Rethinking Cost Risk Management:
What if ... we cannot plan away uncertainty?

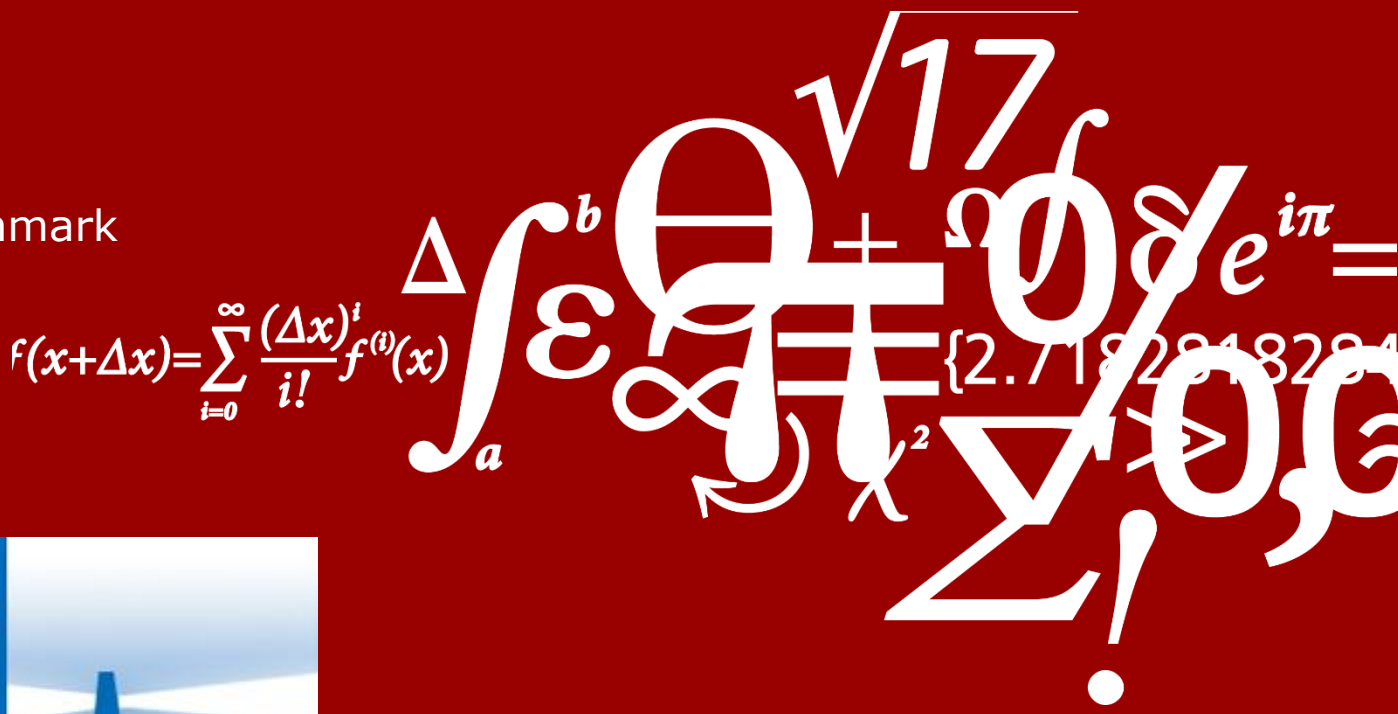
Josef Oehmen

Christian Thuesen

Andreas Claus Hansen

DTU RiskLab & DTU ProjectLab

