



“Getting back under Control...”

Concurrent Control Engineering for Optimal System Design

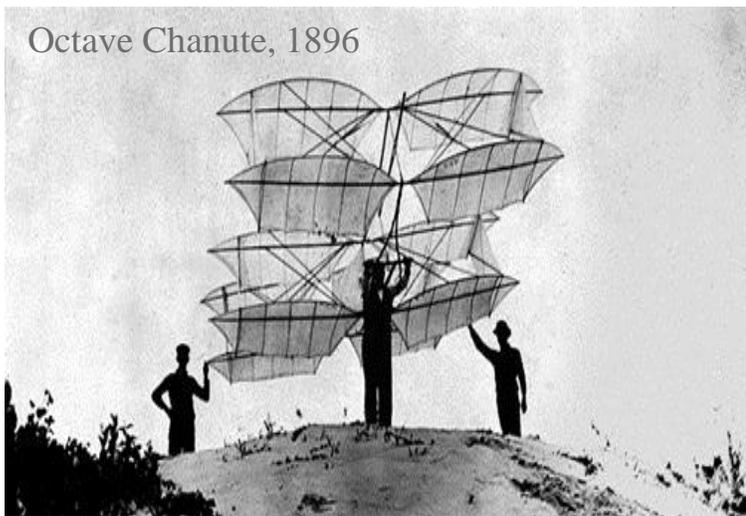
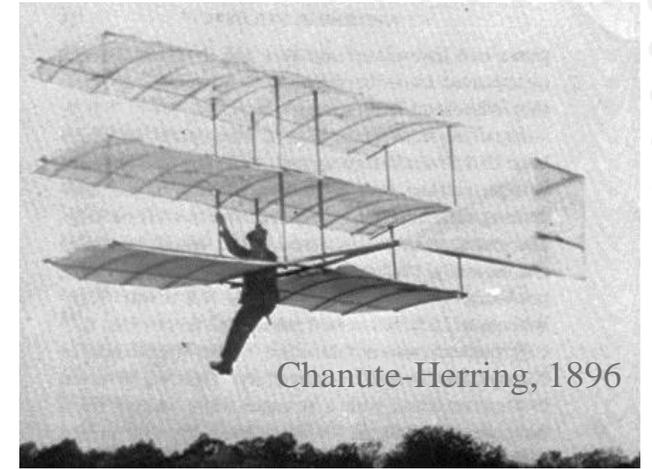
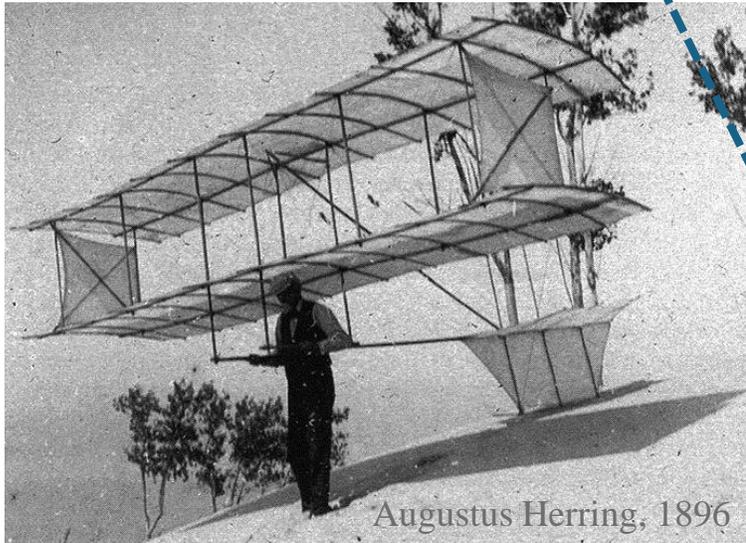
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U.S. Department of Energy

March 13, 2018

Why did the Wright brothers succeed?



Because they used Control concepts in the design...

