




Analysis of marine operations – theory meets real life

Two male workers in orange high-visibility work clothes and yellow hard hats are on an offshore oil platform. The worker on the right is wearing safety glasses and large black earmuffs, gesturing with his right hand while speaking. The worker on the left is also wearing earmuffs and is seen from the back. In the background, there is a yellow crane and the ocean under a cloudy sky.


**The analysis report
says we cannot
do the operation**

Why?

The analysis is wrong

A lot of reasons why this is the case, which boils down to

Conservatism & Uncertainty



The analysis report
says we cannot
do the operation

**The good news is,
this can be fixed!**

How to get theory closer to reality?

Remove uncertainty by using better analysis methods

Method	Documented workability
Simplified physics	30% (common approach)
Time domain one shot	55%
Time domain optimize	70%
No alpha factor	80%

Example:

Analysis of lowering through the splash zone of a suction anchor



How to find the weather limits

For a set of sea states:

- Estimate tension in the lifting equipment
- Compare to the equipment breaking limits

Must model the behavior of the lifted system



Behavior

The anchor is pitching as it goes down



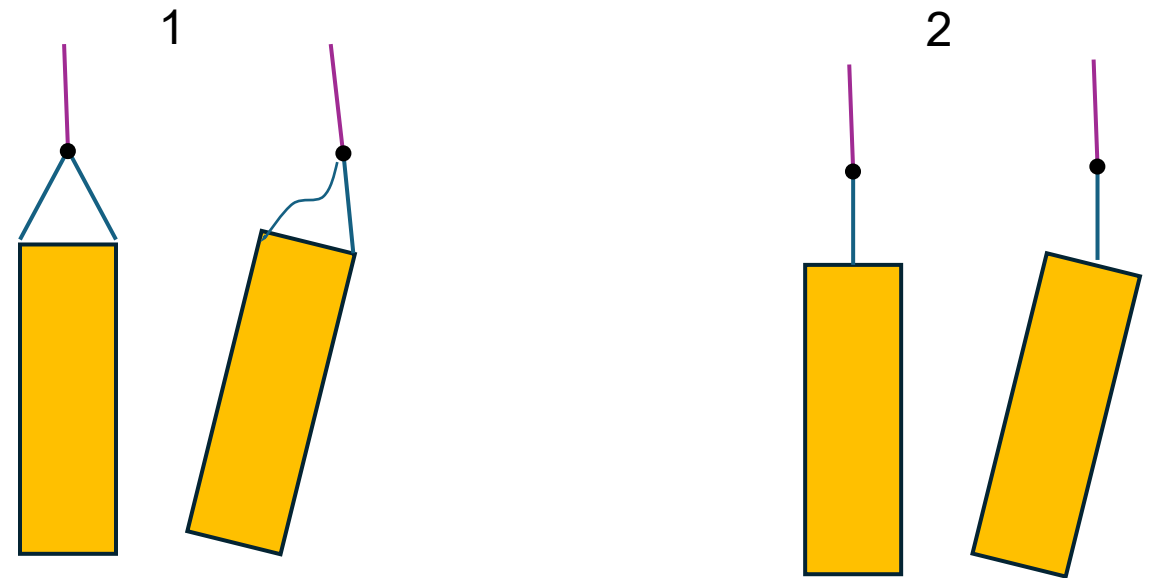
How to rig and plan the lowering

We find two things:

- The crane tip should be high
- The orientation of the slings is important, to avoid them slacking

But

It is hard to document this behavior



Documenting system behavior

2 main sources of uncertainty:

Physics & Statistics

Physics

What physical model appropriately captures the system behavior and thus the **response** to the incident waves?

Statistics

What is the probability of occurrence of the response that would satisfy my need for **conservatism**?

Statistics

From DNV standard for lift

We need to be 90% certain that the real response is lower than the estimated response

What does that mean?