DTU Management, Technical University of Denmark



DTU

Engineering Systems
Department of Management Engineering

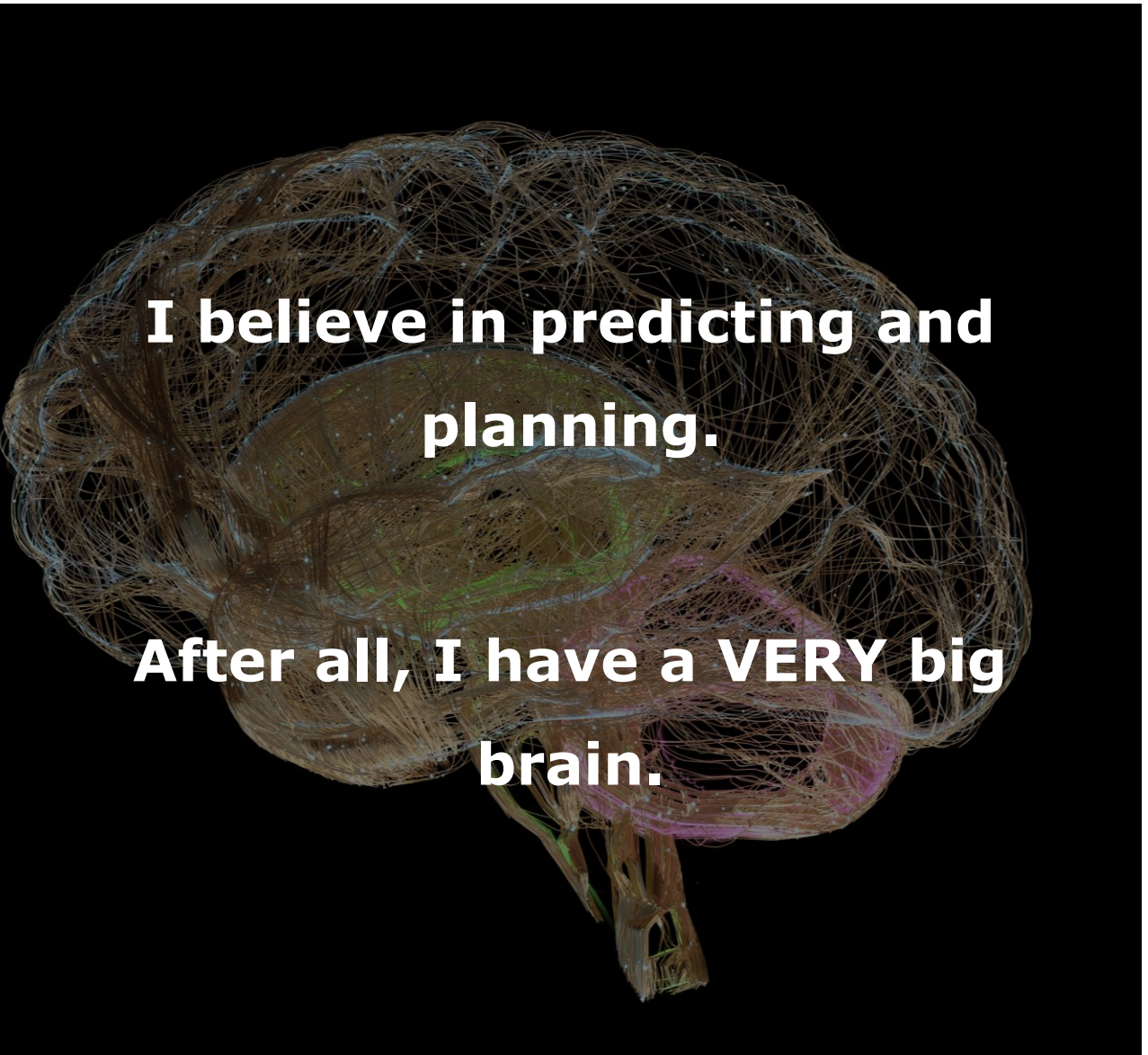
concept

Delivering complex, large-scale engineering and construction projects

...

