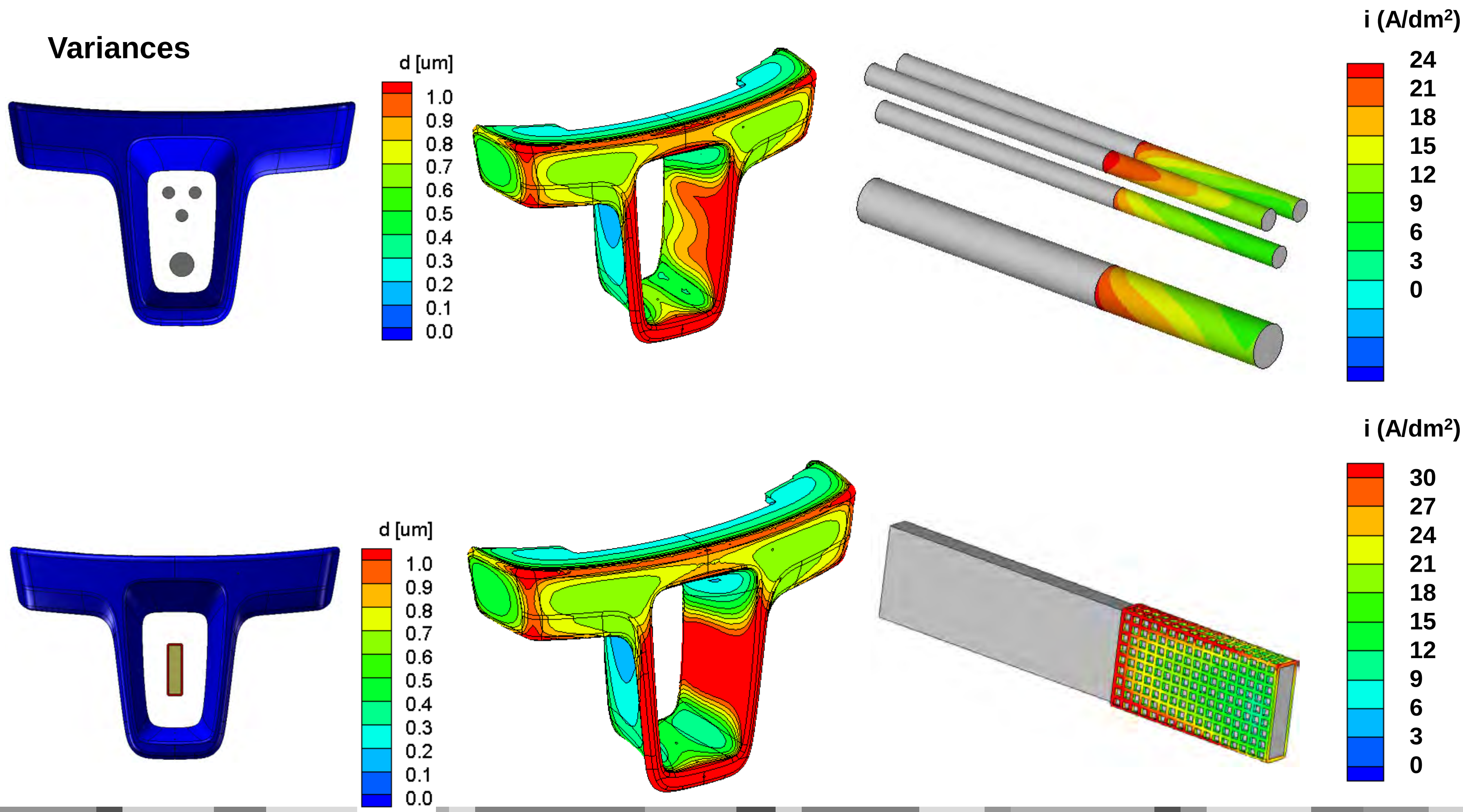
5 auxiliary anodes – platinized Titanium
3 x 3 mm diameter pens