It accounts for two random things:

1) The skill of the crane operator

and

2) The luck of the crane operator

in drawing a wave from the random wave train

But

Current state of the art analysis assumes a blind crane operator

Reformulating initial statement:

We need to be 90% certain that the real response is lower than the estimated response, assuming that the crane operator is blind

Physics

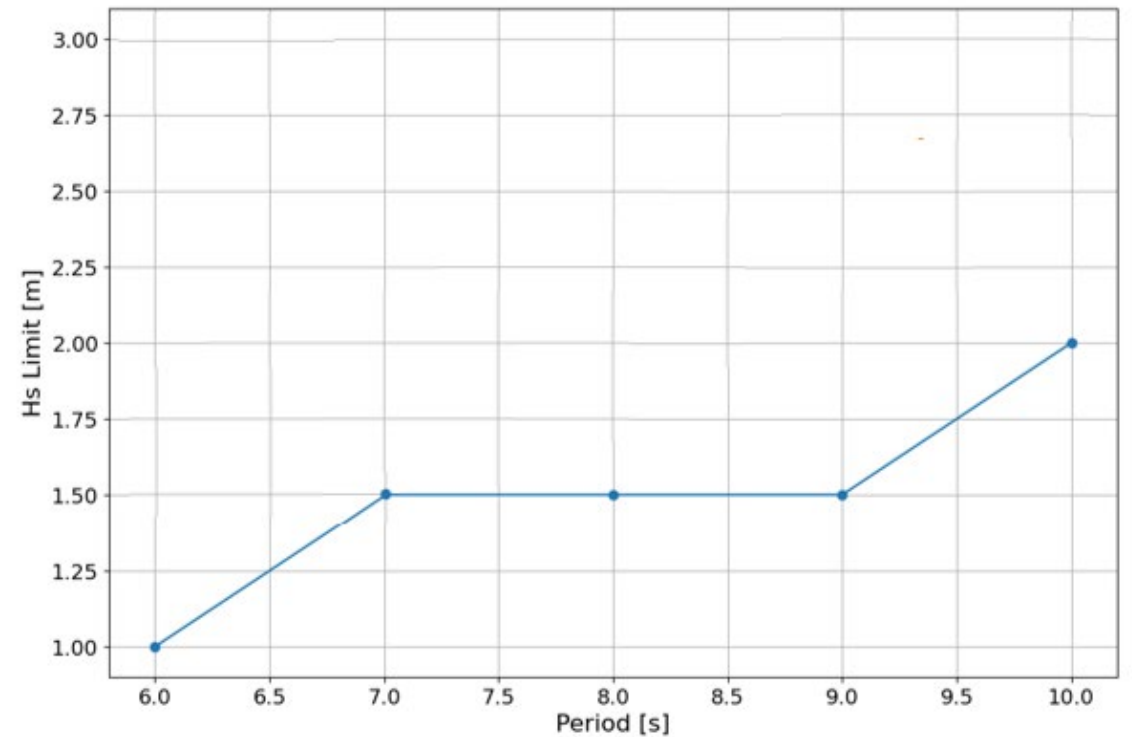
Here is where uncertainty can pile up

But

If you understand the system, there is room for both optimization
and lowering the uncertainty!

First approach to physics: Simplified analysis

- Easy. Can run in Excel, on a laptop
- Maybe good enough for summer



Method

Documented workability

Simplified physics

30% (common approach)