What ties our interests together

The two religions of engineering project management: The "Big Brain Idealists" vs. The "Messy World Realists"



The World We WANT To Live In
Sutter Health's Delivery of Hospital Projects

Clear Requirements

10 pages of core requirements: How many of what kind of m²

Effective Communication, Cooperation & Trust

Co-location of all key contractors in "big office"

Aligned Incentives

Shared risk pool: Use it, or take it home

The World We DO Live In

16 hospital projects – 13 delayed by 1+ years

36 years delay in total (at 71% completion)

Several projects with cost overruns estimated at 20+ %

Planning in 2010 for actual needs in and cost in 2025

Need for adaptation to changing requirements for healthcare

https://www.ft.dk/samling/20211/almdel/SUU/bilag/242/2546837.pdf

The World We DO Live In

50.000+ sqm, education and research

Original budget 1.8 billlion DKK

Estimated total cost 4.6 billion DKK

More than 6 years delayed

Unclear roles and responsibilities

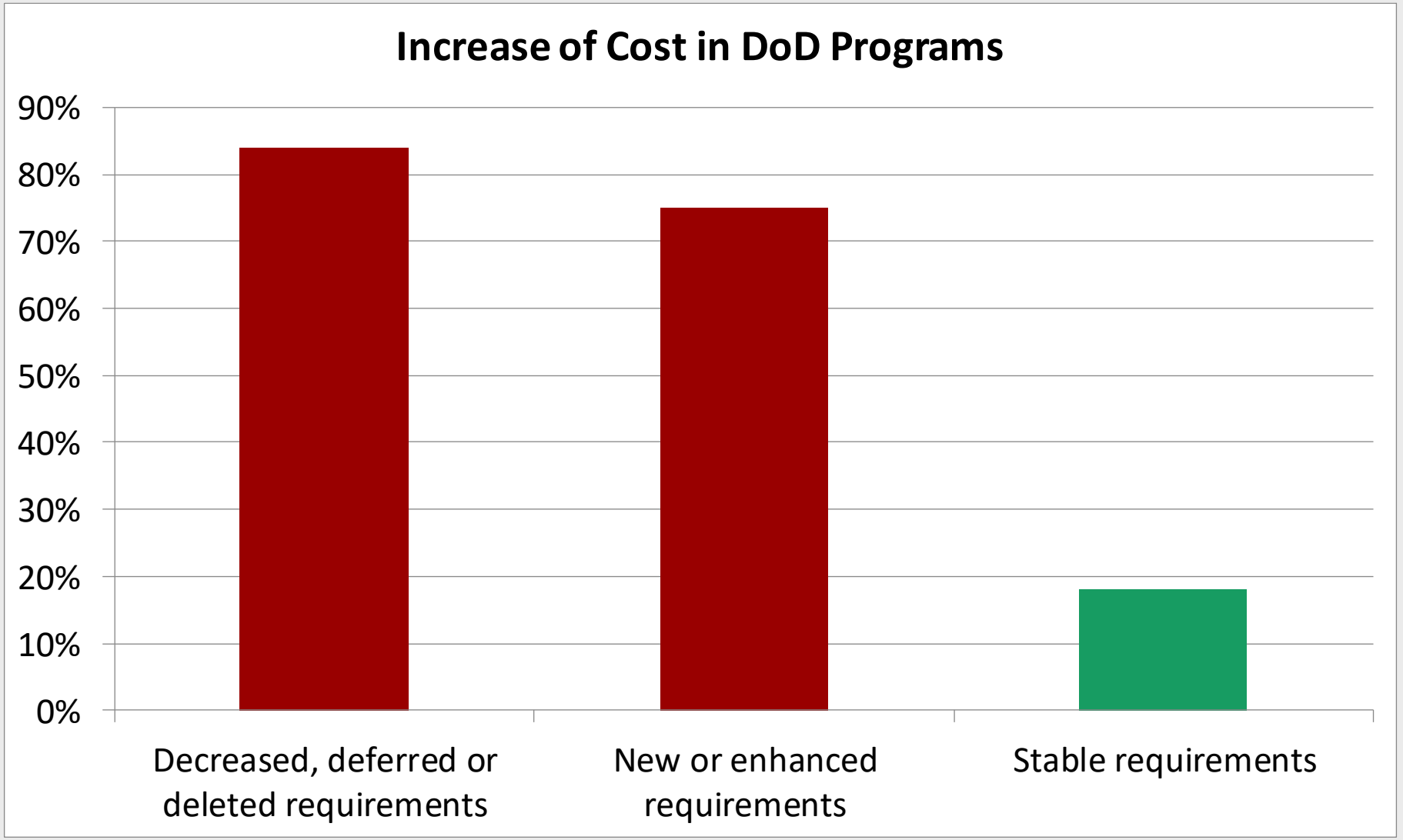
Conflicts on requirements vs quality levels of technical installations