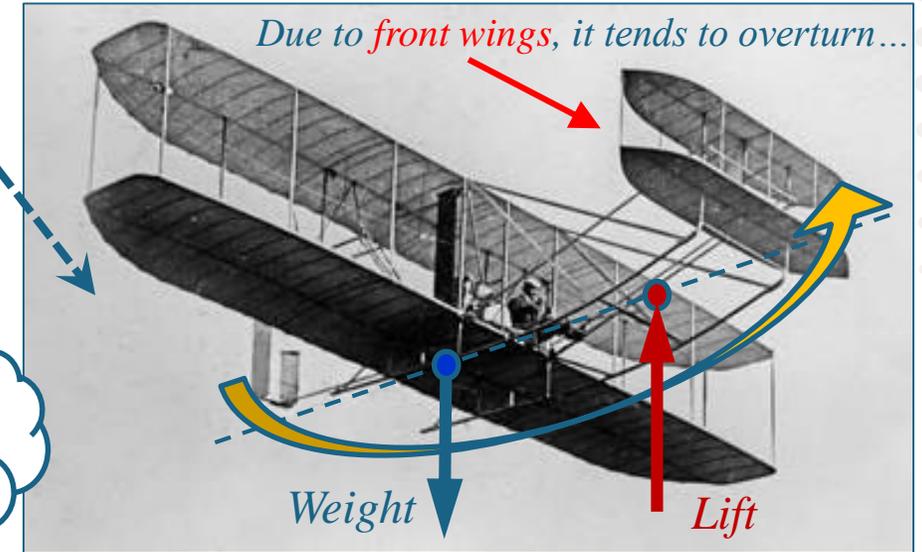
*The World's first heavier-than-air, powered
and controlled human flight*

Kitty Hawk, North Carolina
December 17, 1903

Wright brothers, 1903



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They designed an
“Unstable/Controllable”
system

with dynamics
fast enough to control
wind disturbances

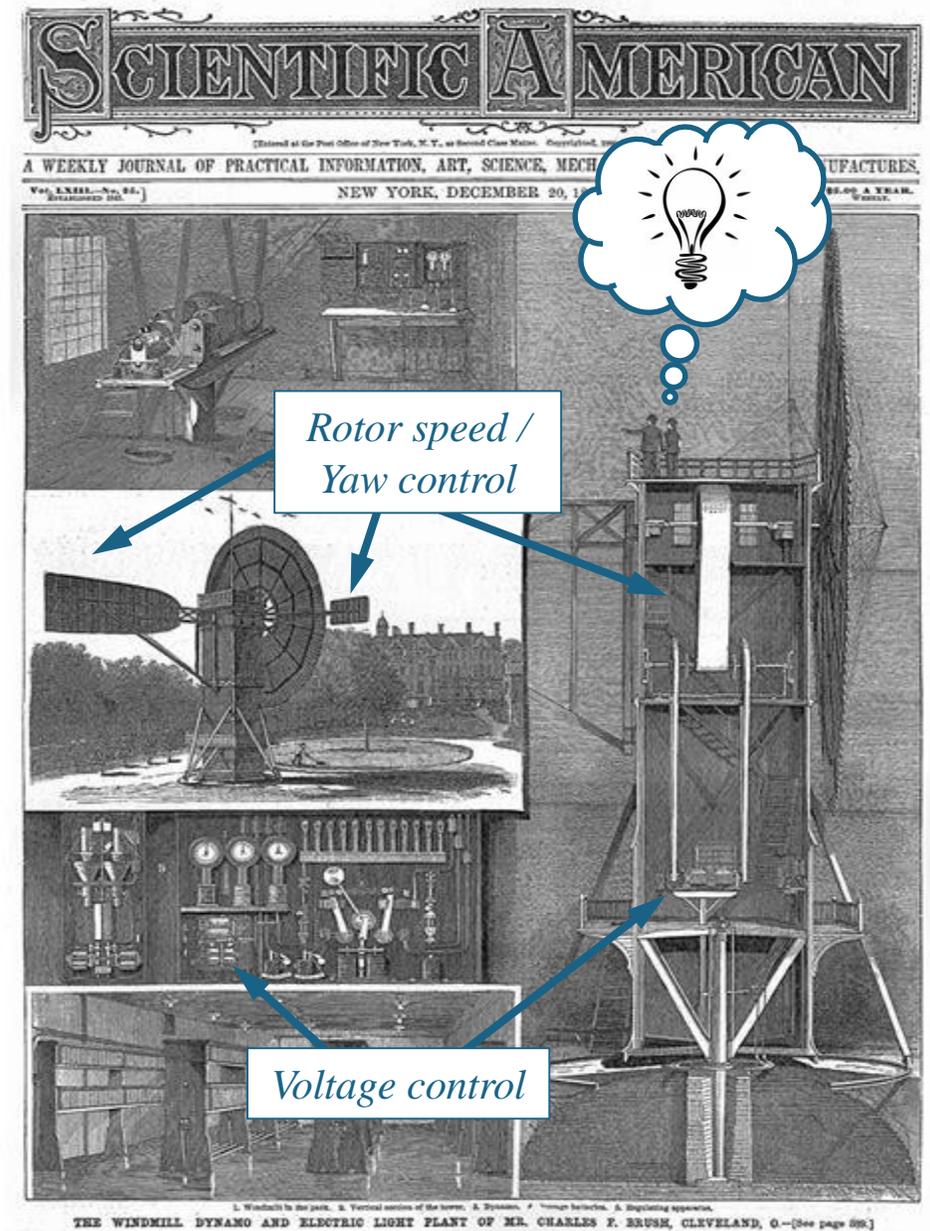
Why did Charles Brush succeed?

