TYPHOON firefighting system

Development, design and tests

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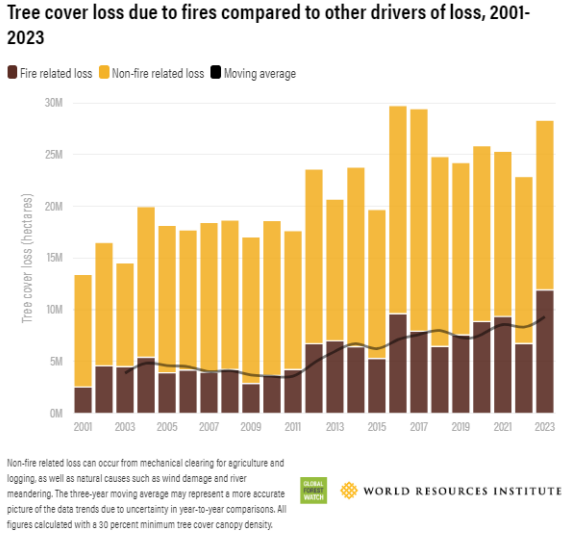
Introduction

- Wildfire hazard is **increasing** over the years; global trend
- Fires can also appear in **many other scenarios** (urban fires, industrial fires, confined spaces, etc.)
- **More challenges emerging** (e.g. EV / battery fires).



Emerging trends in firefighting

- **Water mist** systems have been established in fire-fighting
- Existing systems are **bulky**, limiting potential applications.

"Big Wind"

Minimax

EmiControls

- TYPHOON is a water mist system, with **enhanced flexibility and integration of automation & remote control**
- Addressing **FIRE-RES challenges:**

  4.2 Specialised equipment and solutions

  5.2 Integrated, large-scale coverage forest monitoring

System presentation

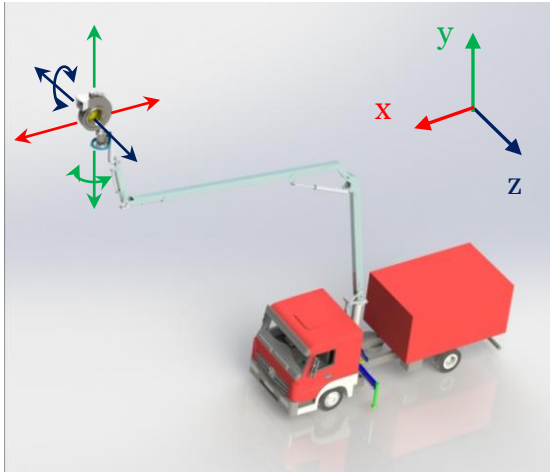
Main features:

- Crane/fire extinguishing remote controlled
- Dual engine setup
- Hydraulic-driven centrifugal blower with dedicated oil cooling circuit
- Centrifugal blower, air flow rate 6-15m^3/s.
- Air speeds up to 700km/hr (Mach 0.6)
- Customisable performance; 100-600hp (74.5 – 450kW)
- Water flow rate up to 0.1m^3/s (6000lt/min)
- Operational with **water** or **fire-fighting foam**

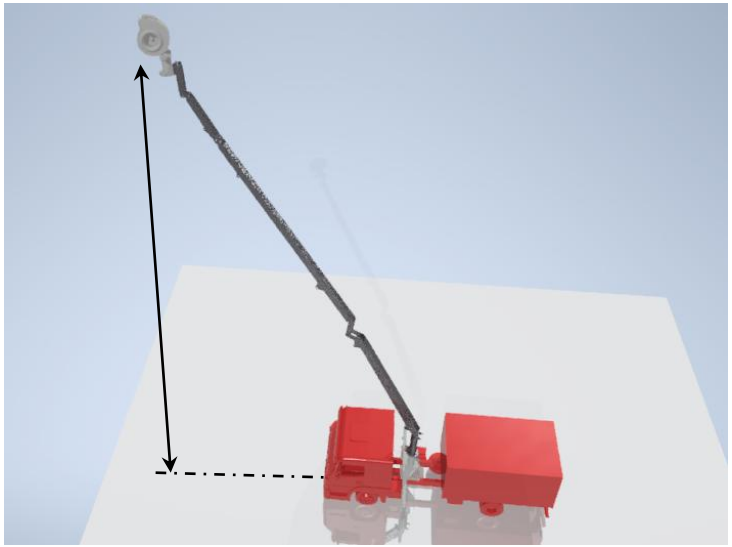
Capabilities / degrees of freedom

Main features:

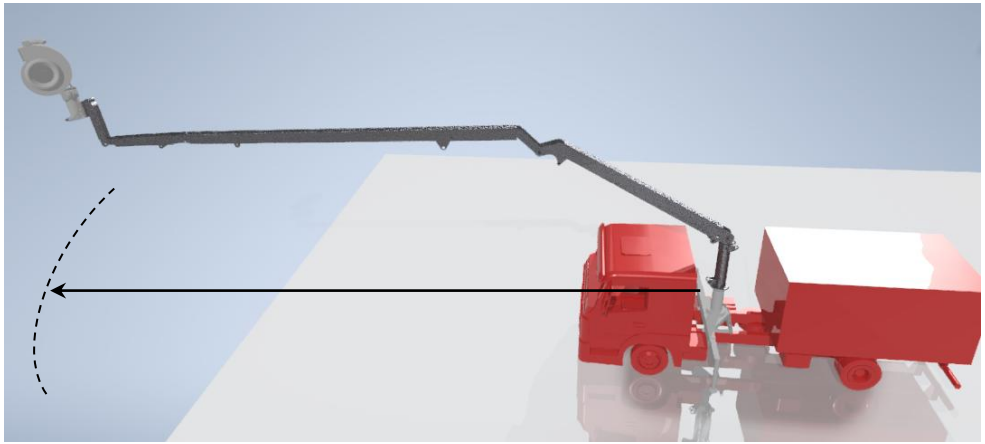
- Fully articulated arm
- 5 Degrees of Freedom for end-effector (Blower & water jets)
- Adjustable jet width, spray angle and spray range
- Capability to mount tube to direct jet for indoor use



Capabilities / degrees of freedom



Max. crane height ~15m

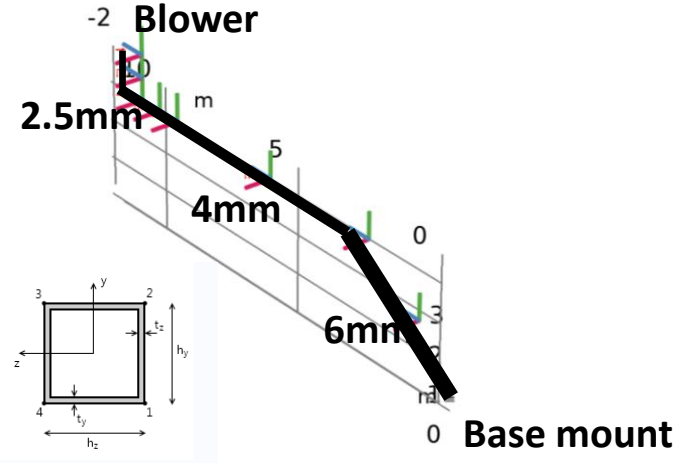


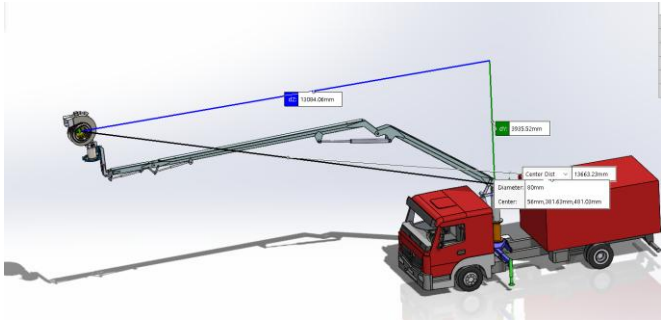
Max. crane reach radius ~11m

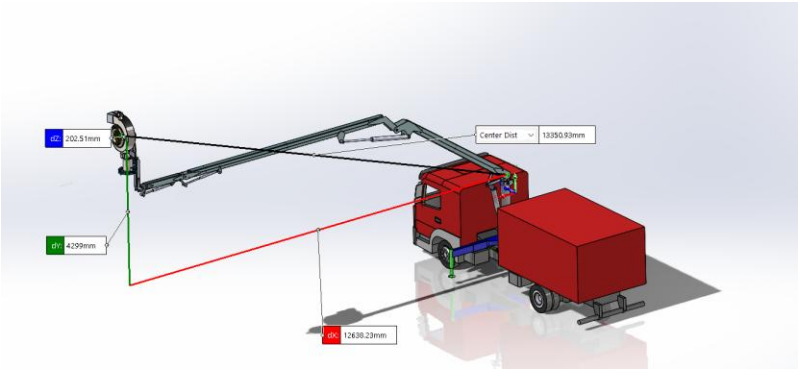
Structural aspects / analysis

Preliminary crane analysis:

- One dimensional structural analysis to dimensionalize base mount and forces for several configurations



