Transformative Interdisciplinarity

7th Interdisciplinary Learning and Teaching Conference at our Chelmsford campus on 20 April 2023.

A design stream based academic framework that transformed student satisfaction and experience on an interdisciplinary Aerospace Engineering programme

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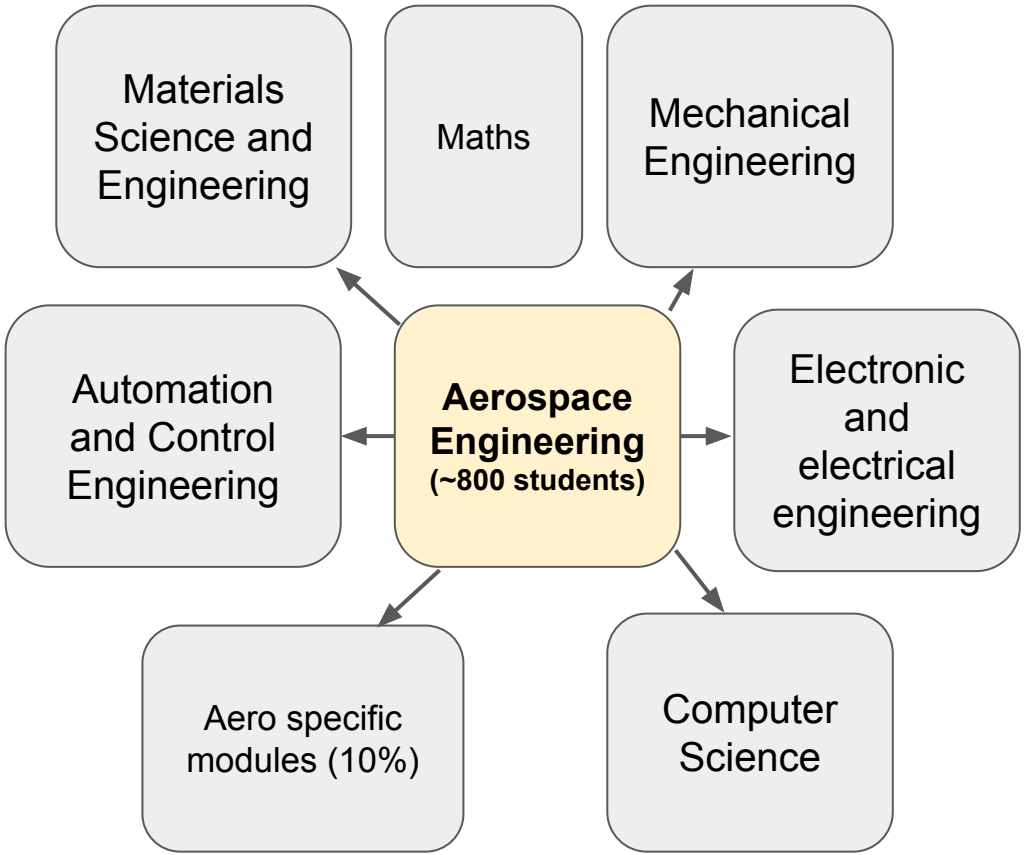
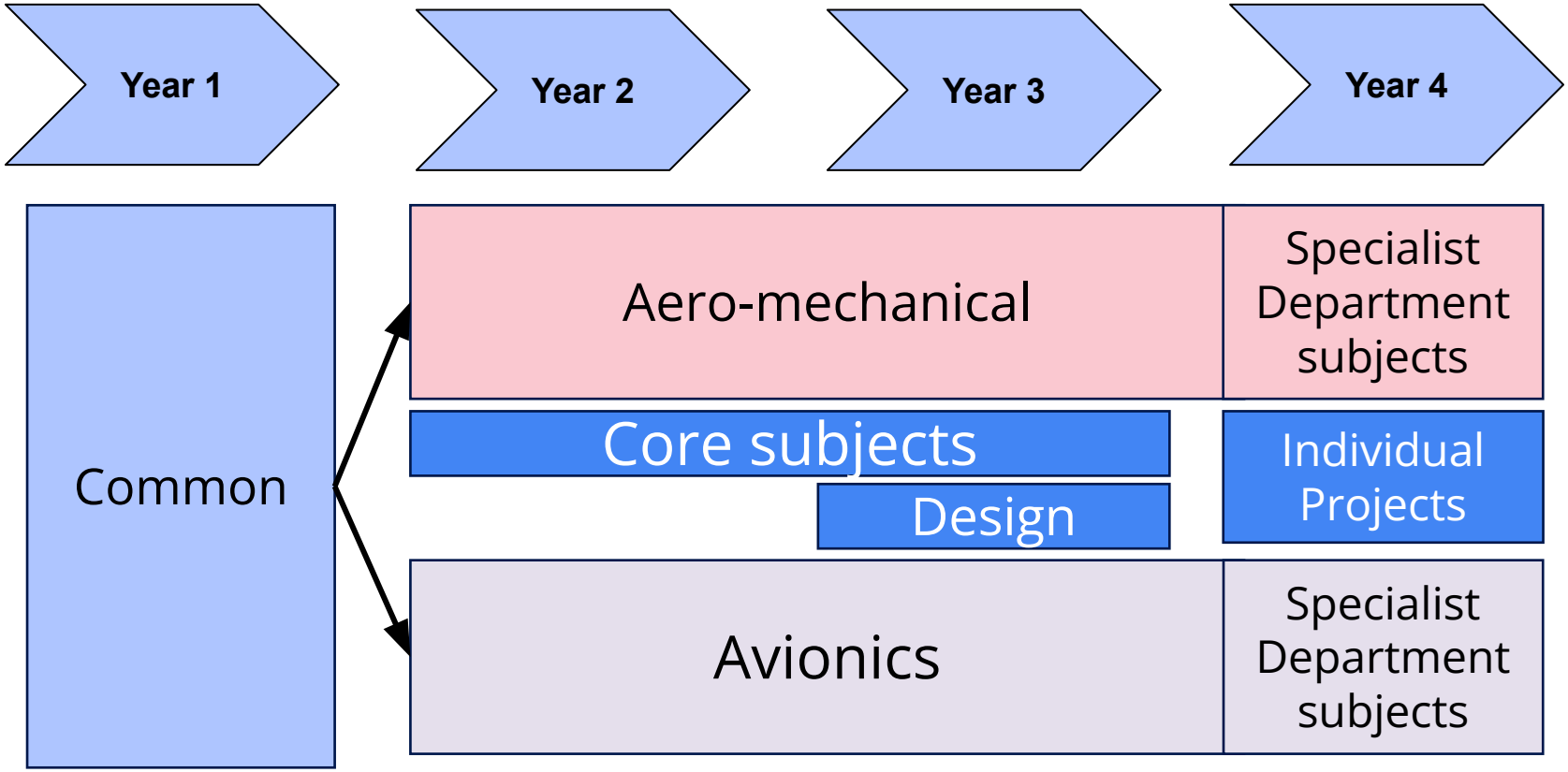
Aerospace Engineering | Bioengineering | General Engineering | Science & Engineering Foundation Year