The World's first automatically operating wind turbine for electricity generation



Because he used “control concepts” in the design...

Reliable to work without problems for over **20 years** (1887 - 1908)



Today...

- The increasing complexity of technology has changed the **way we study** engineering at **university**.
- Engineering **careers** are now much more **specialized**.
- New **engineers**:
 - have a deeper knowledge of some aspects
 - at the cost of a much **narrower picture!!**
- Consequences: - a **sequential way of working** in industry
 - we incorporate **control** at the **end...**
- This sequential approach **limits** the **possibilities** of the design.

Sequential

Control at the end

Aerodynamics



Mechanical/
Structural



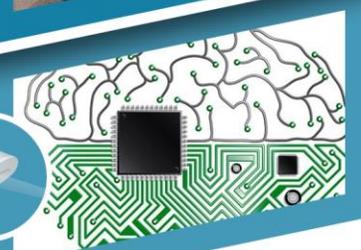
Electrical



Electronics

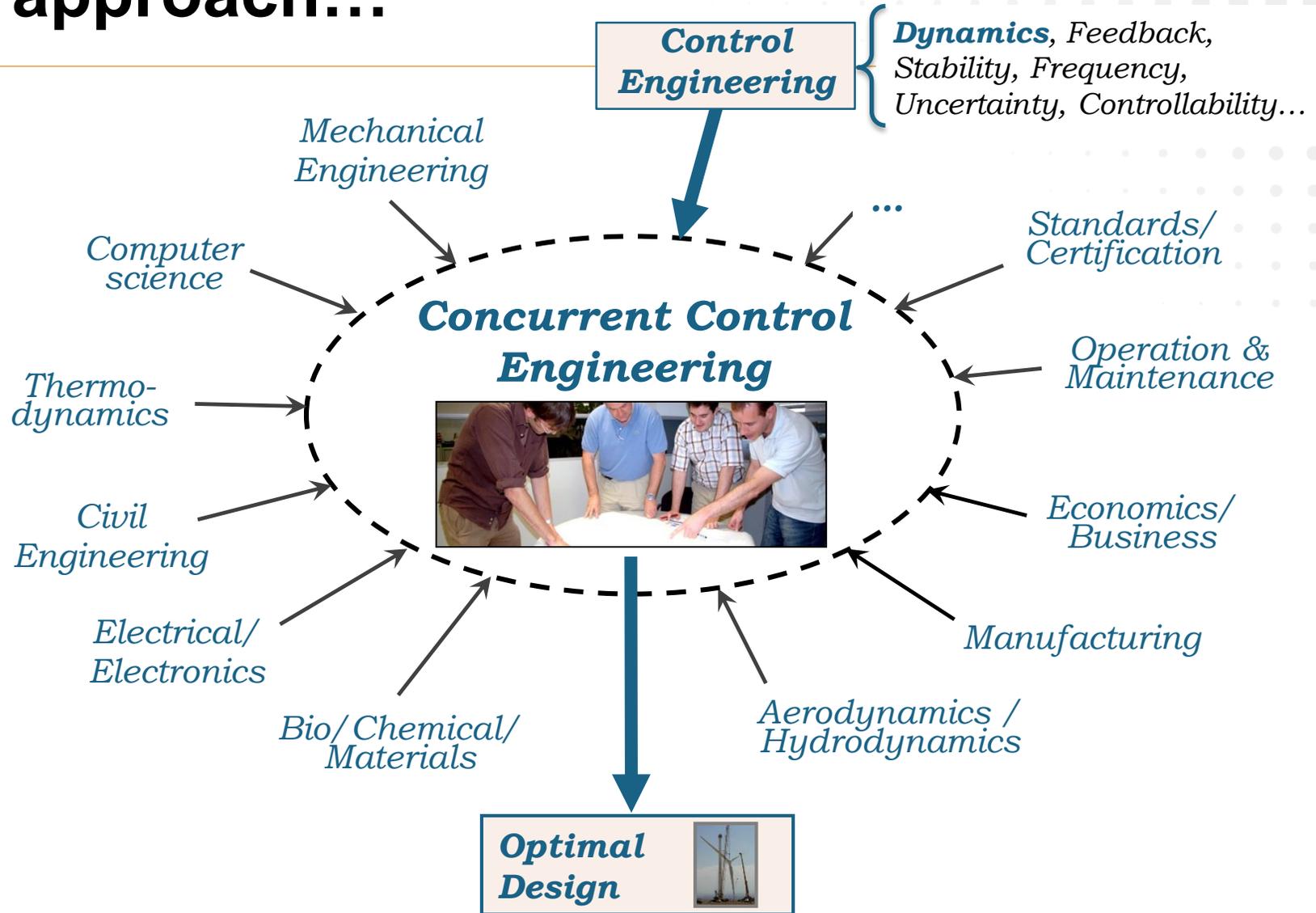
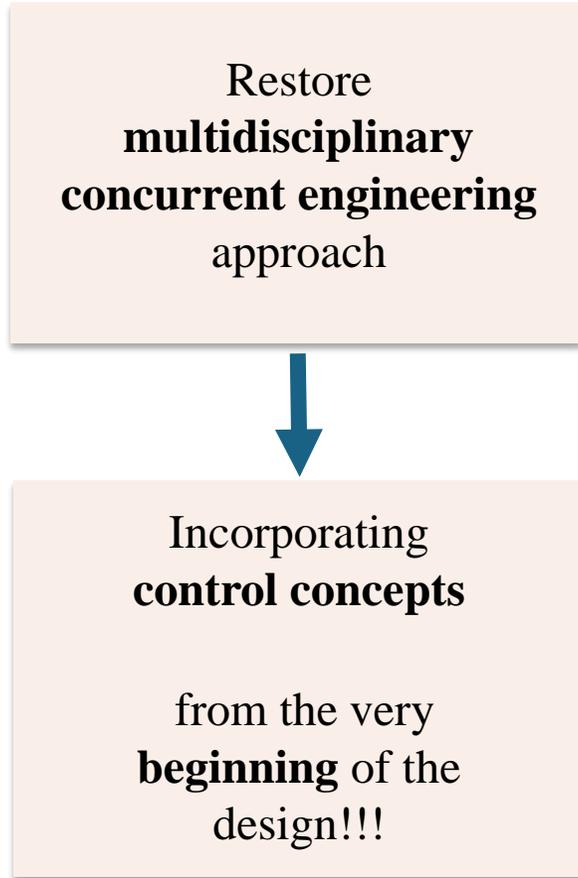


Controls



PIDs...

