CFD RACE TO MARKET
HPC USER FORUM
September 13-15, 2010
Swift Engineering: Winning the Race of Market Innovation...
- Established in 1983 specifically for motorsport design
- Expanded company’s culture and approach into other markets in the 1990s

- 60,000 Sq Ft purpose built, state-of-the-art facility in Southern CA, providing:
  - Vertically integrated in-house design to manufacturing capabilities
  - Product development assistance (products first-to-market)
SWIFT’S CULTURE

- 27 years of continuous motorsports design: 10 series, 500+ cars, 40+ championships
- Motorsports = INNOVATION/PERFORMANCE/RACE-TO-MARKET
- Leverage Swift’s culture, approach, in-house talent and capabilities into different markets
SWIFT INDUSTRY EXPERTISE

AUTOMOTIVE

AEROSPACE

AVIATION

- Collaborative projects with global client/partners, including:

  - HONDA
  - DODGE
  - VOLKSWAGEN
  - TOYOTA
  - MAZDA
  - BMW
  - FORD
  - BOEING
  - Raytheon
  - LOCKEED MARTIN
  - NORTHROP GRUMMAN

- Collaborative projects in **OTHER** market sectors include:

  - Callaway GOLF
  - UNIVERSAL STUDIOS
THE RACE OF MARKET INNOVATION

1) PURPOSE DRIVEN DESIGN
2) ENGINEERING & ANALYSIS
3) RAPID IN-HOUSE PROTOTYPING & TESTING
4) IN-HOUSE TOOLING & MANUFACTURING

CLIENT'S VISION

Swift Engineering Inc.

CLIENT’S END-PRODUCT

SWIFT: SPEED-TO-MARKET

32 WEEKS

30 WEEKS

28 WEEKS

RACECAR

UNMANNED AERIAL VEHICLE

PRIVATE JET
PRODUCT DEVELOPMENT CAPABILITIES

PRODUCT DEVELOPMENT PROCESS

Conceptual Design

PRODUCT DEVELOPMENT PROCESS

Initial Production
PRODUCT DEVELOPMENT CAPABILITIES

Conceptual Design  Computational Fluid Dynamics  CAD Modeling  Finite Element Analysis  Initial Production
Styling & Surfacing  Dynamic Simulation  Wind Tunnel Verification  Prototype & Testing
Swift offers solutions at any level of product development.
**CFD CORNERSTONE CAPABILITY**

Aero performance is the critical key component to Swift’s product development from racecars to airplanes to hairdryers!

Swift’s increased CFD capabilities improve speed-to-market:

- *Model generation and modification faster in virtual environment*
- *Ability to run multiple complex models in same environment*
- *Increased data points and analysis capabilities*
SwiftSizer MDO
- Layout
- Performance
- Stability & Control
- Weight & Balance
- Sizing
- Optimization

CFD++ Cray CX1000
- 3D Aero
- Loiter Drag
- Dash Drag
- Stability
- 3D $C_{L_{\text{max}}}$

CATIA v5
- Packaging
- Big-Bones
- FEA

Xfoil CFD++
- Airfoil Design
- Cruise Bucket
- Section $C_{L_{\text{max}}}$

Vortex Lattice
- Loiter Span-load
- Trimmed $C_{L_{\text{max}}}$
- Trimmed Dash

ALIAS
- Class-A Surface
- Definitive OML

PRODUCT DEVELOPMENT CYCLE
HPC for Better Entertainment

Closer Racing = More Entertainment
Less Wake Upset = Closer Racing

With CFD Swift can
“Design the Wake”
SWIFT INDYCAR DESIGNED FOR ENTERTAINMENT
SWIFT INDYCAR DESIGNED FOR ENTERTAINMENT

GENERIC INDYCAR

Classic Mushroom-Shaped Wake Behind a Car with Downforce
NO MUSHROOM BUSTER

MUSHROOM BUSTER EQUIPPED

MUSHROOM DISABLED (SPEEDWAY CONFIGURATION)
SWIFT HPC SYSTEM

- Cray CX1 for Pre and Post Processing

- Mesh Tools;
  - “ANSA”, “MIME”

- Post-Processing;
  - Metacomp visualizer
  - TecPlot
  - NVidia GX4800 graphics card

- Cray CX1000
  - 18 node compute array
  - Each node is a dual-processor quad-core
  - Total of 144 compute array processors
  - 36 port Infiniband QDR switch
Each compute node has 24GB of RAM

18 nodes = 432GB of RAM

Storage;
- 12TB scratch  (RAID 0 config for jobs in the queue)
- 12TB storage  (RAID 6 config to archive older data)

Flow Solver; CFD++ written by MetaComp Technologies
- Fully structured meshes
- Fully unstructured meshes
- Moving mesh module

Biggest job to date - High lift grid - 73 Million cells

Max capability is 200 Million cells
Wind Tunnel vs. CFD at Swift

Wind Tunnel
5 vehicles / year
30,000 configurations / year
300,000 points / year

CFD
20 Vehicles / year
200 Configurations / year
600 points / year
Wind Tunnel vs. CFD at Swift

Wind Tunnel
5 vehicles / year

CFD
20 Vehicles / year
Eclipse Concept Jet Wake Survey – CFD++
Unsteady CFD Loads for FEA Analysis

Rolling

Zero-Rates

CL=0.1720
Cm=0.0415
at t=400

CL=0.137
Cm=0.0858
WIND TUNNEL VS. CFD AT SWIFT

Swift’s added HPC resources with Cray’s CX-1 and CX1000 HPC:

- CFD is 500 times less productive than our Wind Tunnel
- But... CFD uses a 5th of the manpower
- Still, CFD is 2 orders-of-magnitude less productive
- But, the barrier-to-entry is much lower without a wind tunnel model
- And, comprehensive flow knowledge is invaluable
- So CFD utilization is going up while our Tunnel utilization is down.
WIND TUNNEL-CFD CORRELATION AT SWIFT

2010 AIAA 1st High-Lift Prediction Workshop

Swift is participating with major Aerospace companies to validate CFD methods at moderate Rn through stall.

Correlation is excellent up to 5 degrees before stall – work continues...
SWIFT’S HPC PLANS

- CFD-based Optimization with Sculptor™ (underway)
- Continued participation in High-Lift Prediction Workshop
- Participation in Drag Prediction Workshop
- Correlation studies with FN09 WT data (underway)
- 3D time accurate windmill solutions (2D underway)
- CFD-coupled MDO with SwiftSizer