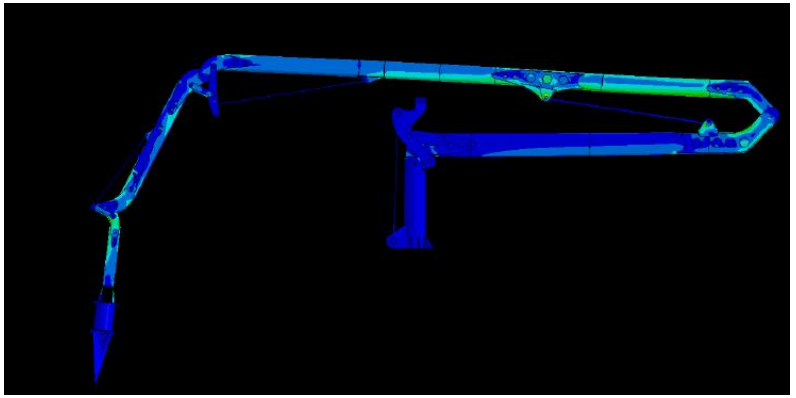


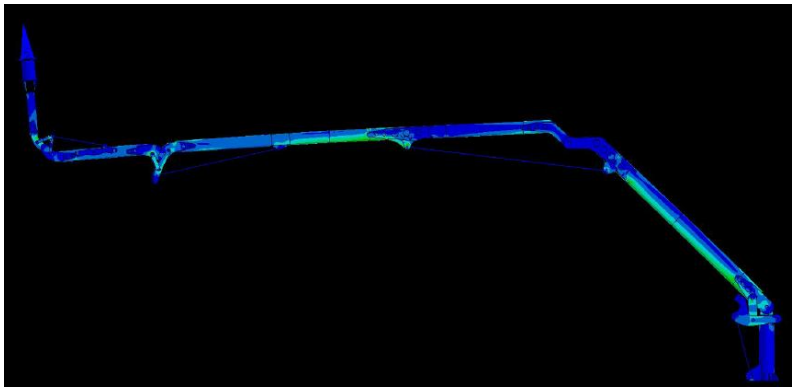


Structural aspects / analysis

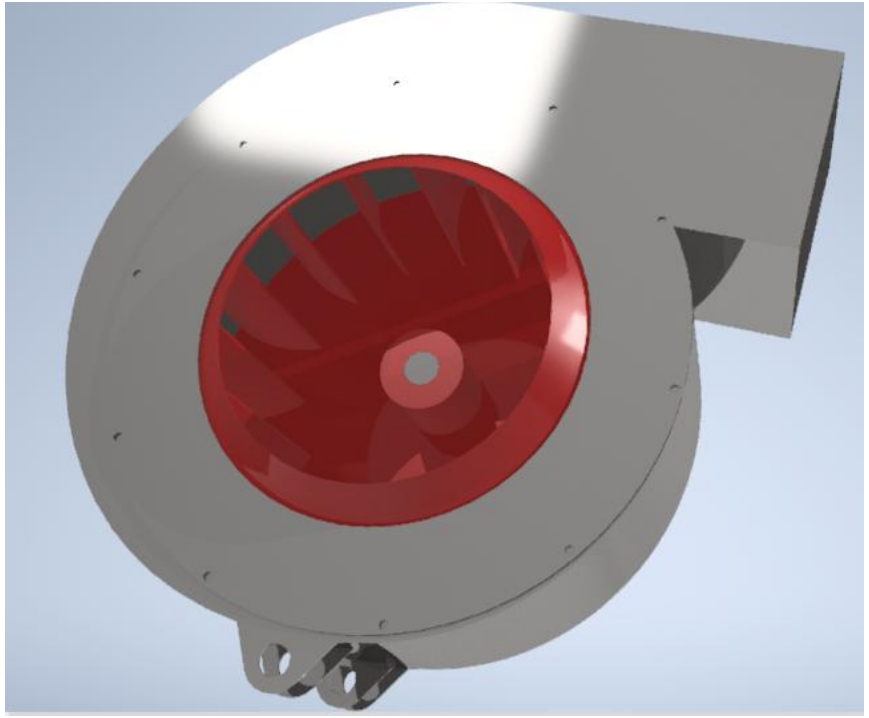
Detailed FEM structural analysis of crane:

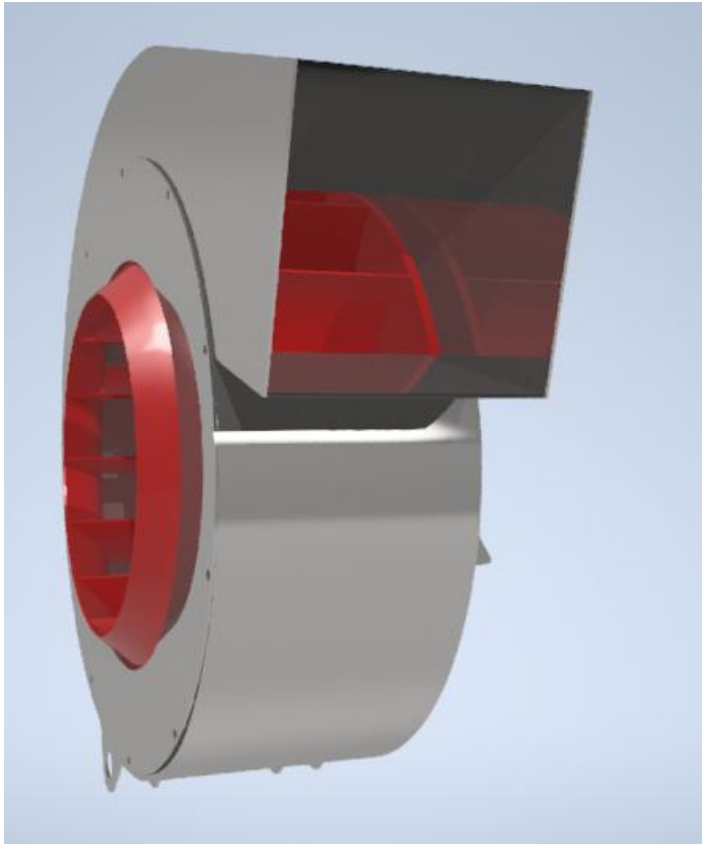
- Detailed structural design of cross-section and joints
- Pistons/hydraulics selection for crane motion
- Automation and control