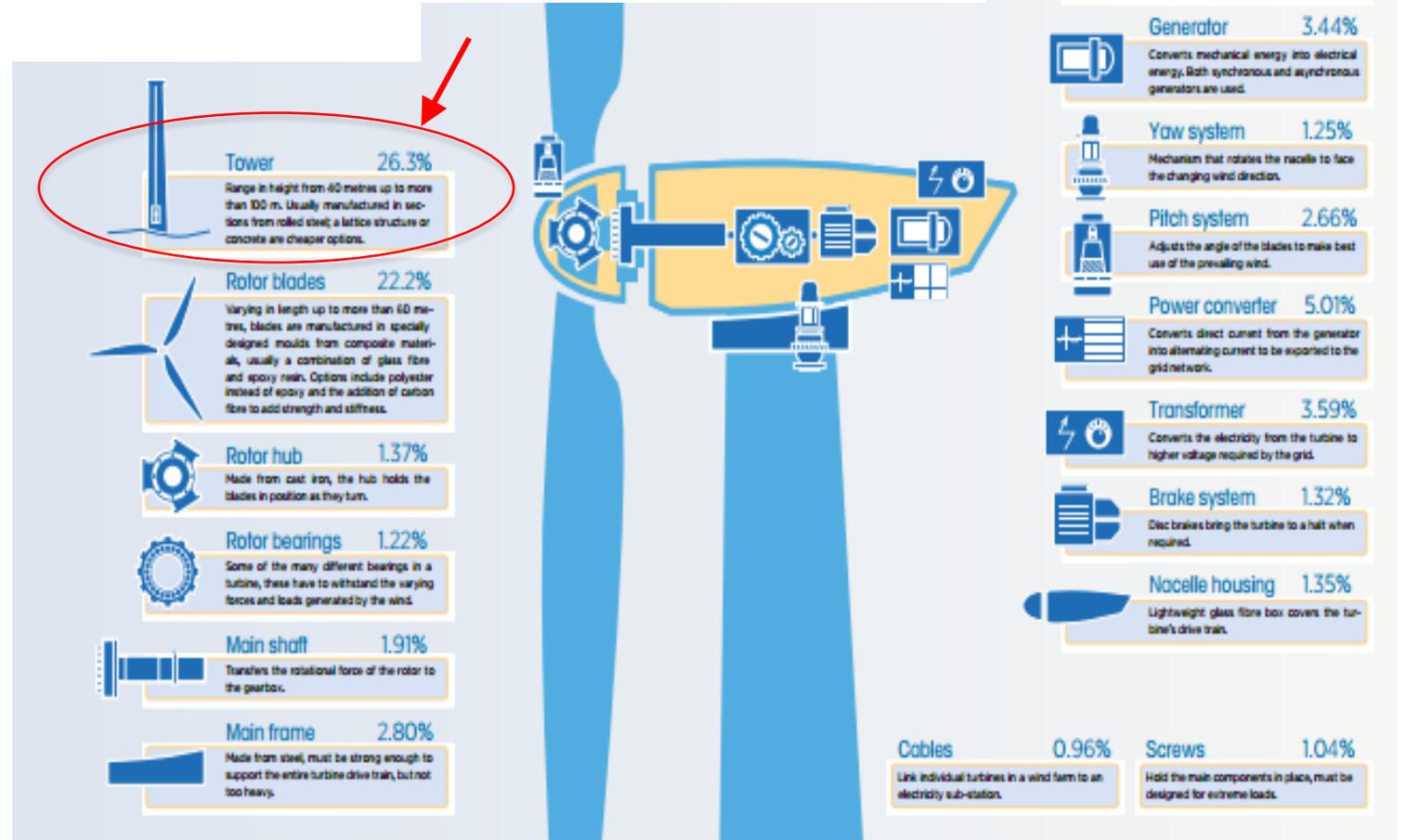
Back to the old/new approach...



