Challenge Italia

The Italian Challenge at the «Little America’s Cup»

At «Star Global Conference 2012»

Amsterdam March 19-21/2012
Giuseppe Musca

Hull designer, CFD analyst
Challenge Italia

The Team

Giuseppe Musca
a sailing team of winning athletes

Francesco Bruni
Pierluigi De Felice
Gabriele Bruni
Vittorio Bissaro
Lamberto Cesari
Luigi Blancato
Gaetano Pennino

- 2 ranking first in ISAF world match racing
- 4 participations in past Olympics
- 5 participations in past America’s Cup’s
- 8 world championships
- 8 European championships
- 33 Italian National championships
a group of winning designers

<table>
<thead>
<tr>
<th>Name</th>
<th>Role/Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benedetto Inzerillo</td>
<td>Project manager</td>
</tr>
<tr>
<td>Attilio Albeggiani</td>
<td>Project manager, construction manager</td>
</tr>
<tr>
<td>Richard Korpus</td>
<td>CFD analysis, wing-sail design and engineering</td>
</tr>
<tr>
<td>Claudio Cairoli</td>
<td>CFD analysis, wing-sail design and engineering</td>
</tr>
<tr>
<td>Giorgio Provinciali</td>
<td>VPP analysis</td>
</tr>
<tr>
<td>Davide Tagliapietra</td>
<td>Structural analysis, FEM analysis</td>
</tr>
<tr>
<td>Massimo De Luca</td>
<td>Hull CFD analysis</td>
</tr>
<tr>
<td>Giuseppe Musca</td>
<td>Hull design, hull CFD analysis, construction coordinator</td>
</tr>
<tr>
<td>Francesco Belvisi</td>
<td>Preliminary hull parameter design</td>
</tr>
<tr>
<td>Luca Caruso</td>
<td>Wing-sail structure design</td>
</tr>
</tbody>
</table>

- 10 participations in America’s Cup campaigns
- Many winning boats in the most different sailing classes

Giuseppe Musca
Our Program

3 projects, 4 boats

Project 1 = 2 boats ready by Spring 2012
Project 2 = 1 boat ready by Fall 2012
Project 3 = 1 boat ready by Spring 2013
Hull Design – C-Class

RULE:
CATAMARAN
LOA: 7.62m
BOA: 4.27m
SA: 27.868 m²
NO WEIGHT RESTRICTION
CREW: 2 @ trapeze

EXCITING ENGINEERING CHALLENGE
Hulls of reference

Classe A

F18

Tornado

AC 45

America’s Cup 2010
## Design parameters

<table>
<thead>
<tr>
<th>Displacement</th>
<th>300-360 Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>reduced wetted surface area</td>
<td></td>
</tr>
<tr>
<td>sufficient volume in the bow</td>
<td></td>
</tr>
<tr>
<td>reduced rocker</td>
<td></td>
</tr>
<tr>
<td>lifting surfaces at the stern</td>
<td></td>
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</table>
Choice of the first hull

Vpp Analysis

CFD Analysis

Hull N°1
The CFD simulation approach and methodology influenced by

- limited computing resources
- time available
Phase 1 (September /October 2011)

Notebook with 8 core intel 2630

development *project 1*

costuction prototypes 1 e 2

“work in progress”

Phase 2 (February /March 2012)

Pc with 8 core intel P960

development *project 2*

(costuction november 2012)
Phase 1

1° step
set up simulation
15 days

1. Mesh sensitivity;
2. Laminar/turbulent test;
3. Time step sensitivity.

2° step
run simulation project 1
15 days
Step 1 - Set up simulation

Mesh sensitivity

Laminar + turbulent test

**Challenge Italia**

**Step 1 - Set up simulation**

Mesh sensitivity

Laminar + turbulent test

<table>
<thead>
<tr>
<th>PARAMETERS MONITORED</th>
<th>test 4Knots</th>
<th>test 12Knots</th>
<th>test 20Knots</th>
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<tbody>
<tr>
<td></td>
<td>turbulent</td>
<td>laminar plus turbulent</td>
<td>diff. %</td>
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<tr>
<td>simulated time</td>
<td>7</td>
<td>7 sec</td>
<td>7</td>
</tr>
<tr>
<td>N° core</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>time step</td>
<td>0.005</td>
<td>0.005 sec</td>
<td>0.005</td>
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<tr>
<td>time simulation</td>
<td>63600</td>
<td>62064 sec</td>
<td>2.41</td>
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<tr>
<td>wsa</td>
<td>1.79</td>
<td>1.79 mq</td>
<td>0.09</td>
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<tr>
<td>sink</td>
<td>-0.0039</td>
<td>-0.0039 m</td>
<td>0.08</td>
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<tr>
<td>y+</td>
<td>34.41</td>
<td>34.13 m</td>
<td>0.83</td>
</tr>
<tr>
<td>F xp</td>
<td>-2.99</td>
<td>-3.01 N</td>
<td>0.86</td>
</tr>
<tr>
<td>F xs</td>
<td>-11.59</td>
<td>-11.61 N</td>
<td>0.18</td>
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<tr>
<td>F z</td>
<td>1749.92</td>
<td>1751.71 N</td>
<td>0.10</td>
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<tr>
<td>My</td>
<td>-18.60</td>
<td>-18.76 N m</td>
<td>0.86</td>
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</table>