Initial concepts

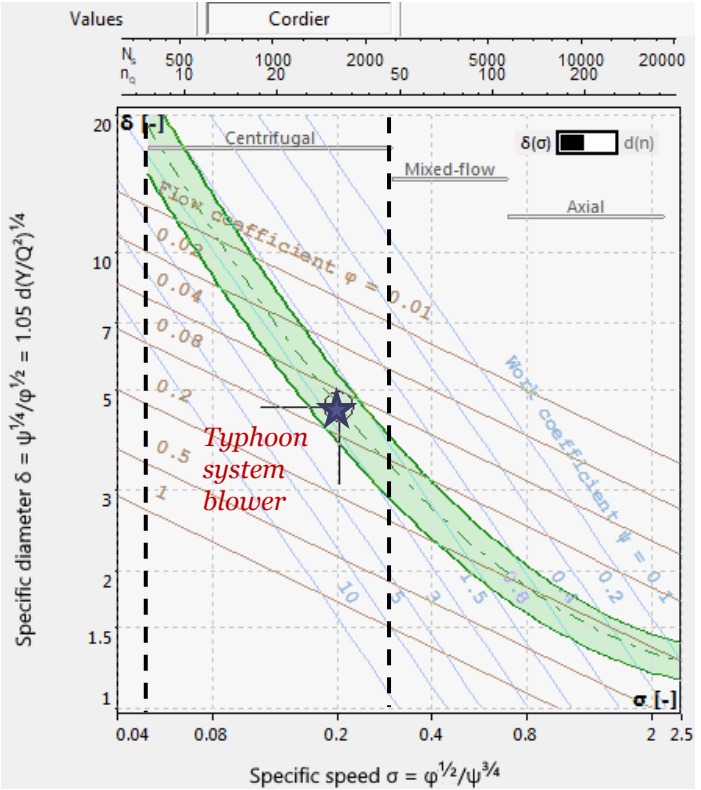




General - selection

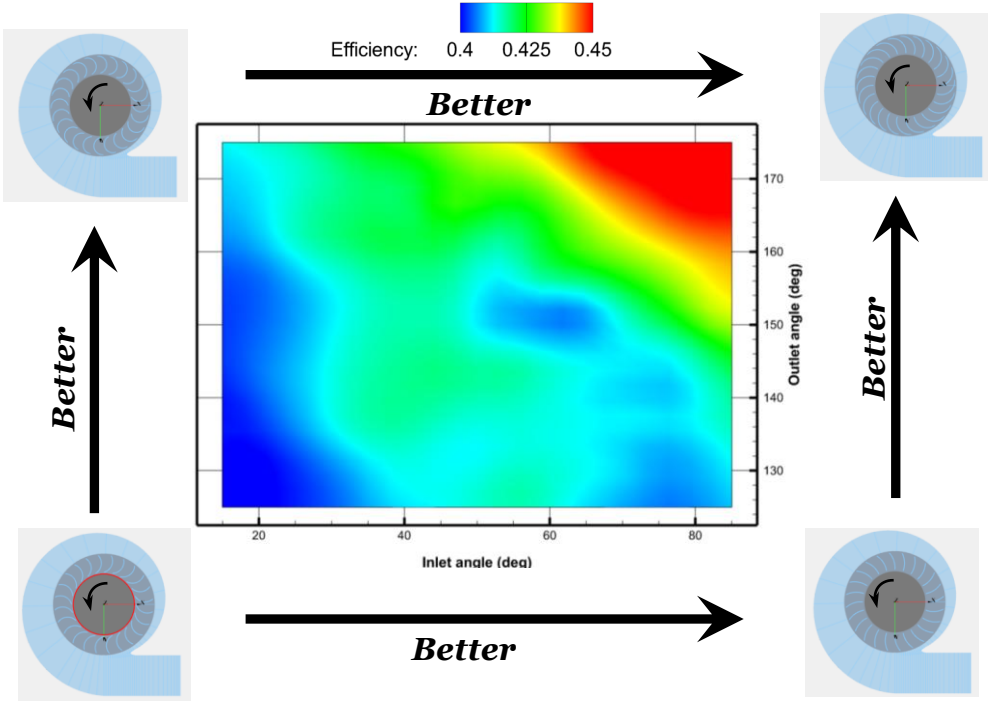
Desired characteristics

- Q=6-15m³/s, top air speed ~ 600km/hr, 3000-4000rpm
- Cordier diagrams indicate centrifugal fans as the most suitable option
- Centrifugal fans **have a higher power density** and **higher compression ratio** than axial fans.

