



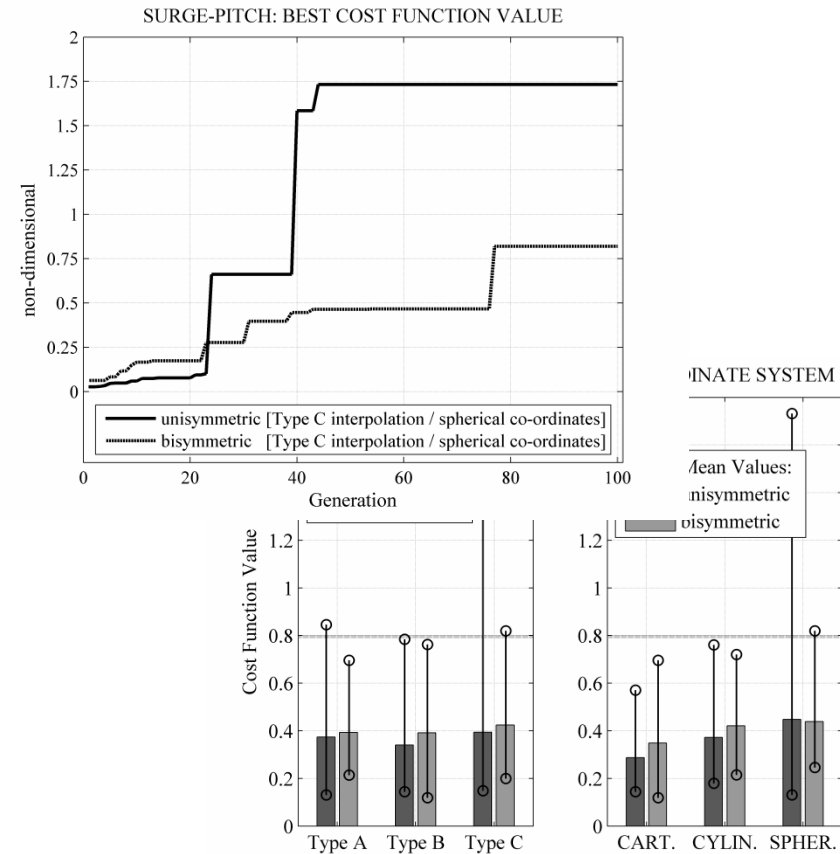
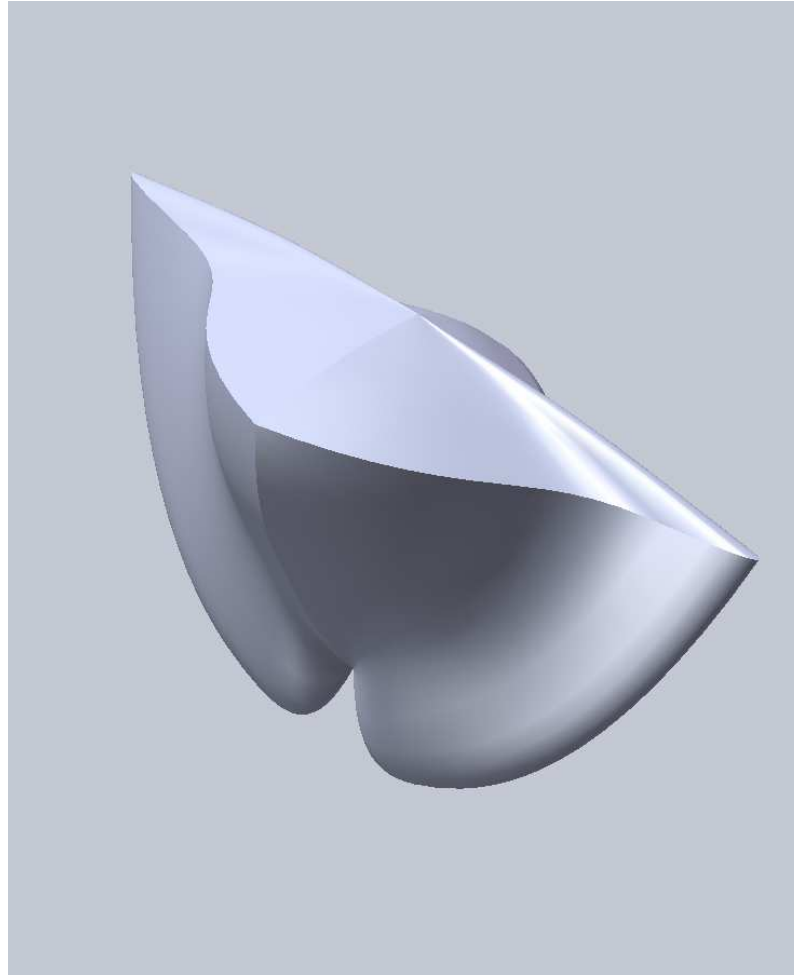
# ***New Shapes by Evolution***