Giuseppe Musca
Time step sensitivity

### Sensitivity time step 8 knots

<table>
<thead>
<tr>
<th>N° core utilizzati</th>
<th>N° elementi</th>
<th>time step (sec.)</th>
<th>FX-P</th>
<th>FX-S</th>
<th>FX-T</th>
<th>FZ-T</th>
<th>MY-T</th>
<th>WSA-T</th>
<th>Wall Y+ average</th>
<th>Z-translation (m)</th>
<th>Time convergence (s)</th>
<th>Total solver elapsed time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>2258754</td>
<td><strong>0,025</strong></td>
<td>-24,817</td>
<td>-48,813</td>
<td>-73,630</td>
<td>1751,422</td>
<td>1,854</td>
<td>64,954</td>
<td>-0,0174</td>
<td>28</td>
<td>56644,88281</td>
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</tr>
<tr>
<td>6</td>
<td>2256954</td>
<td><strong>0,005</strong></td>
<td>-24,919</td>
<td>-48,558</td>
<td>-73,477</td>
<td>1751,104</td>
<td>1,851</td>
<td>64,592</td>
<td>-0,0172</td>
<td>28</td>
<td>231284,6563</td>
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</tr>
<tr>
<td>Diff. %</td>
<td></td>
<td>80,00%</td>
<td>-0,41%</td>
<td>0,52%</td>
<td>0,21%</td>
<td>0,02%</td>
<td>-0,73%</td>
<td>0,15%</td>
<td>0,56%</td>
<td>1,38%</td>
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<td>-308,27%</td>
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</table>

### Sensitivity time step 12 knots

<table>
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<th>N° core utilizzati</th>
<th>N° elementi</th>
<th>time step (sec.)</th>
<th>FX-P</th>
<th>FX-S</th>
<th>FX-T</th>
<th>FZ-T</th>
<th>MY-T</th>
<th>WSA-T</th>
<th>Wall Y+ average</th>
<th>Z-translation (m)</th>
<th>Time convergence (s)</th>
<th>Total solver elapsed time (s)</th>
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<tbody>
<tr>
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<td><strong>0,025</strong></td>
<td>-42,418</td>
<td>-106,234</td>
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<td>1,880</td>
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<td>36349,62109</td>
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<tr>
<td>6</td>
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<td><strong>0,005</strong></td>
<td>-42,519</td>
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<td>-149,089</td>
<td>1751,203</td>
<td>1,879</td>
<td>94,538</td>
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<td>20</td>
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<tr>
<td>Diff. %</td>
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<td>80,00%</td>
<td>-0,24%</td>
<td><strong>-0,32%</strong></td>
<td>-0,29%</td>
<td>0,02%</td>
<td>-0,06%</td>
<td>0,00%</td>
<td>0,01%</td>
<td>-0,17%</td>
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<td>-528,49%</td>
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</table>

### Sensitivity time step 20 knots

<table>
<thead>
<tr>
<th>N° core utilizzati</th>
<th>N° elementi</th>
<th>time step (sec.)</th>
<th>FX-P</th>
<th>FX-S</th>
<th>FX-T</th>
<th>FZ-T</th>
<th>MY-T</th>
<th>WSA-T</th>
<th>Wall Y+ average</th>
<th>Z-translation (m)</th>
<th>Time convergence (s)</th>
<th>Total solver elapsed time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>2256954</td>
<td><strong>0,025</strong></td>
<td>-74,894</td>
<td>-320,674</td>
<td>-395,568</td>
<td>1752,215</td>
<td>2,152</td>
<td>152,937</td>
<td>-0,0229</td>
<td>22</td>
<td>39726,55078</td>
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<tr>
<td>6</td>
<td>2256954</td>
<td><strong>0,005</strong></td>
<td>-75,302</td>
<td>-320,349</td>
<td>-395,652</td>
<td>1751,643</td>
<td>2,150</td>
<td>152,982</td>
<td>-0,0230</td>
<td>22</td>
<td>179973,3438</td>
<td></td>
</tr>
<tr>
<td>Diff. %</td>
<td></td>
<td>80,00%</td>
<td>-0,55%</td>
<td>0,10%</td>
<td>-0,02%</td>
<td>0,03%</td>
<td>-0,11%</td>
<td>0,10%</td>
<td>-0,03%</td>
<td>-0,73%</td>
<td></td>
<td>-353,03%</td>
</tr>
</tbody>
</table>

Average time saved ≈ 400%
Final set up simulation

compromise choice

• 2,2 milion element mesh;
• Laminar/turbulent simulation;
• Time step 0.025sec;
• Time convergence variable (20; 28 sec);
• Time average for simulation 12h.
2° step
run simulation

**three boat to be analyzed**

- matrix calculation 3x3
  - three velocity
  - three fixed trim
  - free sink

27 run tot.

Giuseppe Musca
The construction

Giuseppe Musca
On going tasks

Simulation development Project 2
8 hulls to be analyzed
7 core intel P960
72 run tot. in 36 day
Thank you all for attending!!

www.challengeitalia.it