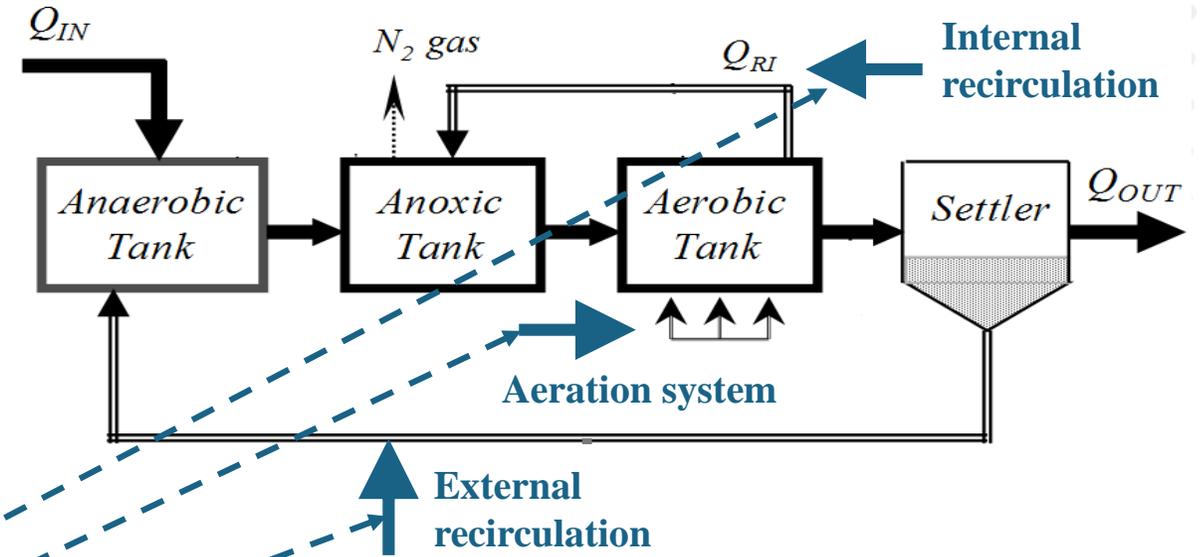
Wind energy / Design



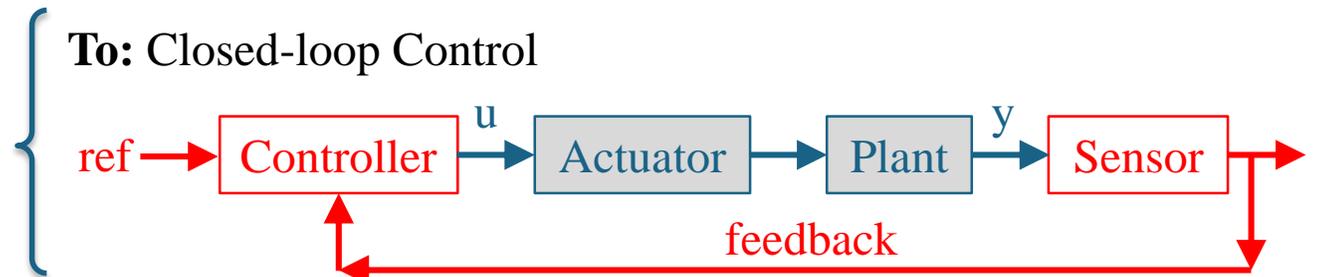
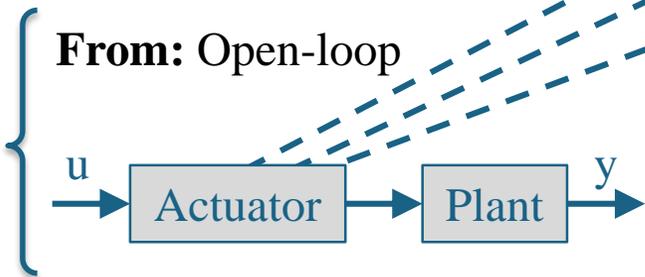
Improving pitch control (blade angles / rotor speed) for a cheaper tower structure (less mech. fatigue)



Water treatment plants / Infrastructure



Incorporating closed-loop controls for a cheaper plant infrastructure



New ARPA-E Program?



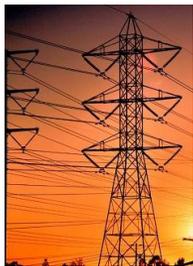
Water/Bio Systems
Infrastructures, Plants, Networks, Digesters, Desalination...