***Andy McCabe  
Lancaster University***

# Background

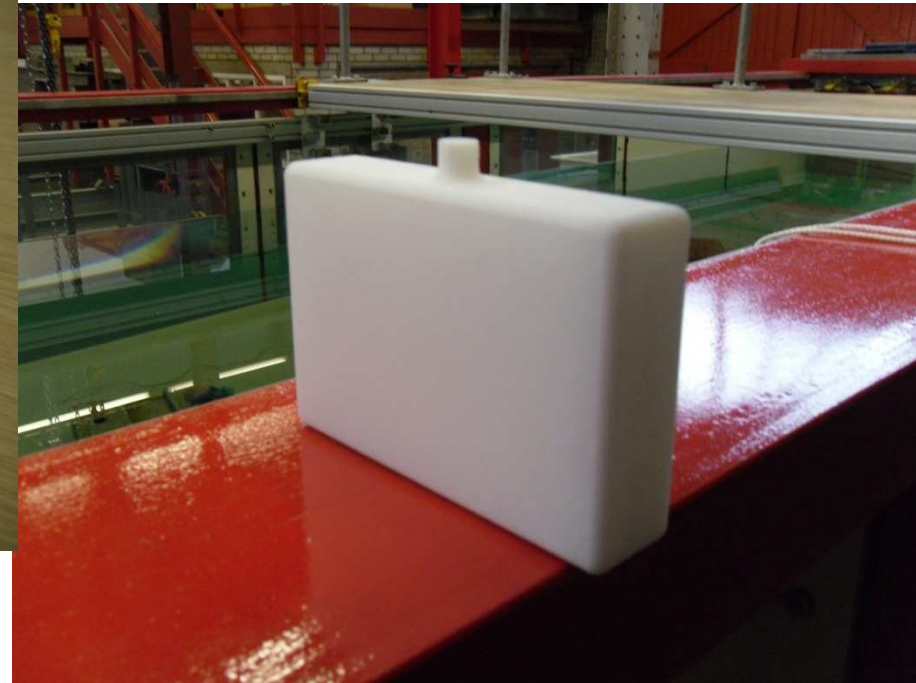
- A systematic approach to the optimisation of the shape of the wave energy collector is desirable to improve energy capture rates.
- The procedure is to be as free of human intervention and preconception as possible.
- The approach requires:
  - the development of an appropriate genetic algorithm,
  - the formulation of parametric descriptions of the wave power devices, and
  - the identification of appropriate cost functions.

# According to the Algorithm...



**Published in Renewable Energy, 2010.**

# Then, The Reality Check...



Laboratory test models made by the Lancaster University RPU (Rapid Prototyping Unit). Models of 'good', 'mediocre' and 'bad' shapes to be compared with run-of-the-mill shape.

