# *Industry perspective on potential costs/economic benefits of vessel-quieting technologies (e.g., effects on fuel usage, efficiency) for large vessels*

**Dr. Dietrich Wittekind** (DW-ShipConsult)

***Potential Application of Vessel-Quieting Technology on Large Commercial Vessels***
***Silver Spring, Maryland, 1-2 May, 2007***

*With thanks to Dokumente des Meeres GmbH Dieter Paulmann*



## Summary

There is a high probability of noise interference between shipping and mammals in low frequencies at least in in the future

Low frequencies are dominated by propeller noise in connection with cavitation

Fuel consumptions of ships at given speed can be reduced by 10% (short term) and 30% (medium term), but the gain in noise reduction is very low

Technology to investigate and improve ships in model and full scale are available

Silencing of low speed diesel engines by active mounts seems feasible

Short to medium term improvement of low frequency noise by 5 to 20 dB is possible

There is a large gap in knowledge of radiated noise of conventional ships

**This presentation has been made possible by**

| | |
|---|---|
| Dokumente-des-Meeres GmbH | |
| www.hsva.de Hamburg Ship Model Basin | Propellers and Cavitation |
| www.friendship-systems.com | Numerical optimisation |
| www.hutchinsonrubber.com | Active mounts |
| www.nordseewerke.de | Containership noise |





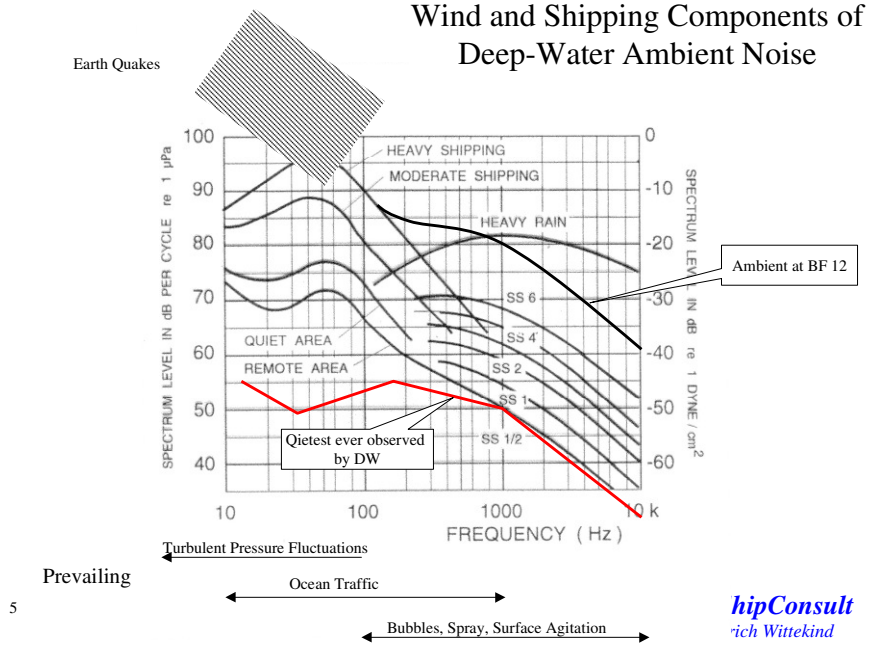
# Contents

The scene: Where is shipping noise in the natural spectrum?

How economical can ships be?

Are there easy ways to silence ships not compromising economy?

## Wind and Shipping Components of Deep-Water Ambient Noise

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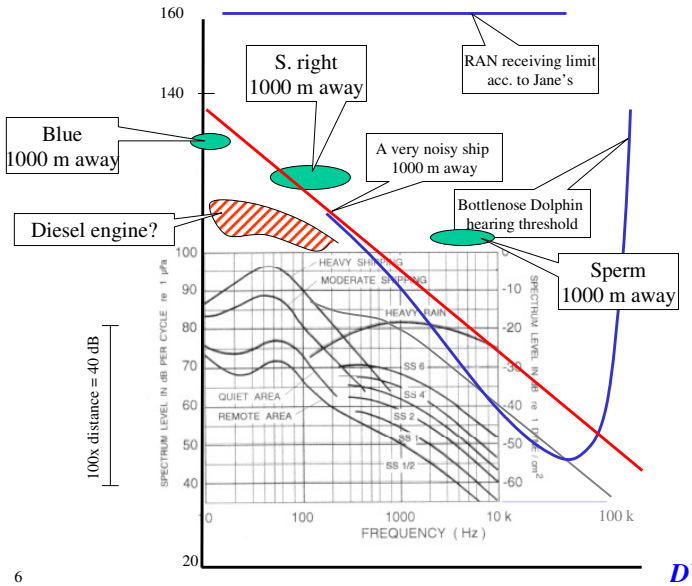