Time domain one shot

55%

Time domain optimize

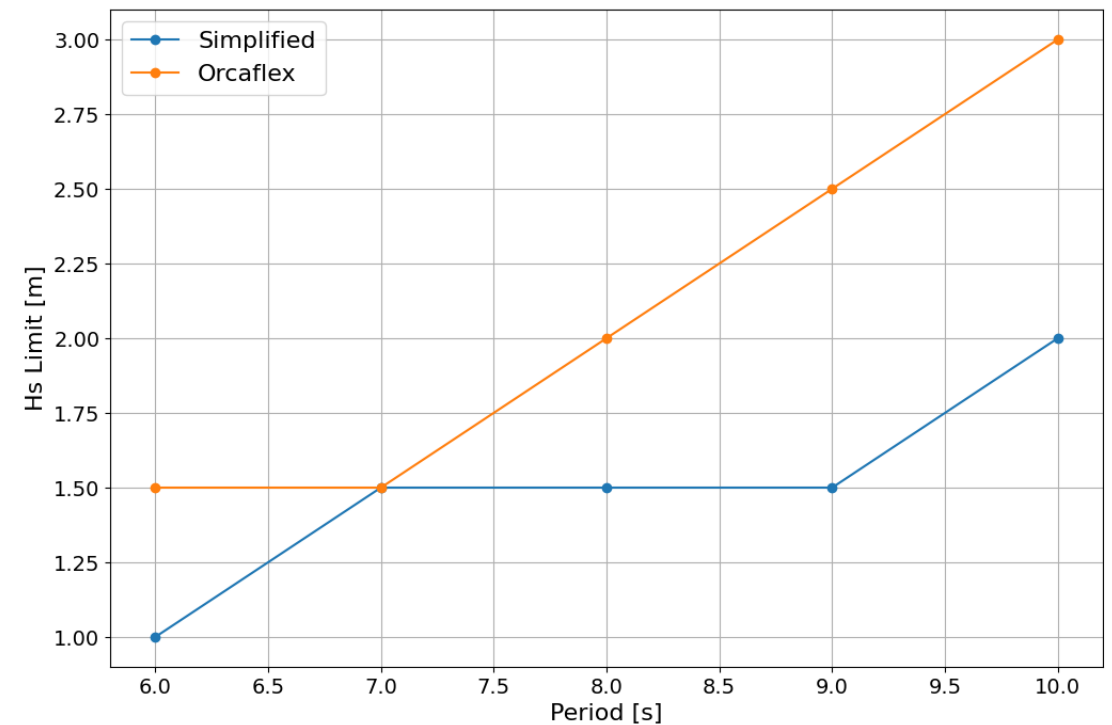
70%

No alpha factor

80%

Second approach: Time domain analysis, one shot