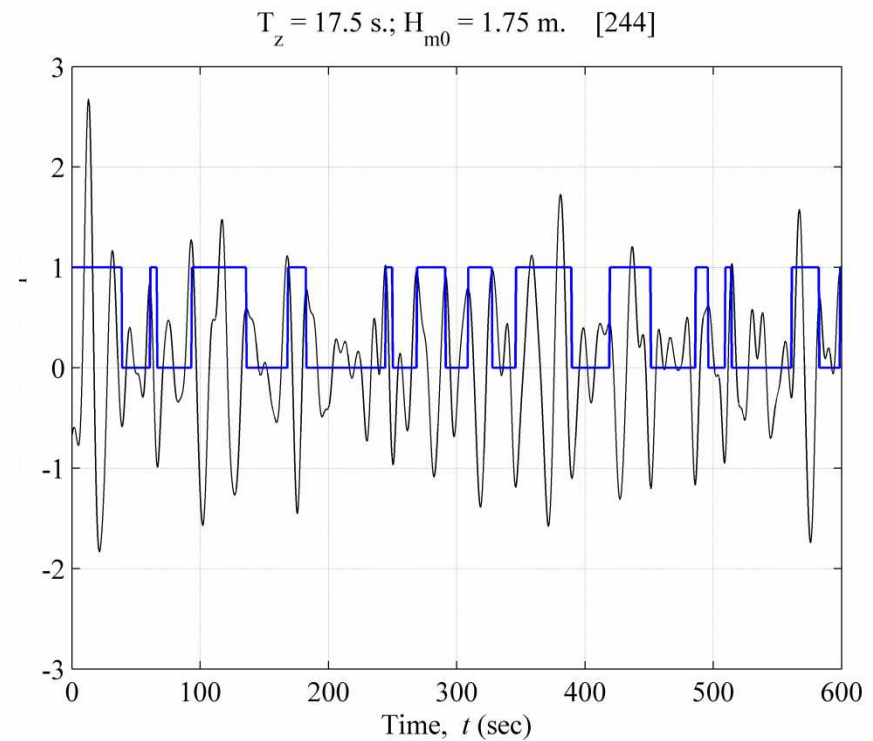
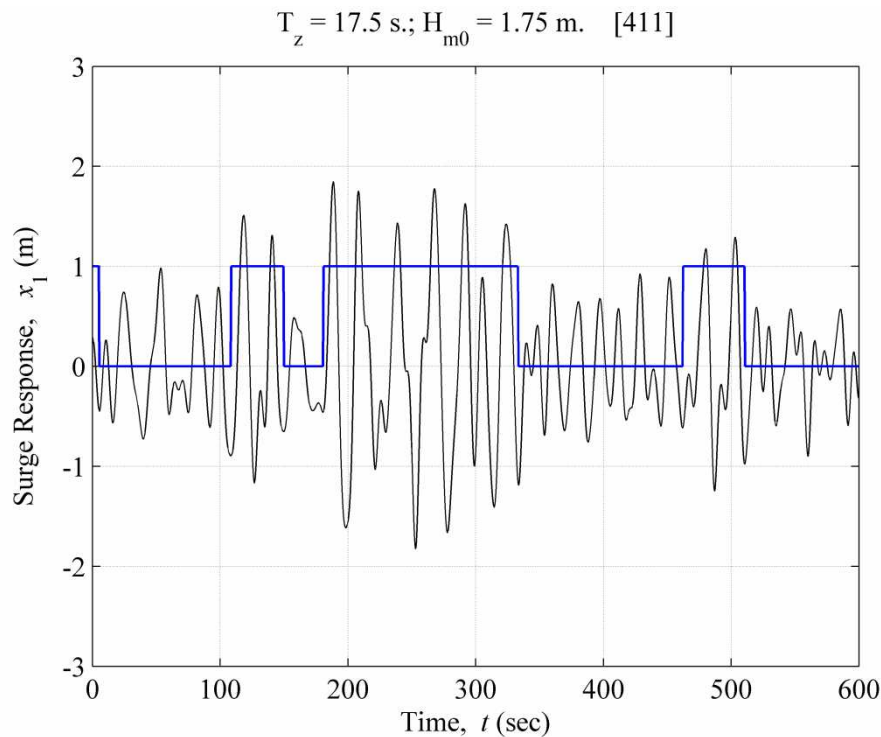
# Then, The Reality Check...