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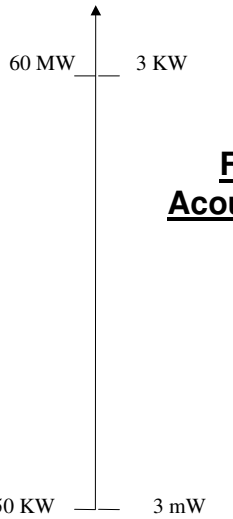


**Radiated Acoustic Power**

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## Is there a connection between noise and economy?

Not really, but.....

In general: Noise is a matter of

speed.....

rather than power

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## Some things to think about

Slow steaming is not necessarily economical

Ships get 30 years old → slow technical change

Each new ship has to fit into a global rythm

Economy is work sharing, interfaces have to be simple

Nobody ever really thought about noise of cargo vessels

We talk about large vessels - but smaller, bad ones may be worse



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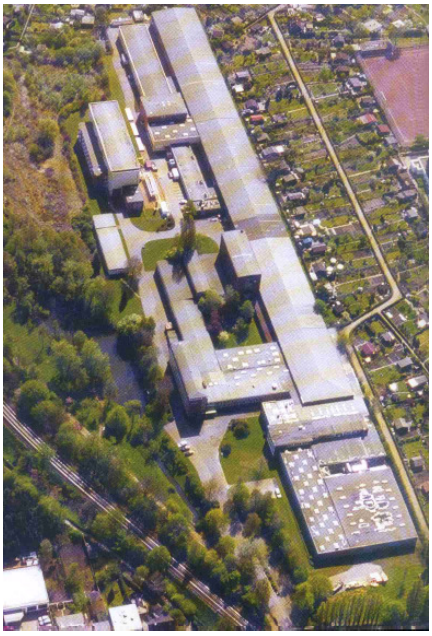

## A Model Basin (HSVA)



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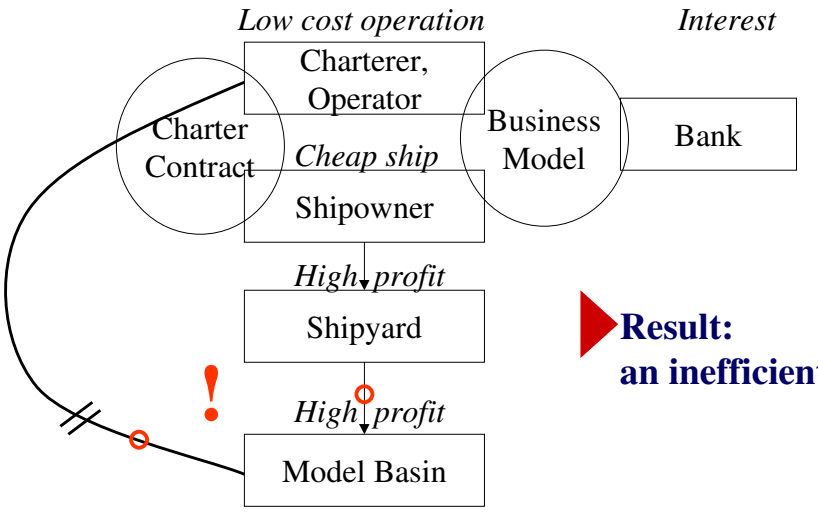
## A new ship: the chain of interests