Hydro-Kinetic Energy
Tidal, Waves, Streams



Wind Energy
Turbines, Farms, On/Off-shore, Floating Turbines, Flying Turbines

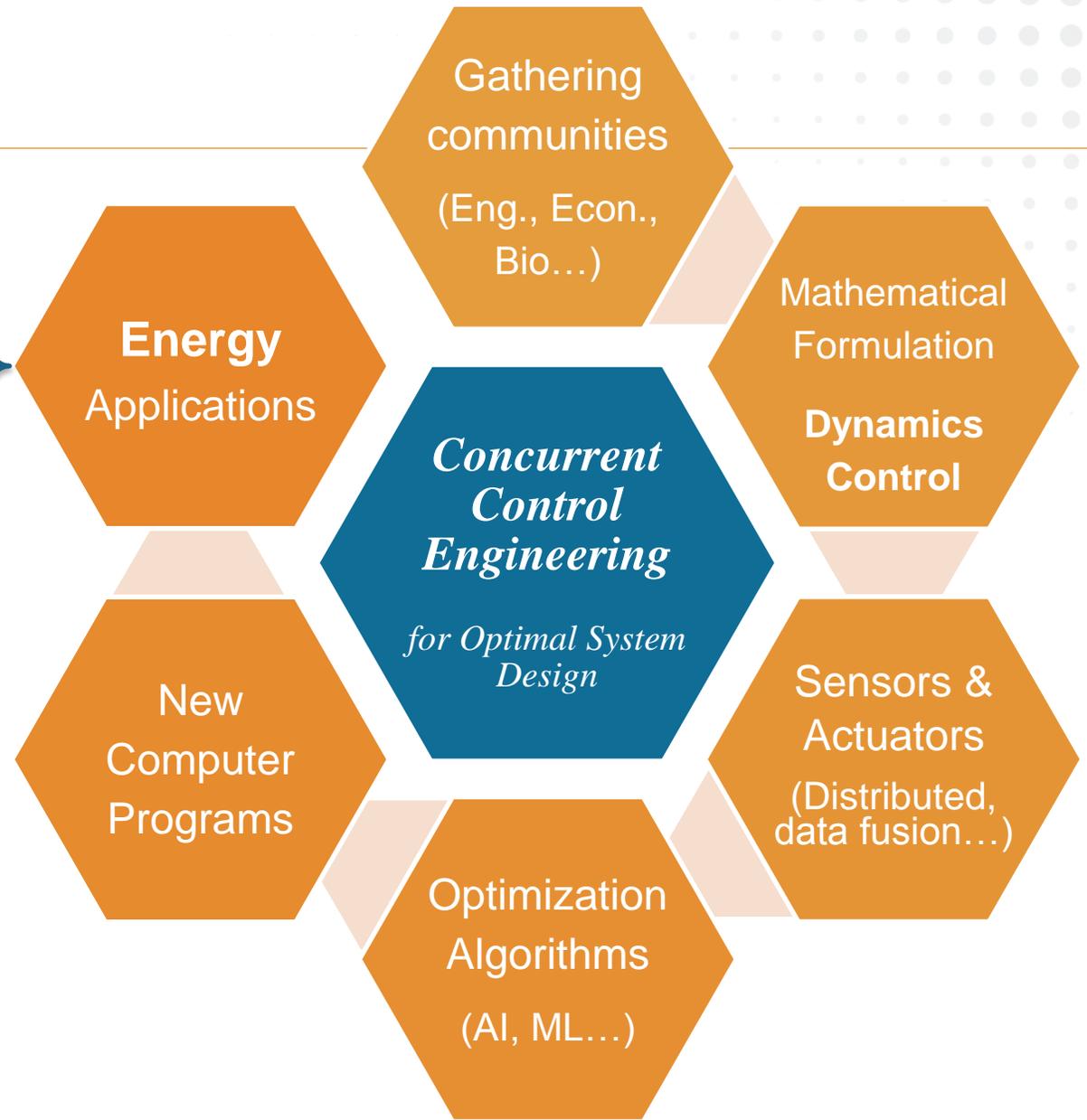


Conventional Generation
Nuclear, Coal, Gas, Geothermal...

Grid
Reliability

Solar
PV, Thermal

Hybrid Systems
Wind+Tidal+Waves





*Incorporating
Control concepts
at the very beginning
of the design!!*

Please, send us your comments !!!

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THANKS !!!

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