# Irregular Sea States ...

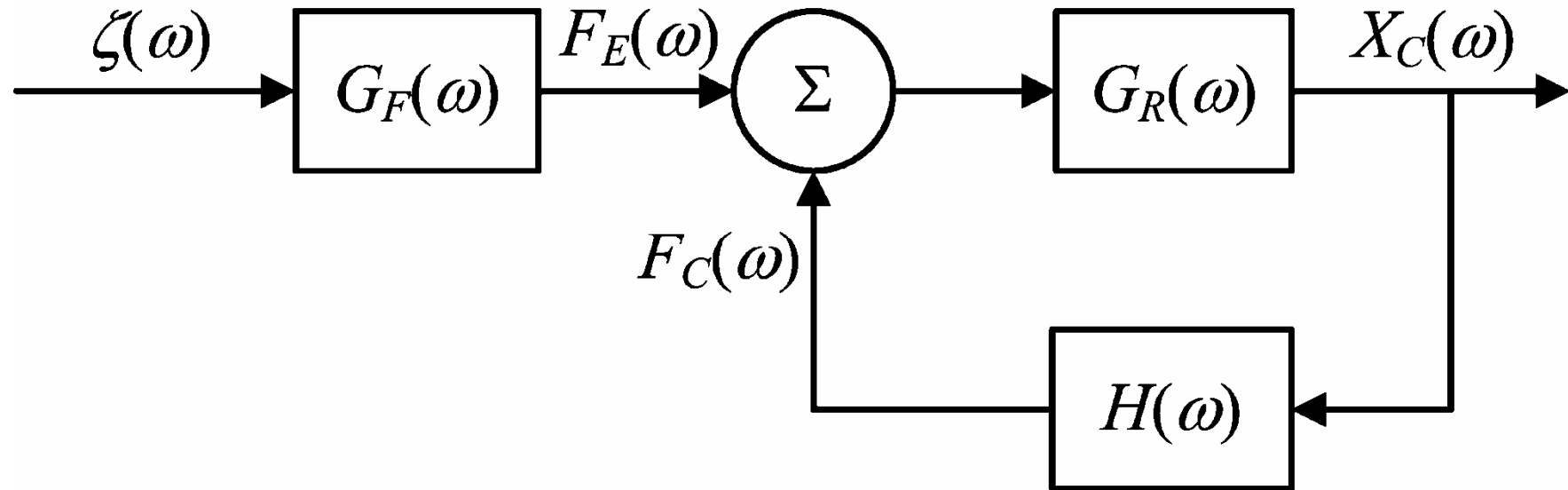
1. Central North Sea
    - JONSWAP spectrum
  2. West Shetland Shelf
    - Bretschneider spectrum
- Discrete spectra based on mid-point zero-crossing period and significant wave height.

- Performance averaged from response to three waves with varying degrees of ‘groupiness’



Advanced controller design used:

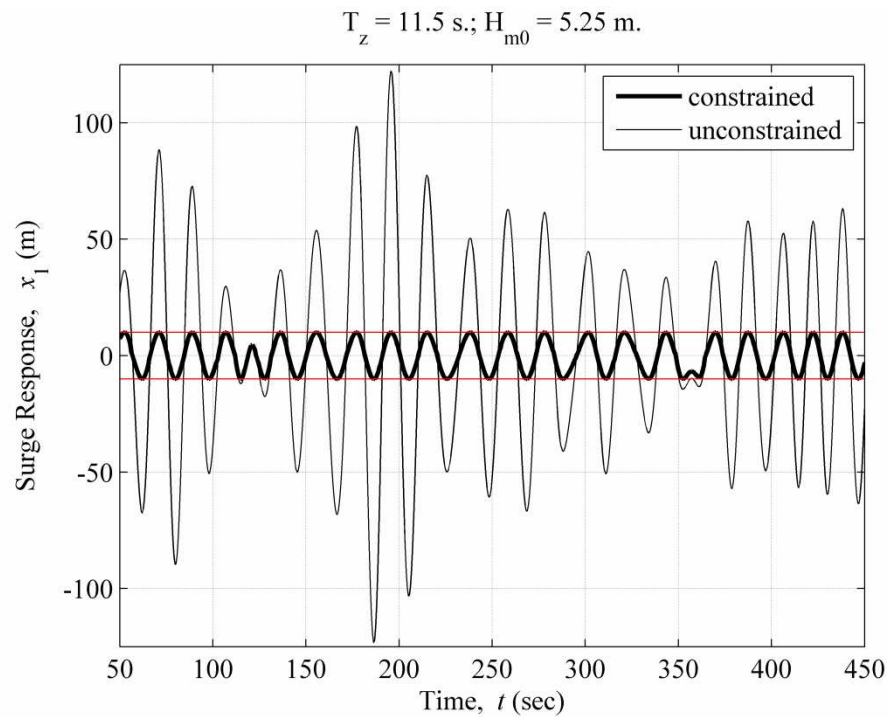
- Developed from the basic design presented at ICOE 2010.



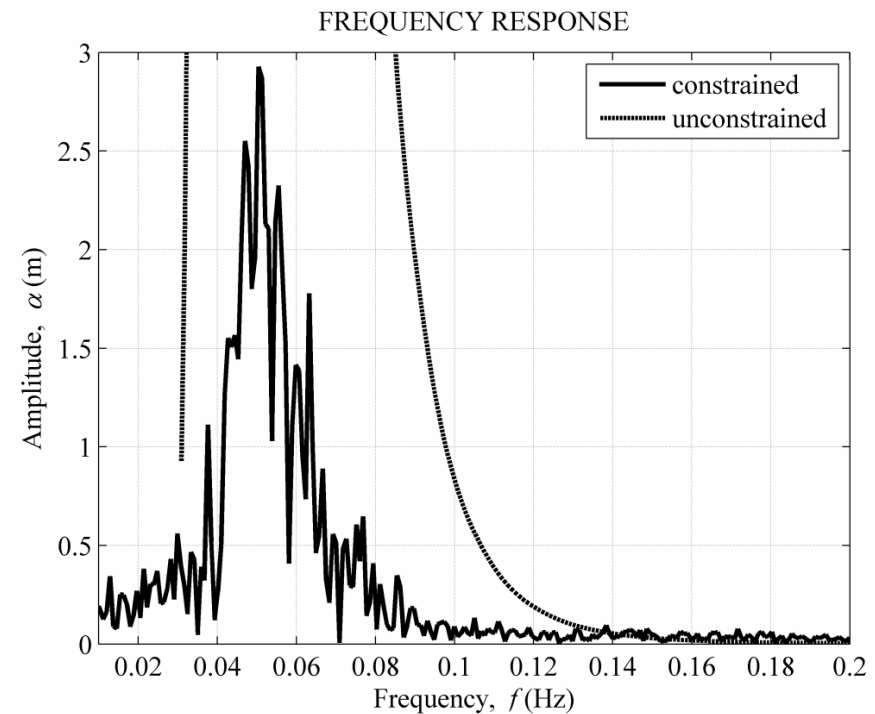


## Moorings:

- Slack-moored with non-compliant end-stops. Collector response constrained within these limits by the controller.