https://www.trm.dk/media/efthdrdi/ey-granskning-af-nbb-30oktober2017-finalpdf.pdf

https://ing.dk/artikel/ni-ud-ti-doedssynder-ramte-niels-bohr-byggeriet-se-dem-her-252888

https://www.tv2lorry.dk/koebenhavn/milliarddyrt-skandalebyggeri-er-udskudt-gang-paa-gang-nu-lover-regeringen-huslejerabat

My standard answer:
Please, FINALLY, get requirements management right!



GAO (2008), own analysis

But what if we looked at it the wrong way?

What if ESPECIALLY large, complex infrastructure MUST be able to accommodate changing requirements?

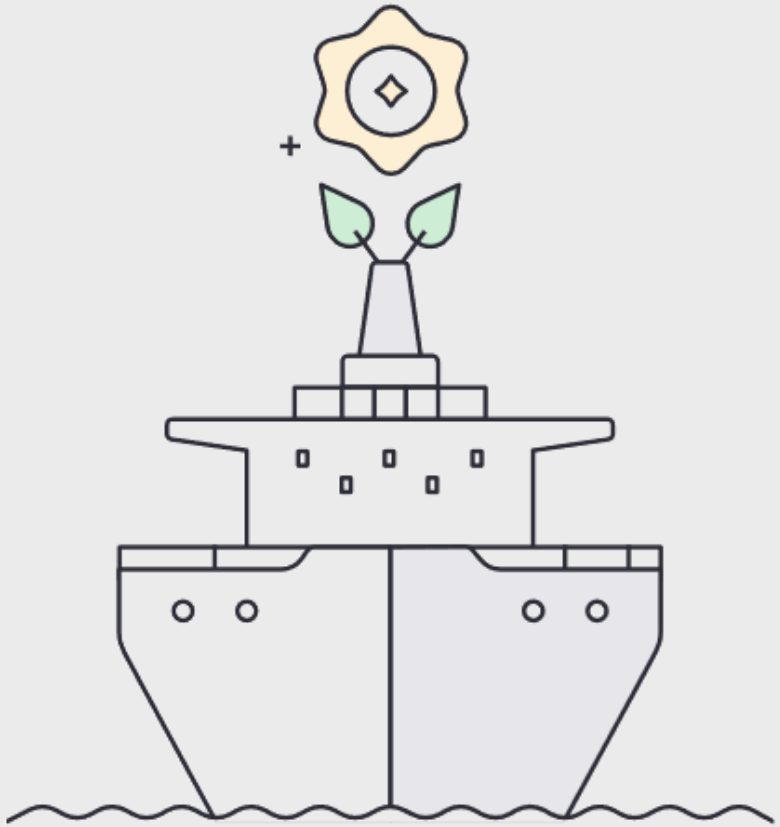
(i.e. requirements uncertainty, not "just" requirements risk)

Motivation for Adaptive Project Execution

Enhancing Schedule Performance:

Pricing-in the "Cost of Doing Nothing"

(e.g. MMMCZCS 2021)



Maximizing Lifecycle Value:

Reducing Up-Front Cost AND Increasing Lifetime Benefits (e.g. De Neufville 2013)