**Result: an inefficient ship**





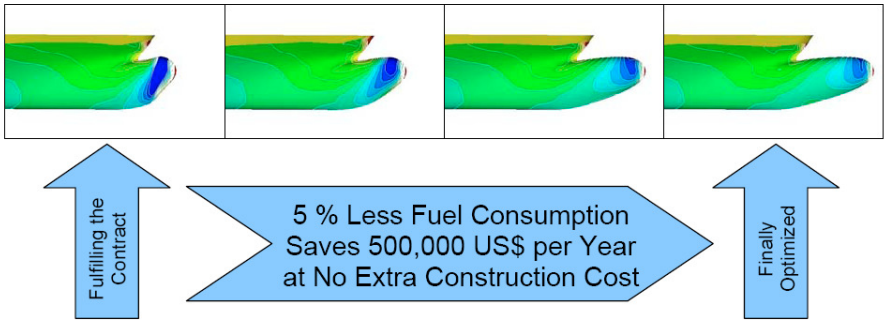
## Interests

| | |
|---|---|
| Bank | High interest on a safe credit |
| Ship owner | Cheap ship and a high charter |
| Charterer | Low operation cost |
| Shipyard | High price, low building cost |

Consequence: Shipyards builds ship which meets requirements, no interest in further improvement. Charterer is interested but is not at the table

# 5% less power.....

Reductions in fuel consumption of 5 % can often be achieved on ship owner's initiative by optimization beyond the contract requirements. For a 5000 TEU container vessel this means 10 tons less fuel per day or a saving of about 500,000 US$ per year. This pays back the additional costs for optimization within months!

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## Result of evolutionary optimisation

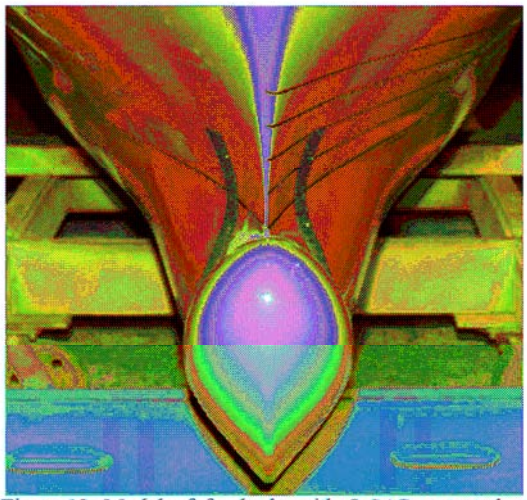

Figure 12: Model of forebody with *InSAC* as tested at HSVA (photo by courtesy of HSVA)

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## How efficient can you get?

| | |
|---|---|
| 5% | less power by further optimisation |
| 5-10% | less power by proper numerical optimisation |
| 30% | less power by new developments |

## How much quieter does it get?

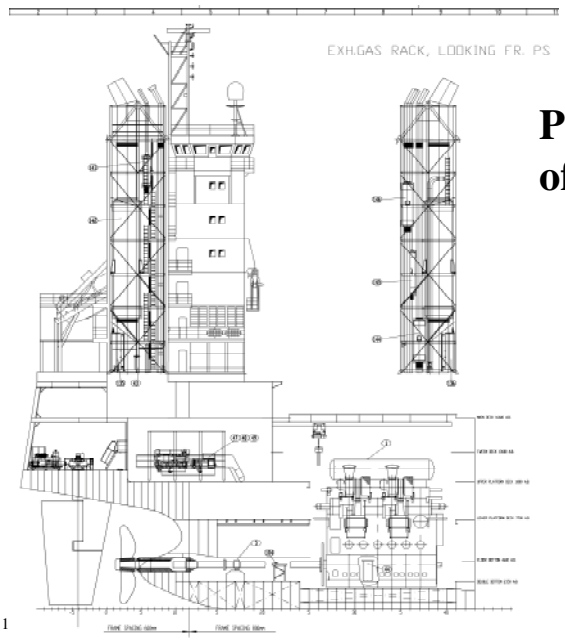
~ 2 db





## New question:

**How can we get substantially quieter without harming economy too much?**




# Propulsion system of a container ship

1

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## Two propellers for the same purpose