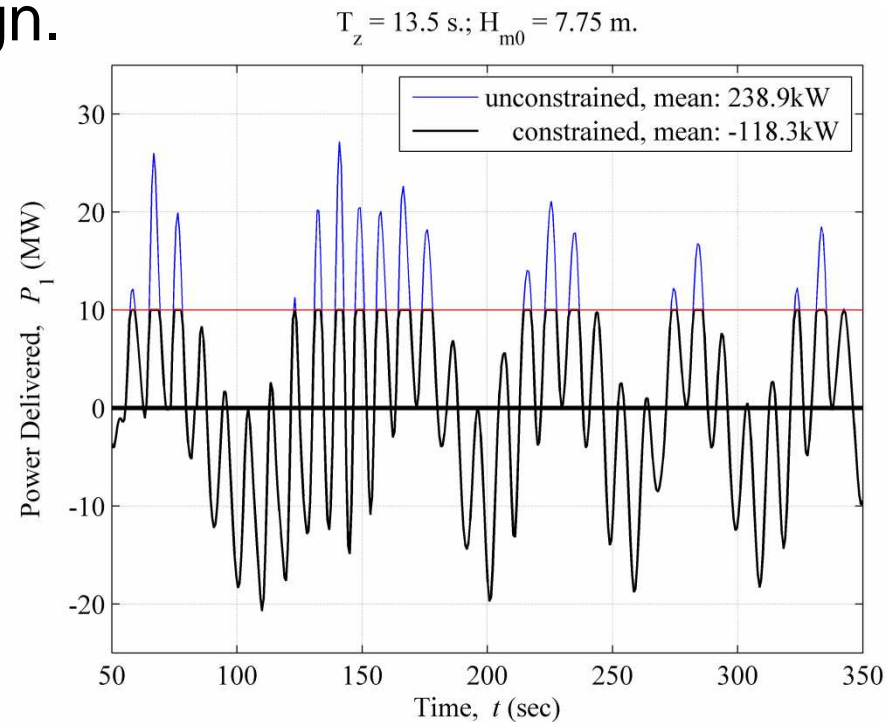
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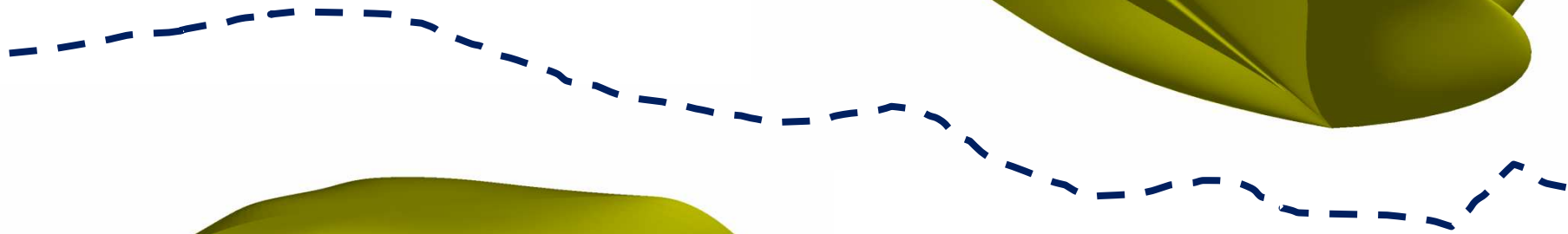
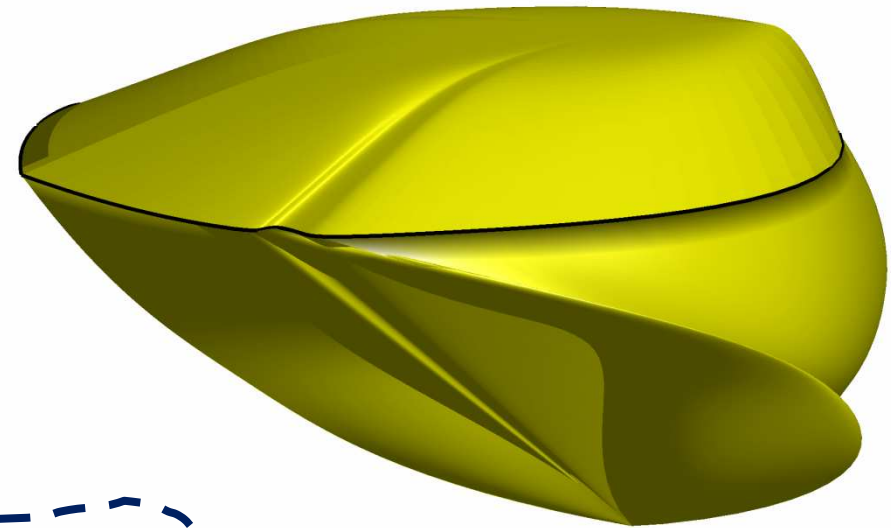
## PTO:

- Simplified model with constrained by an upper limit on the power delivery. No constraint is put on the power returned to the collector by the controller – this becomes a penalty on the design.



# Irregular sea states and constraints

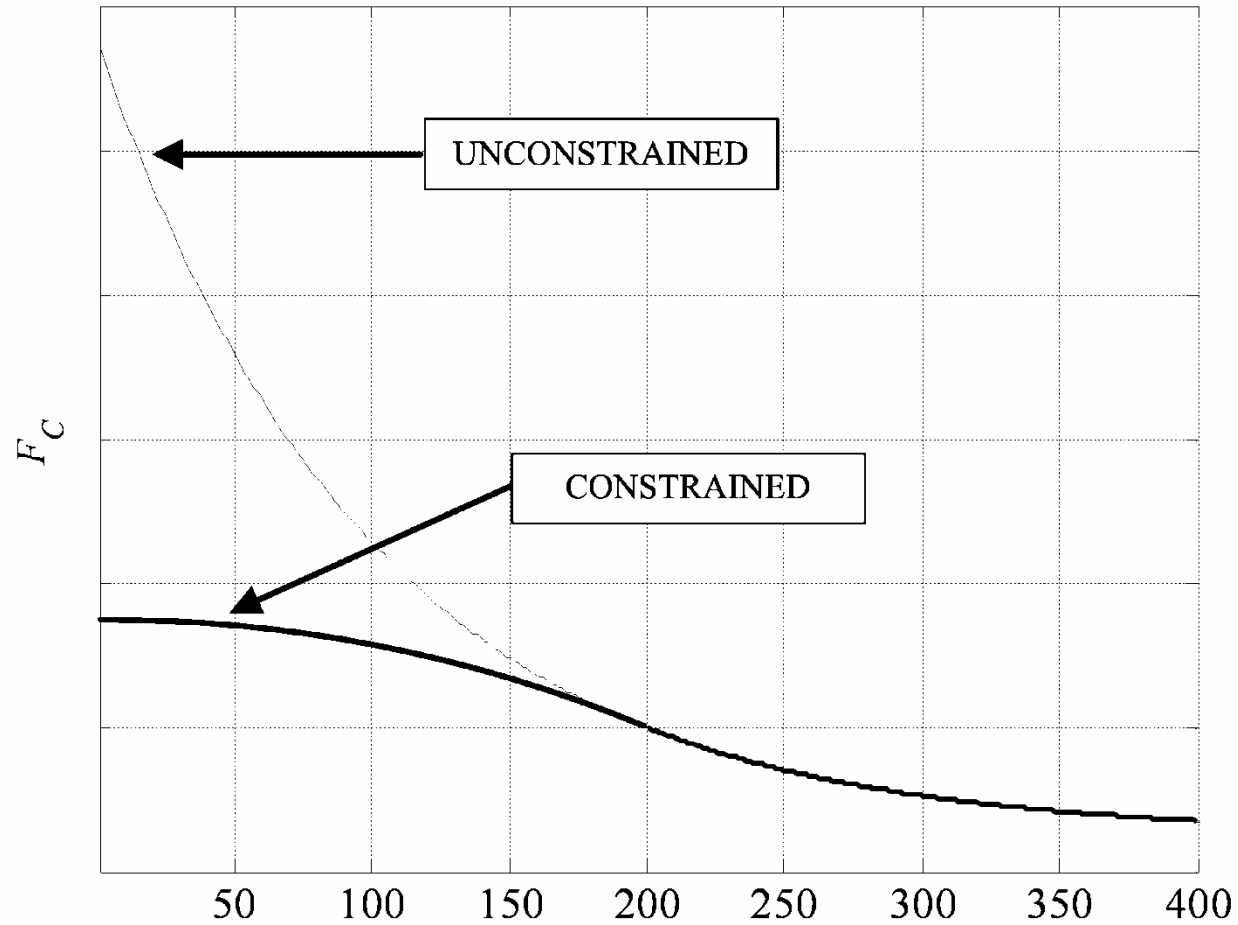
West Shetland Shelf  
(*Bretschneider*)