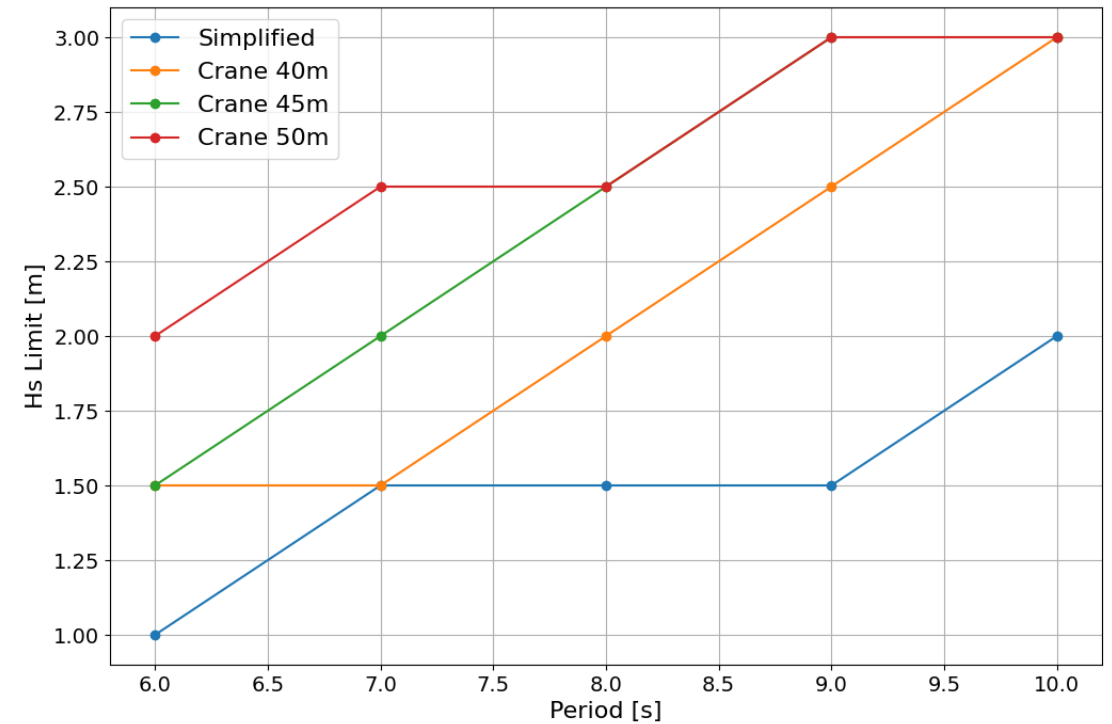
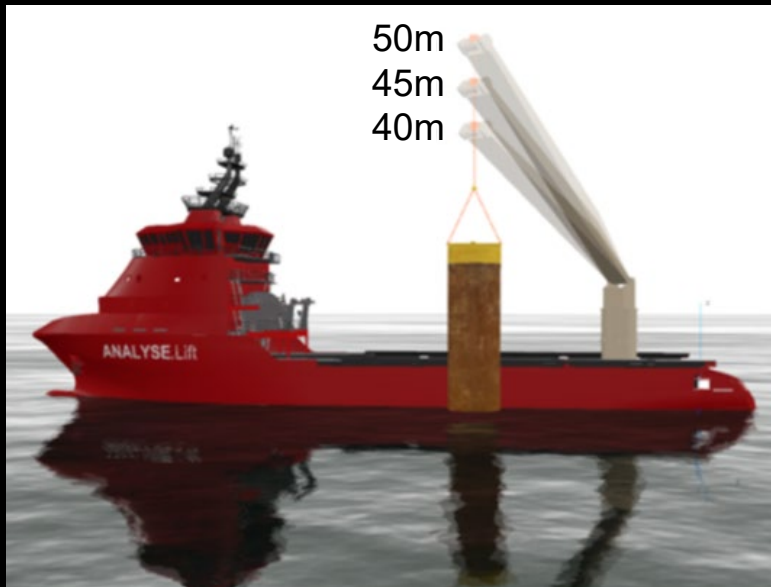
- Advanced software. Analysis costs more
- Maybe good enough for autumn