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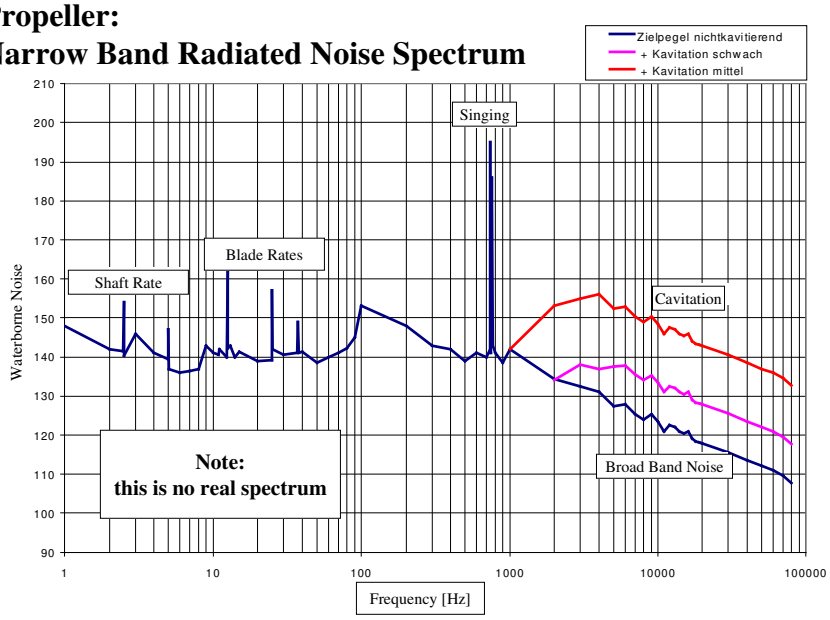
## Propeller:
## Narrow Band Radiated Noise Spectrum

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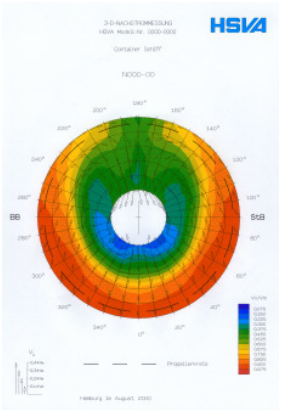
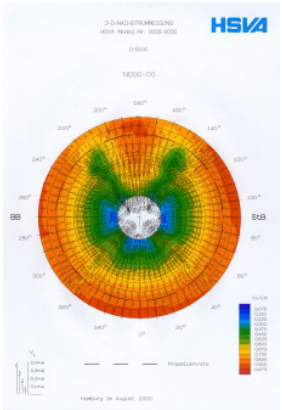
## Wake Fields

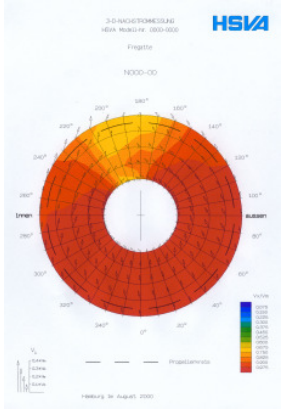
1-S Containership




Submarine




2-S Surface Ship

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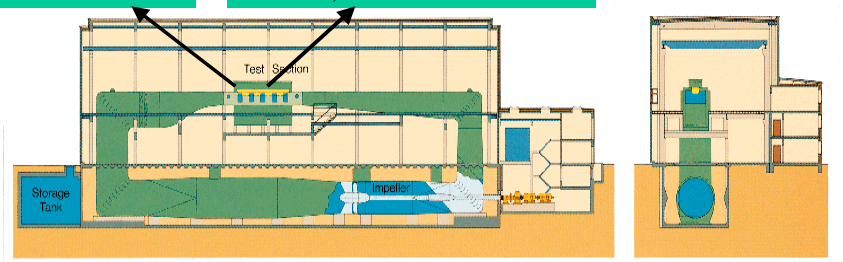
# Modern Cavitation Test Facilities

LCC in USA | GTH in France | SCAT in Korea | LCT in China

Vmax= 11.7 m/s

L = 11m, B = 2.8m H = 1.6 m




## HSVA --> HYKAT



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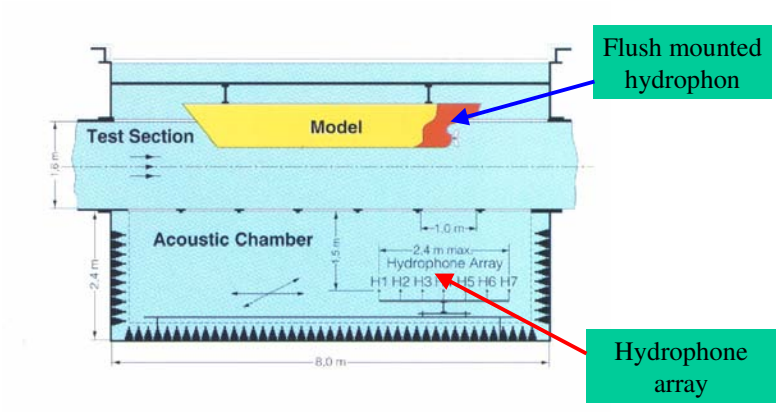
# Modern Cavitation Test Facilities