Life Cycle View: Adaptive Infrastructure Projects

Adaptation DURING and AFTER construction

Design

- Identification of adaptation needs:
  - What uncertainty can be reduced?
  - What uncertainty must be accomodated (through adaptivity)?
- Identification of Adaptation Options
- Cost-Benefit Evaluation of Adaptation Options

Construction

- **Adaptability during construction**
  - Aggressive schedule goals whilst minimizing cost and functional risks
- **Enabling of continued post-construction „phased investments“**
  - Minimizing up-front cost, maximizing life-cycle value

Operation

- Identification of decision points for phased investments
  - Capacity expansion (or reduction)
  - Functional transformation

So can we operationalize

“Adaptability during construction”

and

“Adaptability as post-construction phased-investment” ?

Where are we?
Technology and Engineering Perspective

„Adaptive Technology Choices“ Perspective

Decoupling Critical Technology Risks from Project (Cost and Schedule) Risk

Concurrent Engineering

e.g. Eppinger 1991, Sobek 1999

Set-based Design

e.g. Singer 2009, Shallcross 2020

Technology and System Readiness Levels

e.g. Olechowski et al 2015; Kenley et al 1999

Technology Infusion

e.g. Smaling et al 2007

„Phased Investment“ Perspective

Decoupling demand risk from commercial risk

Flexible Engineering Systems

e.g de Neufville et al 2011, Cardin 2014

Reconfigurability & Modularity

e.g. Siddiqi et al 2008

Evolvability

e.g. Silver et al 2007

Platforms & Modular Design

e.g. Suh et al 2007

Where are we?
Project and Program Management Perspective

Resilient Project and Program Execution

„Wrong, but not failed“

Resilient project execution

e.g. Wied et al 2020

Design Flexibility

e.g. Gil & Tether 2011

Collaboration through Modularization

e.g. Tee et al 2019

Modularization-based Industry Platforms

Thuesen et al 2022

Building a flexible piece of infrastructure

„Future Proofing“

e.g. Gil et al 2015

Real-Options Reasoning

e.g. Krystallis et al 2020

Where are we?
Policy Perspective

(Public) Governance and Investment Decision Making

Current governance models (expecting us to know what the perfect solution is and sticking to it).

Stage-Gate Models to protect "as-is" definitions of projects.

Integrated Project Delivery, Strategic Partnerships, Alliancing are making first steps towards adaptability.

Dynamic Adaptive Planning

Adaptive Policy Making (mitigating / hedging)

e.g. Walker 2001

Adaptation Pathways (exploration / sequencing)

e.g. Haasnoot 2012

Dynamic Adaptive Planning

e.g. Haasnoot 2013

Take-Aways

Cost risk is driven by requirements uncertainty

Requirements risk can be reduced – requirements uncertainty must be accommodated

We have three choices: a) Best Guess, b) Robustness, and c) Adaptation

Since a) and b) do not solve our problem, we should try c)

Adaptation is surprisingly complicated

- Along life cycle: Design, Construction, Operation
- Project execution adaptability AND Infrastructure Adaptation

How do we evaluate adaptability and flexibility in our engineering and construction projects?

Terry:

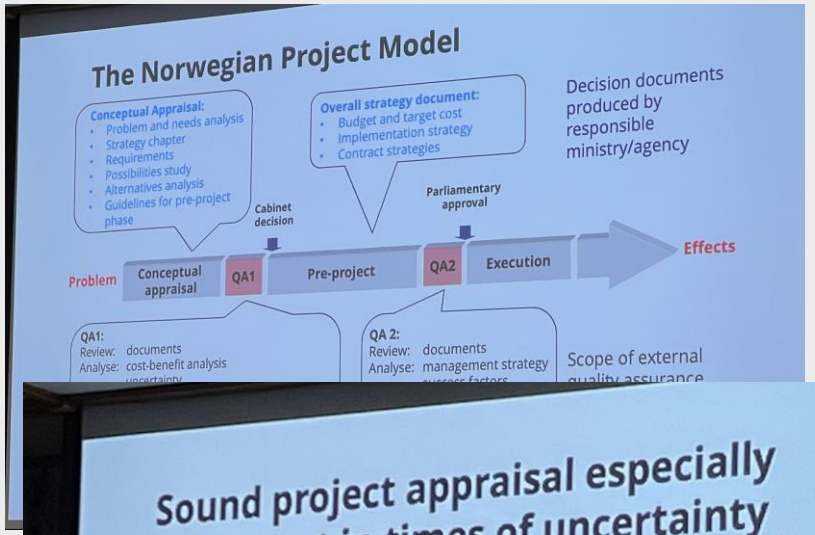
"Solve the problem, don't just deliver the project."