Method	Documented workability
Simplified physics	30% (common approach)
Time domain one shot	55%
Time domain optimize	70%
No alpha factor	80%

Third approach: Time domain analysis, understand, optimize

- Advanced system. Analysis is expensive
- As good as it gets during planning



Method

Documented workability

Simplified physics

30% (common approach)

Time domain one shot

55%

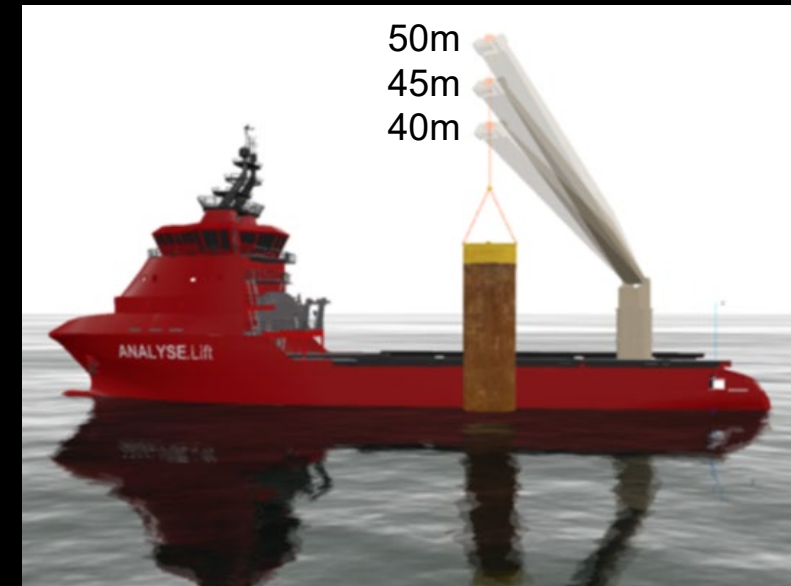
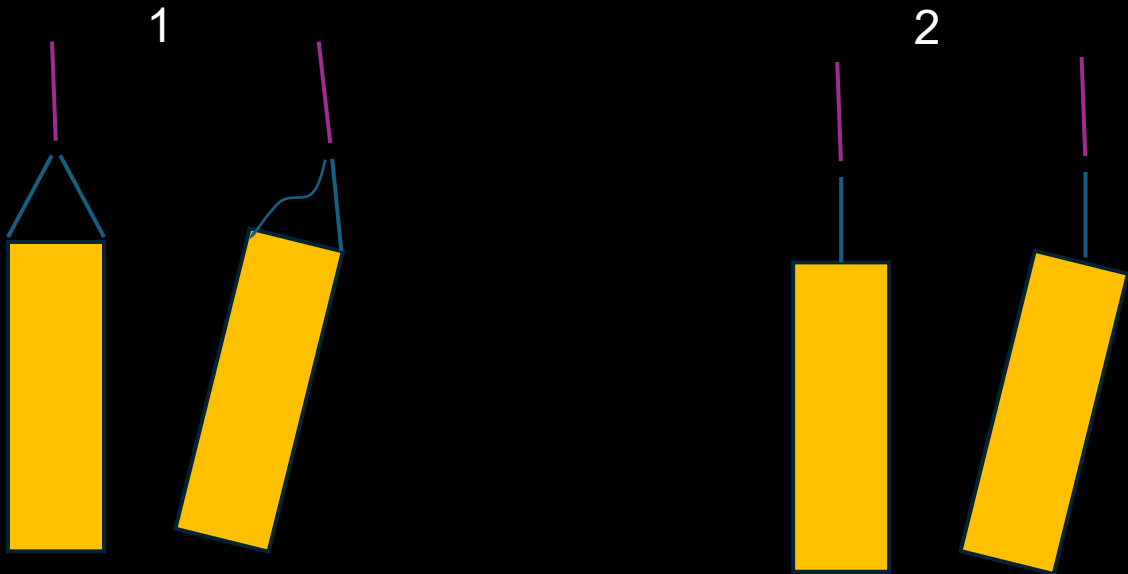
Time domain optimize


70%

No alpha factor

80%

Understanding system behavior leads to optimized method!



The background image shows two men in orange safety suits and yellow hard hats with communication equipment. They are on an offshore oil or gas platform, with a yellow crane visible in the background and the ocean in the distance. A speech bubble is directed at the man on the right.


**The analysis report
says we cannot
do the operation**

Yes, I know.

To be conservative, I had to pile uncertainties on top of each other:


Simplified physics that doesn't capture the behavior

90% response to account for a blind and unlucky crane operator




The analysis report
says we cannot
do the operation

**With better methods
during planning,
we fixed this**



The analysis report
says we cannot
do the operation

How good can it get?

The background image shows two male workers on an offshore oil or gas platform. They are wearing bright orange high-visibility work shirts, yellow hard hats, and large black communication headsets. The worker on the left is seen from the back, while the worker on the right is facing him and gesturing with his right hand. In the background, a large yellow crane structure is visible against a grey, overcast sky and the ocean.