1 auxiliary anodes (rectangular)
12,7 x 3,2 mm

Performance auxiliary anodes

Variances

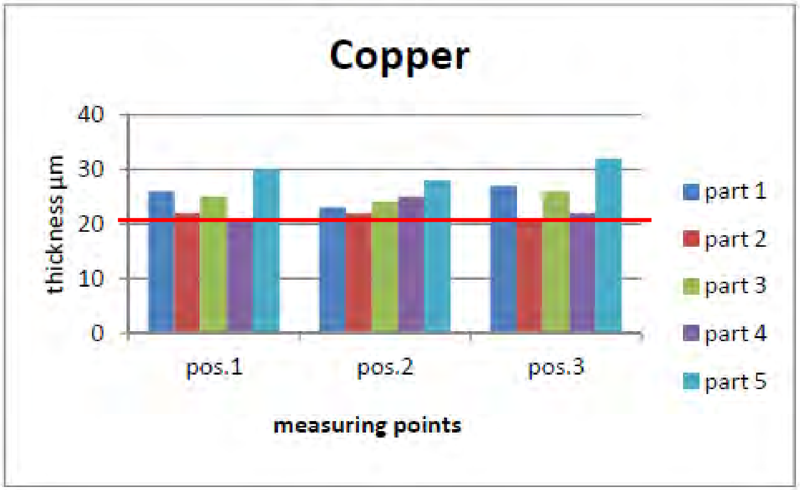


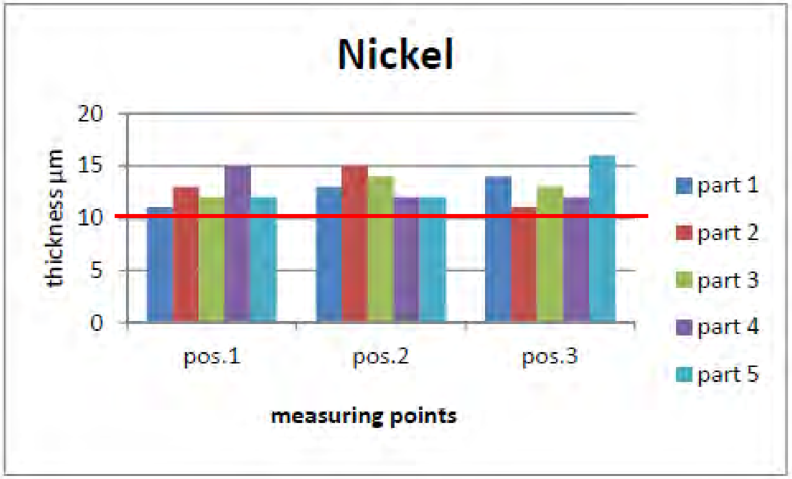
Results of production

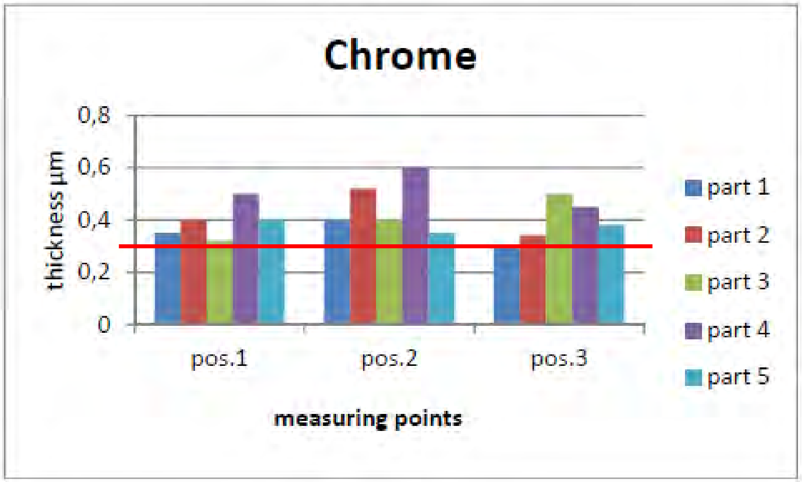
Electroplating with auxiliary anodes

Measuring point	Cu 20 µm	Ni 10 µm	Cr 0,3 µm
1	21-30	11-15	0.32-0,50
2	22-28	12-15	0,35-0,52
3	21-32	11-16	0.30-0,50

Thickness entirely according to customer specification







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Summary

Results from the overall research were successful

- Plastic components with complex shapes could be metalized
  this implies more flexibility for the designers

- Worldwide one of the very few examples of a decorative
  bezel using auxiliary anodes

- Overall aims of this technologically challenging production process
  were met using auxiliary anodes

- Simulations provided all required information
  to ‘produce-right-first-time’

- Very short time windows are challenging, but not impossible

Is it catching on?

- GM14668
- Ford Engineering Design Rule
- Several large platers implemented across the board

Conclusions

- Engineering simulation is more flexible, predicting ahead – empirical relies on the past and experience
- Awareness and use of prediction tools in Surface Finishing is very low compared to other sectors
- OEMs recognizing value and beginning to call out in SORs

Origin of the Phrase “Rules of Thumb”

One origin of the phrase “rules of thumb” is not flattering…

The exact origin of the phrase is uncertain. The earliest citation comes from J. Durham’s *Heaven upon Earth*, 1685, ii. 217: "Many profess Christians are like to foolish builders, who build by guess, and by rule of thumb."[1]

Thank You. Questions?

Don't be Distracted by the Rearview