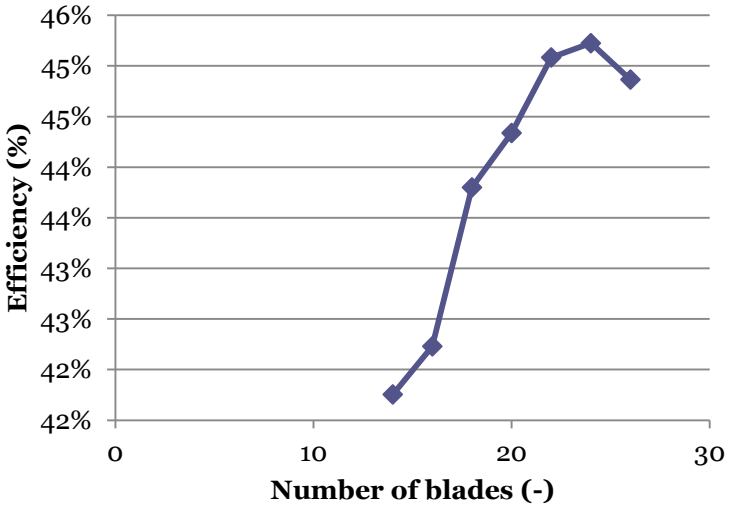


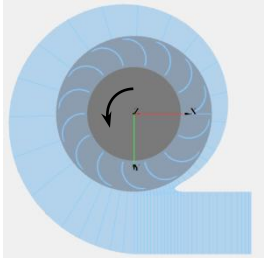
Flow optimisation

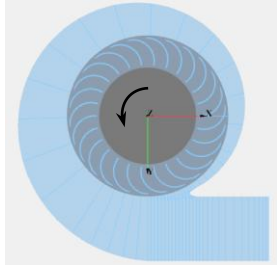
- Blade shape optimisation



- Blade number optimisation

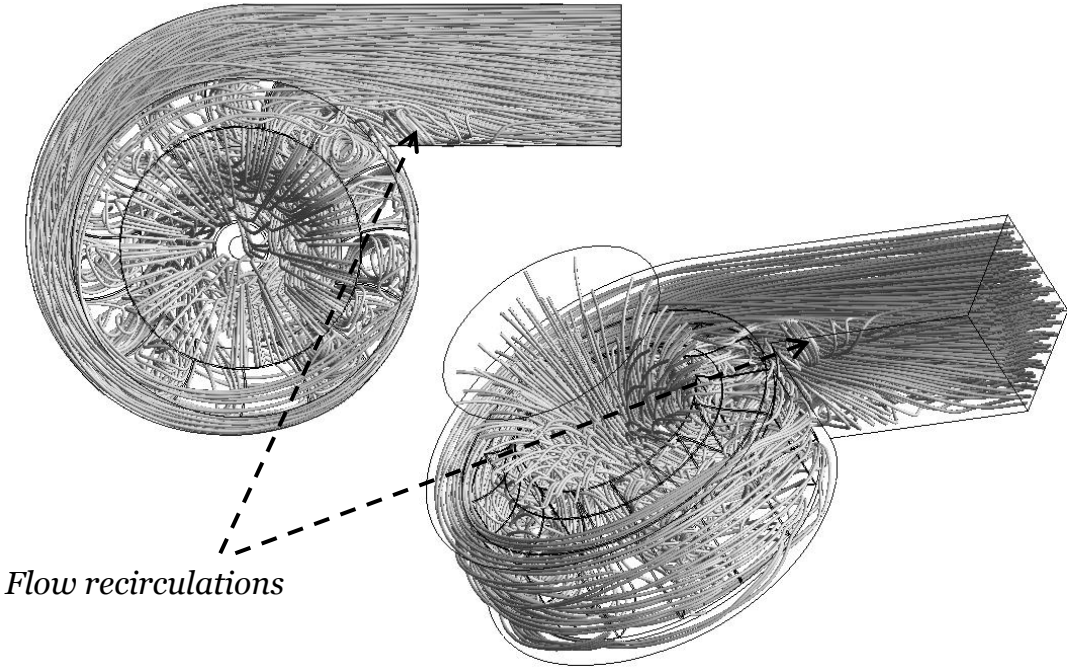






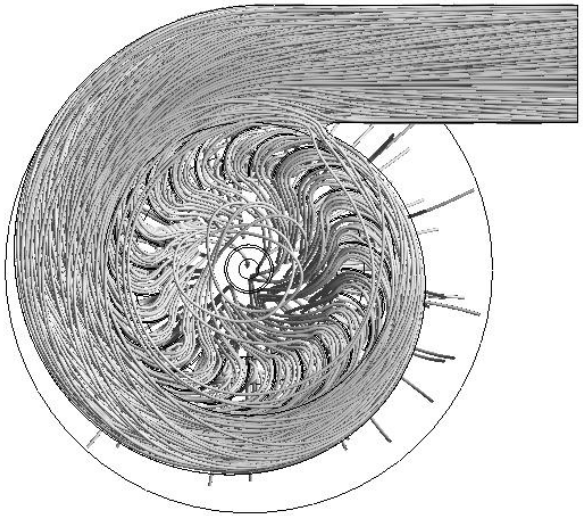
Optimisation results

- Initial design



Flow recirculations

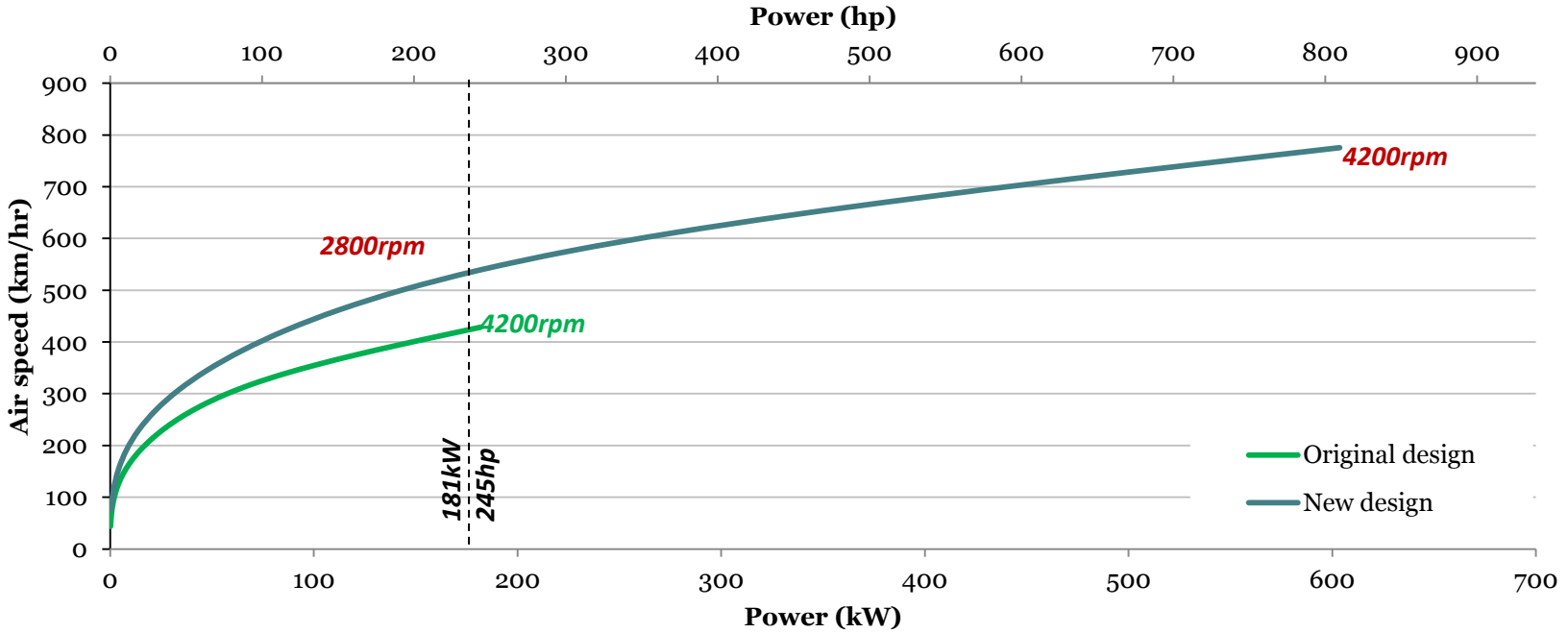
- Optimised design



Includes: blade number & angle optimisation + intake funnel optimisation