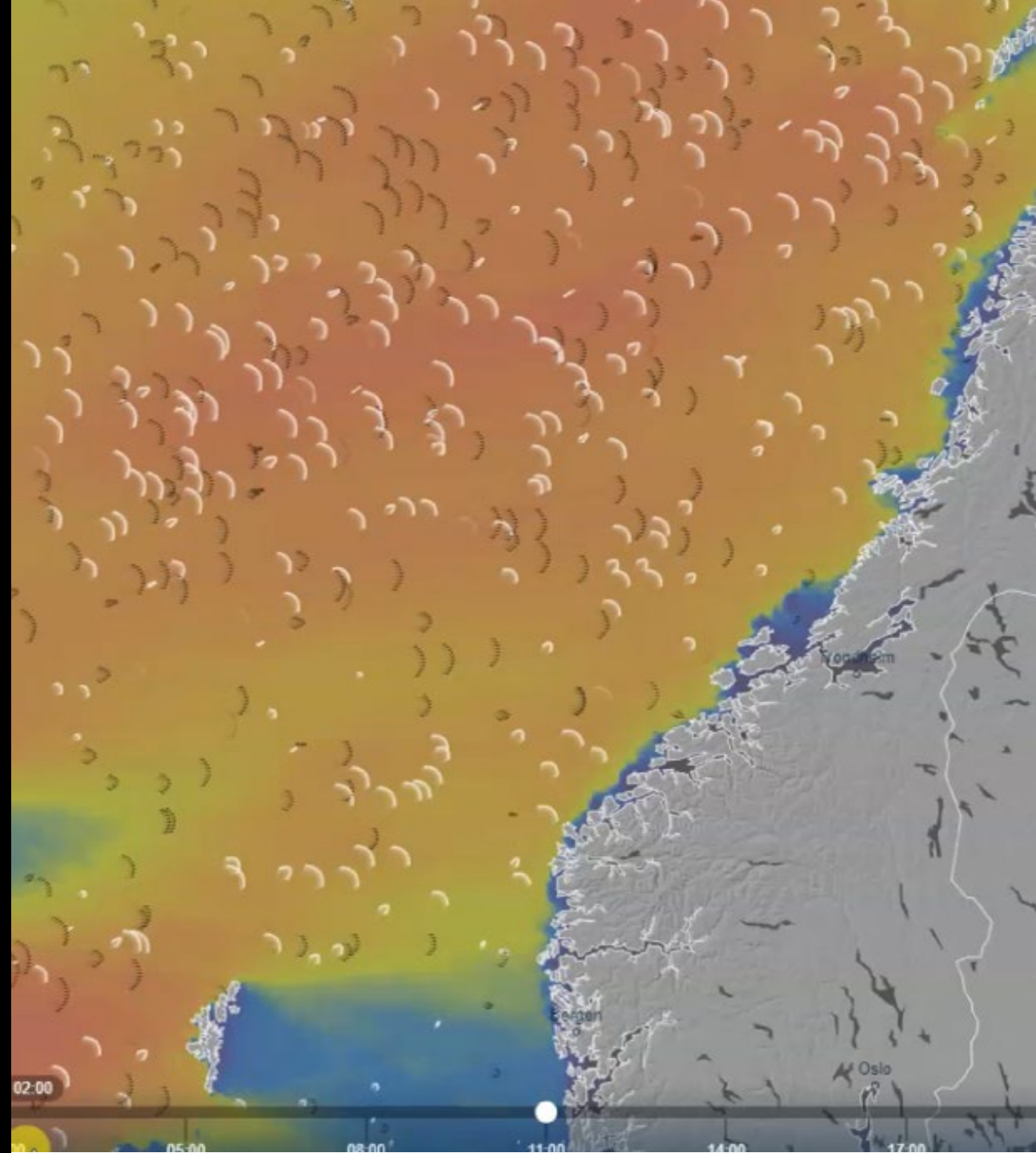
The analysis report
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Analysis during execution

Response forecast

Reduce 2 sources of uncertainty:

1. More than one wave train (physics)
 1. From: All energy in worst direction and period
 2. To: Distribute energy correct in accordance with the forecast
2. Using the complete span of scenarios (the ensemble) can potentially remove the alpha factor (statistics)
 1. 50% estimate forecast: $H_s=2\text{m}$
 2. 90% from ensemble: $H_s=1.9\text{m}$
 3. With alpha-factor: $H_s=1.5\text{m}$



Why is response forecasting hard?