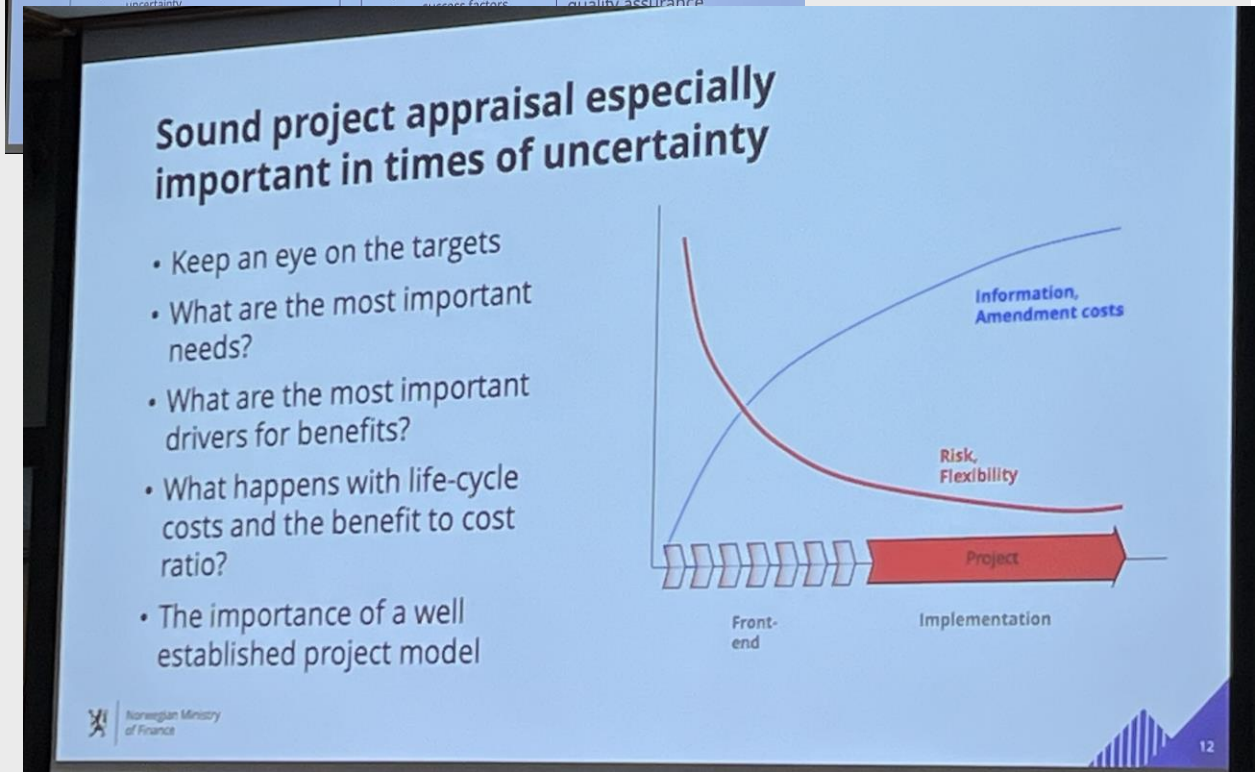
"We only manage risk during the implementation, not up front."

Gro:

"The simple solution would have been better."

"How do we decide when to stop exploring and start focussing?"





Thank You!