Efficiency ~ 65-70%

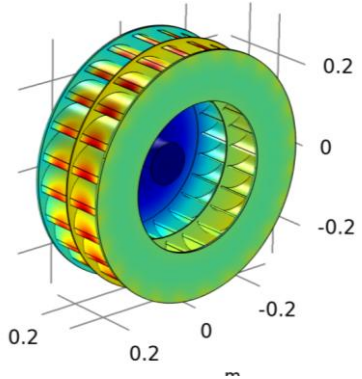
Performance chart



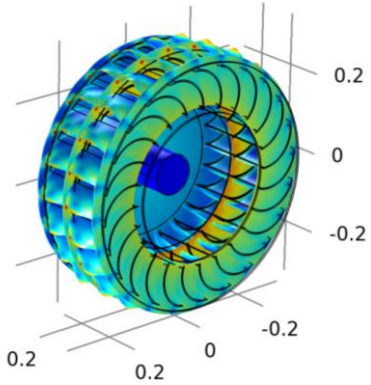
Structural design

- Structural analysis of impeller

Deformation

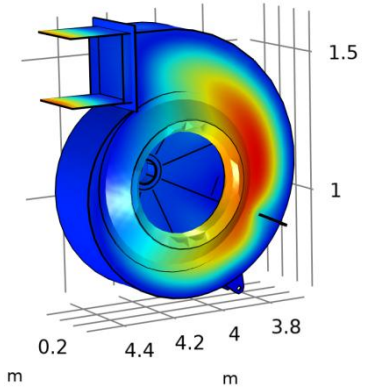


Von Mises stress

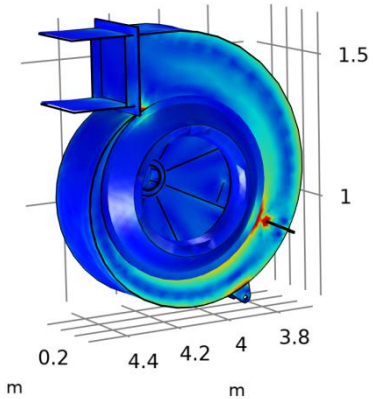


- Structural analysis of casing

Deformation



Von Mises stress

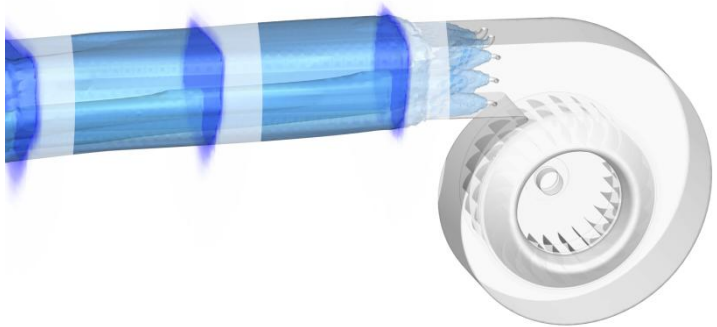


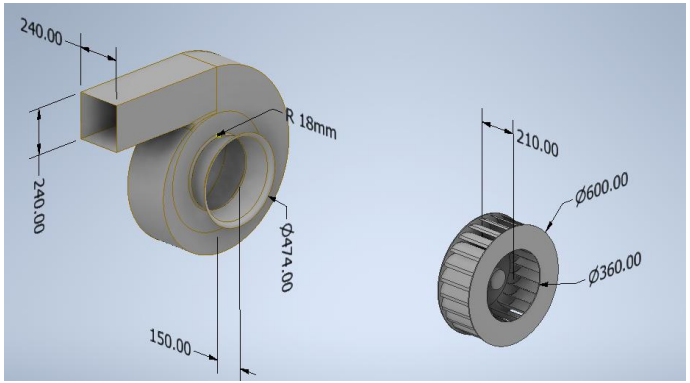
- **Structural capacity up to 4200rpm, 600kW power, >0.5Mach air speed**
- **Roughly 75kg total weight of complete fan (casing & impeller)**

General dimensioning

Centrifugal fan:

- Developed digital-twin including water jets
- Customisable for different sizes, depending on requirements, e.g.:
- Air flow rate, water flow rate, number of nozzles, etc.
- Size (impeller width, centrifugal fan width) depending on desired application (compact or efficient?)