## Arrangement for Noise Measurements



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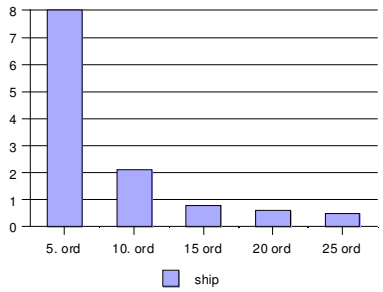
# Vibrations and Noise
## 1970 ies




**Pressure Fluctuations in kPa**

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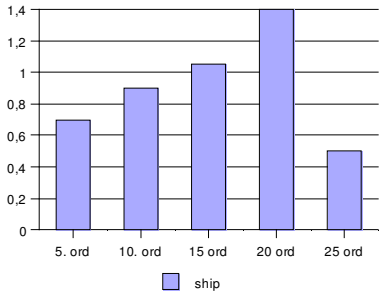
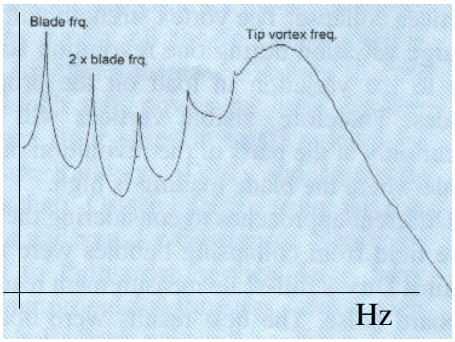
# Vibrations and Noise
## 1990 ies and today




**Pressure Fluctuations in kPa**

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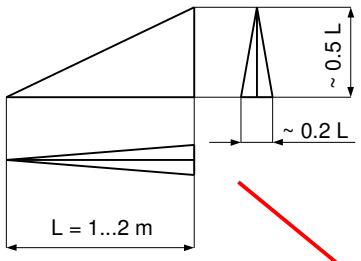
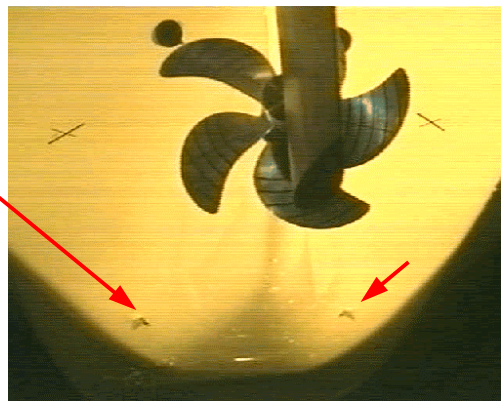
## Reduction of Pressure Pulses by Vortex Generator Fins



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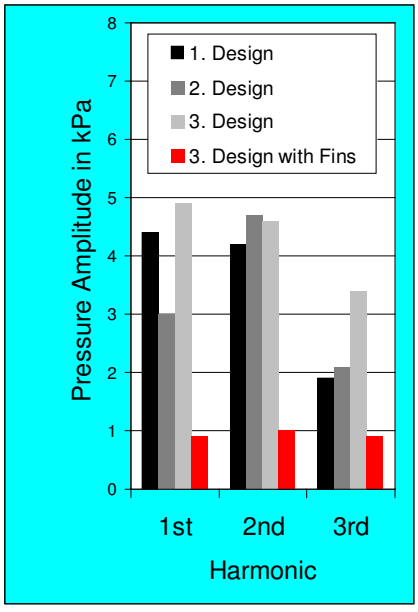
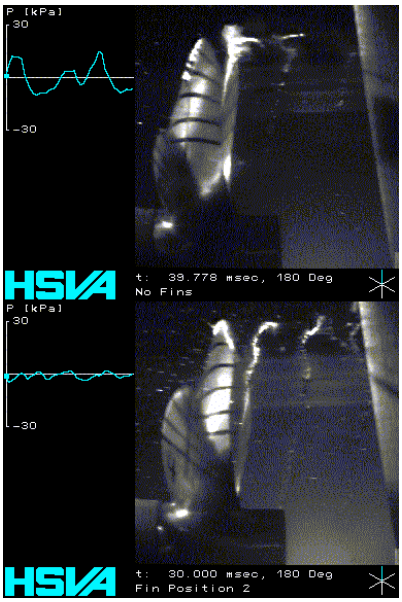
Courtesy of HSVA



