Test for design

機械工程實務 2024

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System design with clear objective

Linear car motion

$$\text{M a = Gravity} - \text{friction} \pm \text{hydro. force}$$

1. Make a free-body diagram

2. Identify variables in the balance equation

3. Identify components likely to build
    --start with something you're more certain and can quickly realize/modify

4. Mark uncertain items/components
    -- this is what to be discussed as a priority
    -- discuss by the degree of uncertainty (low-to-high)

Identify your system components

--Start with a free-body diagram
--Identify items of certainties (constraints)
--Mark uncertain items, rank the degree of uncertainty

- Gravity force

- Basal friction force

- Hydrodynamic force

"Design" the uncertain items

Starting from the one with least uncertainty

- Make assumptions

- Look up/estimate feasible values for …

- Measure …

- Simulate …

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"Design" the uncertain items

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- Simulate …

Can't I just cut & try?

- Trial & Error

- Your trial should be a **Designed Test for validation**.
- Observe & analyze for refinement
- Work with a clear logics.

I want to measure the mass of the
car M to formulate $M \frac{d\vec{u}}{dt} = \sum \vec{f}$

I want to measure the strength of the
base plate so that it does not deform...

I want to measure the friction coefficient of
the bull eye wheels to ...

I want to perform CFD simulation to ...

Start a task with a clear objective

Design your test/task

What? **Objective: component vs. system**
Obtain data, analyze performance, validation, refine strategy…

How?
1. Identify the desired output
2. Clarify physical constraints (those you cannot design)
3. Pick methodology
4. Execute, observed & record
5. Analyze & Evaluate
6. Data presentation & conclusion
7. Redesign

What? **New Objective**

How? **Iterations with logically evolved objectives…**

I want to measure the friction coefficient of the bull eye wheels to …

I conduct experiments to measure friction coefficient f

I conduct a second set of experiments to check if f varies with ….

"How"?

End a task with a conclusion that addresses the objective; so think of your conclusion.
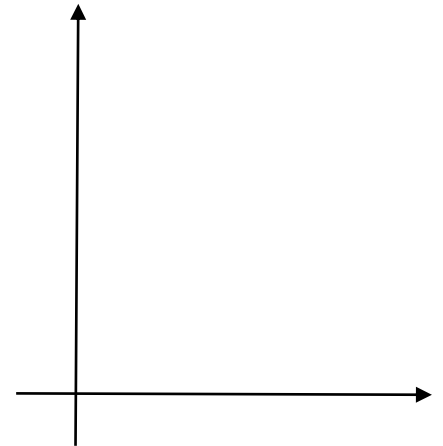
Planning towards conclusion

A task conclusion must address its objective.

A scientific conclusion is preferred.

--Think of concise statement, with quantitative (qualitative) descriptions.
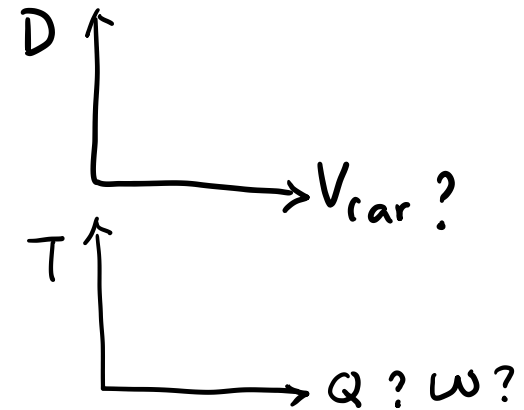--Even better, present your data in view of a plot/table

--Plan how to obtain the 'values'

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What have been done for 'components'

- 風道測試**control vol. analysis** 估計阻力

- 風場可視化估計**[扇葉]** 推力

- 摩擦力　　起動　靜摩擦力：滑動 vs 滾動??
　　　　　　轉彎　"側滑"動摩擦 = 離心力

- 開放風場測試推力

The conclusion from these measurements should reflect the functionality of each component.

D

V_{car} ?

T

Q ? ω ?

Validation as a system?

At system level, recall the starting point:
The balance equation

Ma=gravity– tire friction – hydro. force – braking

Not equal → rerun tests?
→ redesign tests?
→ REDESIGN components?
→ invoke control strategy?

**Observe and learn from the existing designs.
Think, propose, test and debug with logics!**

Reminders

- Wind strength decays with the distance from the blower.
- Crosswind may cause lateral sliding/tumbling.

- Test wind field will be provided with portable velocimetry.

- 機工實驗 Routines/reports are good references.

- Other facility (wind tunnel) may be open upon request but with further safety rules.
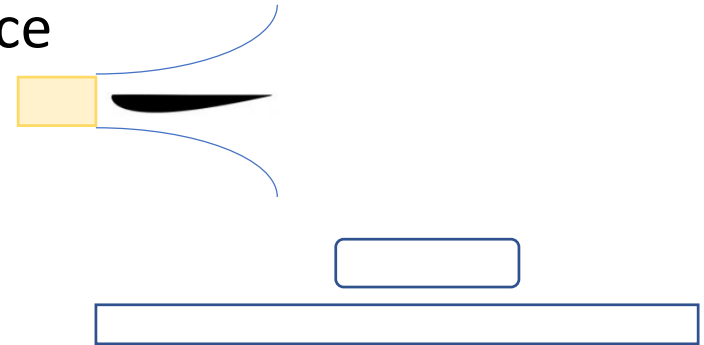
Scientific Report

整體性
- 內容表 (附對應頁碼)、字型統一
- 符號要統一**!!!!!** 也要在第一次出現時定義

科學性
- 具體精簡的論述 (避免太口語化的敘述)
- 力學根據的討論
- 數據呈現的方法 (圖、表 支持你的設計力學)
- 要交代計算設定細節、理論分析假設 (以別人能重現為原則)
- 改善的勇氣

閱讀性
- 善用字體、大小粗細標線幫助區分內容屬性
- 方程式編號
- 照片、表編號附圖說及目的、元件尺寸
- 內文字和照片內的字大小不要差太多
- 新段落不要在頁底開始