Complex system of interacting software and hardware

QA, maintenance, uptime

Requires competence not already in most offshore companies

Method

Simplified physics

Time domain one shot

Time domain optimize

No alpha factor

Documented workability

30% (common approach)

55%

70%

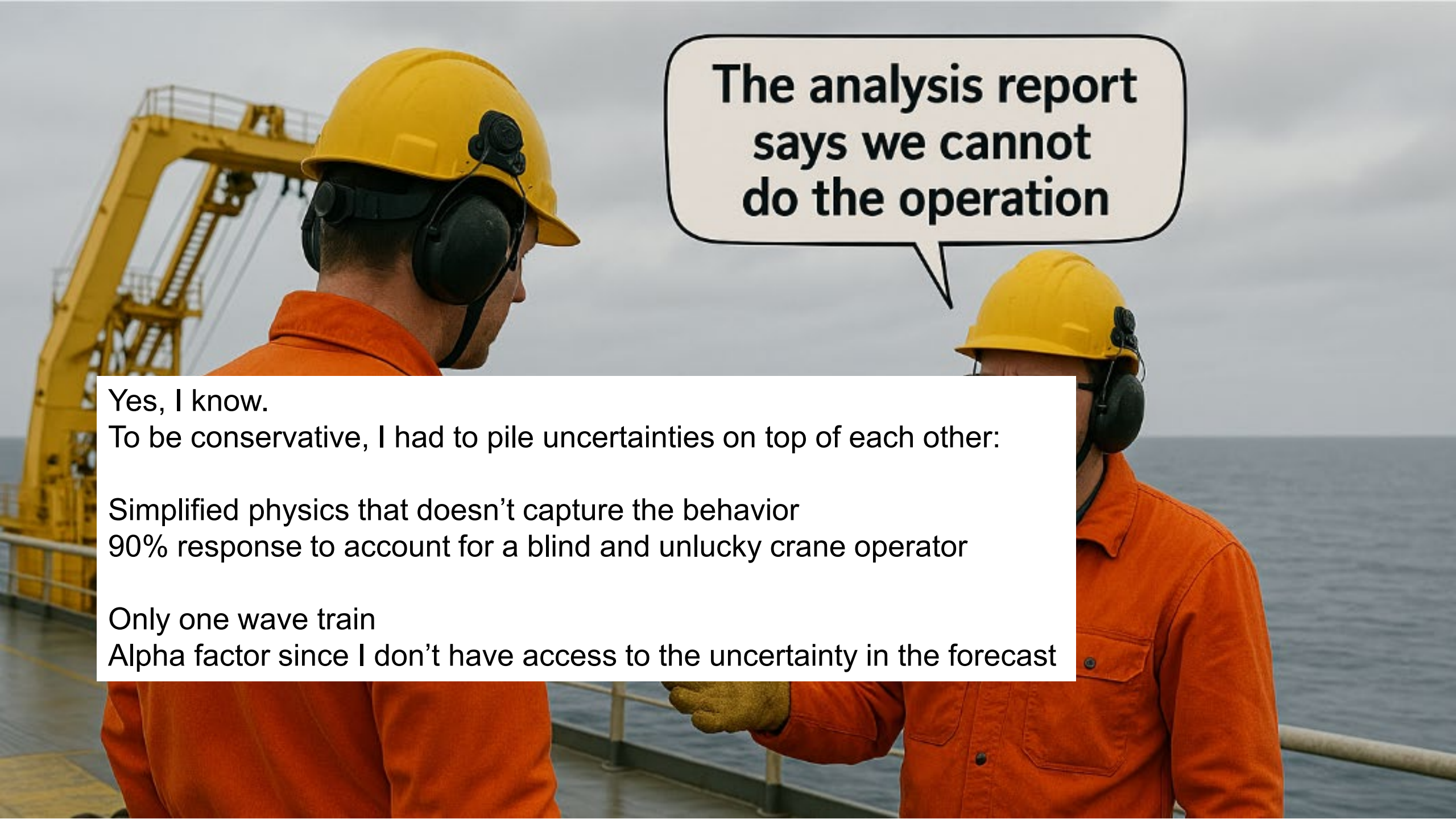
80% (HOW DO WE GET HERE?)

Either

Implemented in a separate department in a large company

or

implemented in separate company and offered as a service



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do the operation

Yes, I know.

To be conservative, I had to pile uncertainties on top of each other:

Simplified physics that doesn't capture the behavior

90% response to account for a blind and unlucky crane operator

Only one wave train

Alpha factor since I don't have access to the uncertainty in the forecast

Thank you for your time