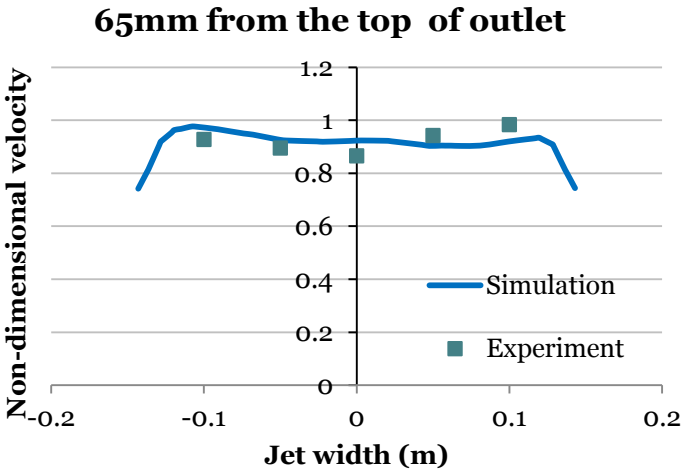
Manufactured designs

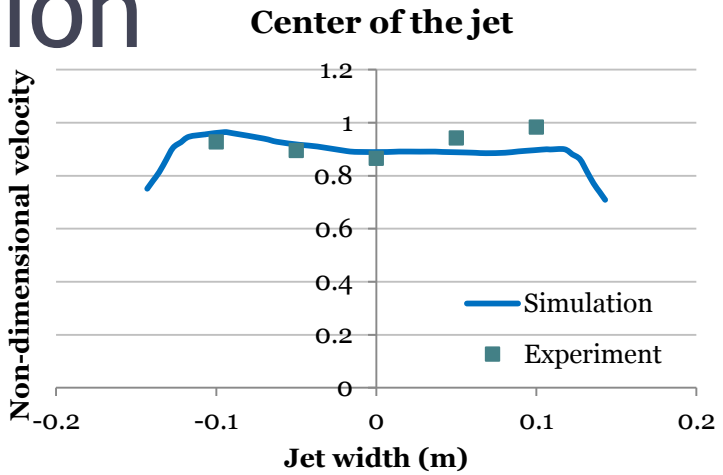
- Impeller

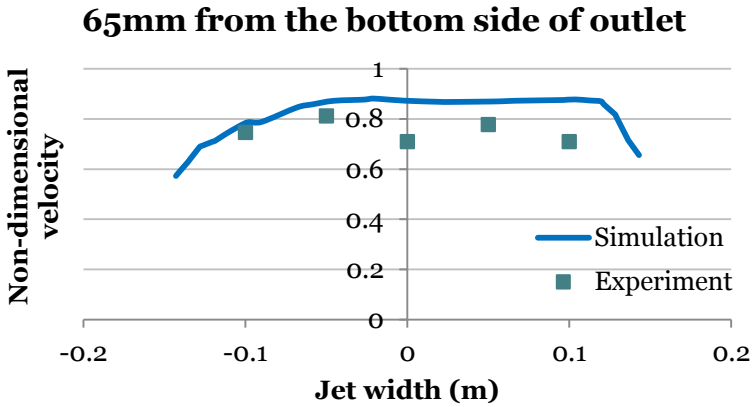
- Complete assembly

Experimental validation

- Flow profiles





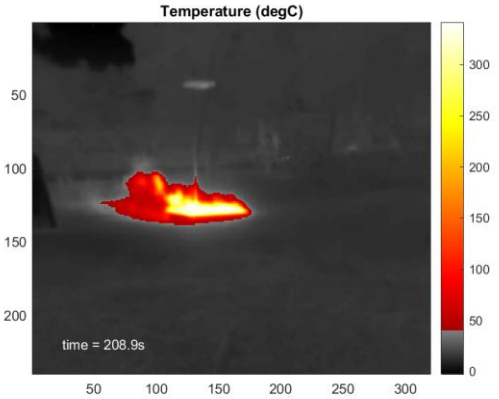


Photos and videos

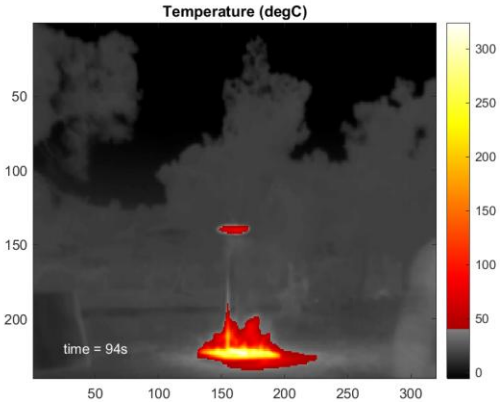
Advantages of TYPHOON

- As a water-mist based system, **has a lower water consumption and better overall efficiency**.
- The large volume of air can **significantly remove heat loads**, can evacuate **smoke from confined spaces**.
- **Flexibility**, can be used to **multiple scenarios**: forest fires, urban fires, industrial fires, confined spaces, specialized fires…
- **Remote controlled**
- **Improves operational conditions**, safety to fire-fighters / crews.

*Air blower **on***

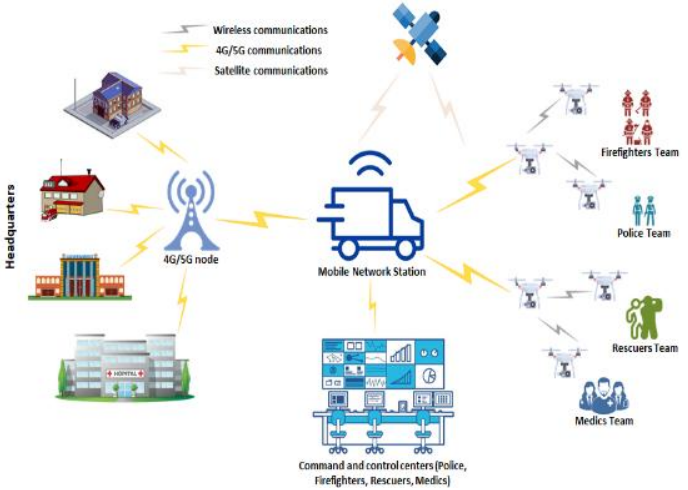


*Air blower **off***



Future directions

- **Diagnostics** (integrated IR-camera)
- **Automation**, integration of automatic fire-extinguishing routines
- **Further integration of robotics** (UAV, UGV,..), telecomms, etc.
- **Enhancement of remote control to the complete vehicle**
- **TRL6/7 → TRL9**



TYPHOON demonstration

- **Selected solution for open innovation challenge**: FIRE-RES project (2021-2025) European Union H2020

- On 25/01/2025 **demonstration of TYPHOON was held** in collaboration with volunteer firefighters of N. Voutzas – Provalinthos and representatives of Haugaland Fire and Rescue IKS (Norway/Sweden Living Laboratory, European Forest Institute).

- TYPHOON **was recognized as an innovative solution to modern fire-fighting needs**.

Thank you for your interest!

Questions?

Cyprus University of Technology