Central North Sea  
(*JONSWAP*)

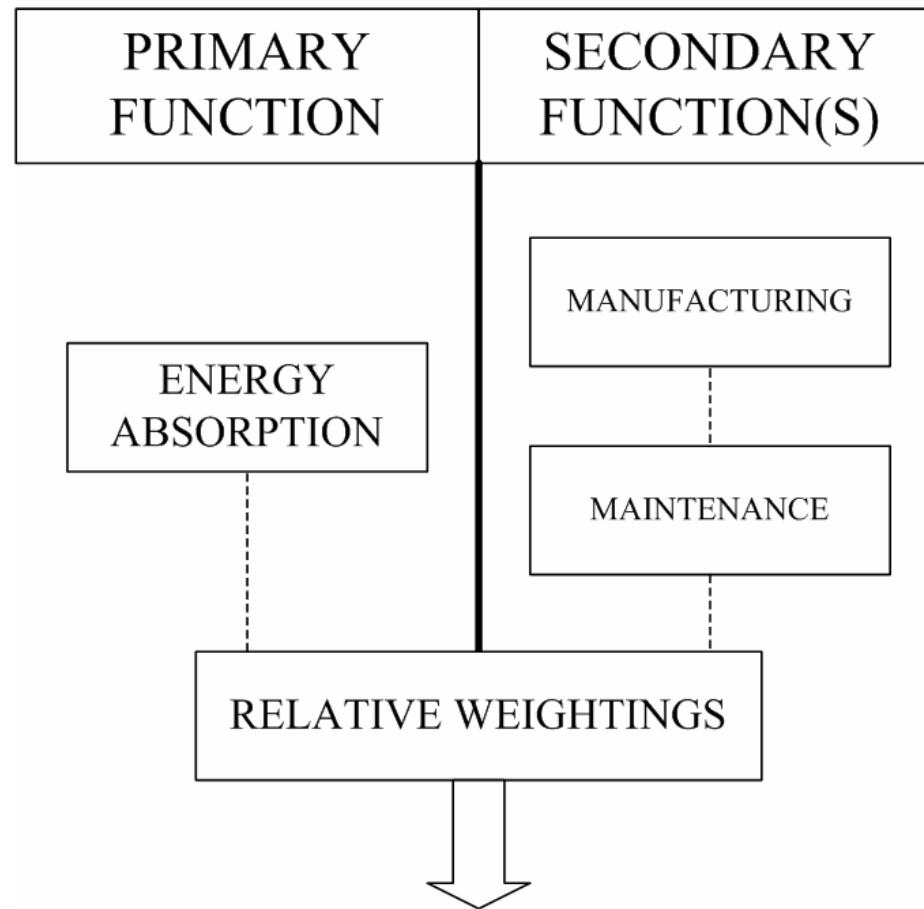
# The Cost Function Value:

RANKED COST FUNCTION VALUES



# The Cost Function:

## Hierarchical Structure:



- The procedure is to be as free of human intervention and preconception as possible.
- The algorithm needs to be able to determine ‘good’ from ‘bad’ – usually a guaranteed source of debate.
- It provides the designer with some original suggestions.



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