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## Possibilities for Air Injection

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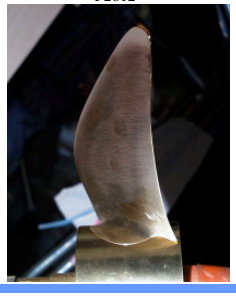
## Blade Tip Variations to reduce cavitation (1)

HSVA

P2612

P2613

P2614



*lt*

## Blade Tip Variations to reduce cavitation (2)

HSVA

P2615

P2616

P2617

*lt*

## A quiet propeller and the consequences

| | |
|---|---|
| • good wake field | => slender ship, large dimensions |
| • reduces loading at large radius | => low η |
| • large area ratio | => low η, increased mass of propeller |
| • small skew | => higher pressure pulses |
| • large skew | => more sensitive to singing |
| • optimizes blade number | => more blades, low η, larger mass |
| • low circumferential speed | => larger propeller = increased mass, high η |

**yields ~ 6 dB**

best short term measure:
put more effort in wake field optimisation and propeller design

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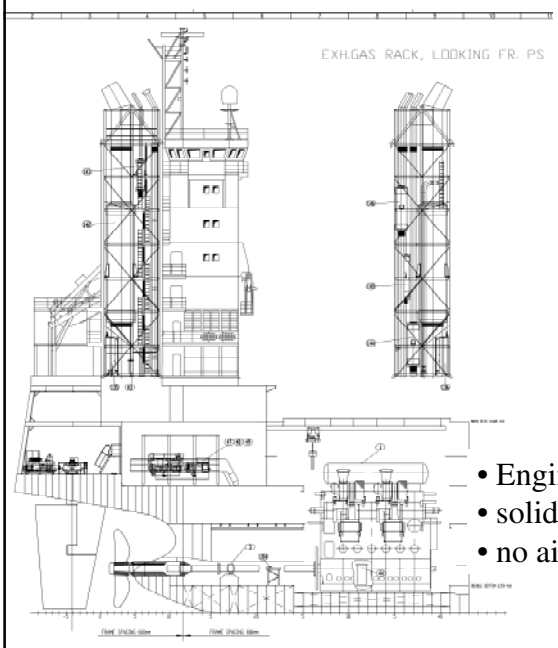


- Engine mounted ridgidly to ship
- solid connection to shaft
- no airborne noise isolation

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## Navy – Active N & V Control

HUTCHINSON WORLDWIDE

MTU 12V4000 Engine equipped with Paulstra active mounts
« Soft » metallic foundation (MTU test facilities)

Common system investigation with MTU in Diesel engine applications

HUTCHINSON PAULSTRA VIBRACHOC STOP CHOC PROPRIETARY

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Multiple degrees-of-freedom active mounts

HUTCHINSON WORLDWIDE

Actuator range

30 N 70 N 100 N

150 N 300 N

Coming soon

140 N 280 N

Modular design :

- large range of actuators from 30 to 300 Newtons
- large range of rubber mounts (for civil and navy applications)
- => infinite number of combinations !



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## Noise reduction of a large low speed diesel engine

Passive measures likely not feasible (large mass of engine)

Active mounts may be a way

needs development
need technology to isolate shaft
look at multipath sound transfer first

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## A Way Ahead

First: Reduce Cavitation

- improve wake field
- improve propeller
- air injection
- more twin screw

Silence Diesel engines

- resilient foundation (smaller engines)
- active noise cancellation (all engines)

But needs some (yet limited) research

**We may get 5-20 dB quite easily**



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