Interdisciplinary Aerospace Engineering



- Students take existing modules from degree programmes in other departments
- together those modules form the Aerospace Engineering degree.
- **No traditional home department**.
- Small academic leadership team - one or two academics (20% FTE)
- There were only a few specialist Aerospace modules inc. a Year 3 Group Aerospace Design Module (a PBL - module).

Original Curriculum Design
- all taught by cognate department staff



The early years of interdisciplinary Aerospace engineering

- When small (50 students / year) student experience was OK (at best) but
  - Cognate department staff teaching ‘their’ modules did not know their audience
    - No idea some (or many) students were on the Aerospace programme
  - Lack of linking between modules
    - Most staff did not know the links between their modules and others
    - Students were expected to see/make the links themselves
    - Only a few aerospace focussed modules (Year 3 Design), but
      - Still taught by department staff (MEC, EEE etc.)
      - Most staff were not Aerospace focussed
  - Lack of coherence within the programme
    - Poor staff/student and student/student community - (evidence NSS)

Mid-life crisis

- Cohort sizes increased
  - More (slightly specific) aerospace focussed modules created
    - Still taught by department staff (MEC, EEE etc.)
    - Module leaders had little/no knowledge of the LOs of the Aerospace degree

- As the cohort sizes grew, student community and experience started to suffer
  - Aerospace students felt like second class citizens compared to other departments
  - Felt forgotten about
  - Little staff/student community
  - Programme lacked coherence
    - evidence NSS, internal surveys and student conversations

Example Year 3 Design Module (before the Design Stream)

- This module was one of the few ‘owned’ by aerospace
- Taught by someone from another department
- Department module lecture material was meant to feed *into* this Design Module, but
    - Poor feedback scores
    - Teaching could be more joined-up
    - Poorly linked or non-aligned supporting academic modules

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Year 3 Design Module (before the Design Stream)

This was a non–module. Nothing was taught. Nothing was explained.

Structure of the module was quite poor

We couldn't trust the module staff to give a proper answer when this question was asked

I did not have any idea where to start with this module

Frustrating

Missing a lot of knowledge that I required

I don't think it was very well thought through

Module could be organised much better

It barely touched on anything we have learned in our degree

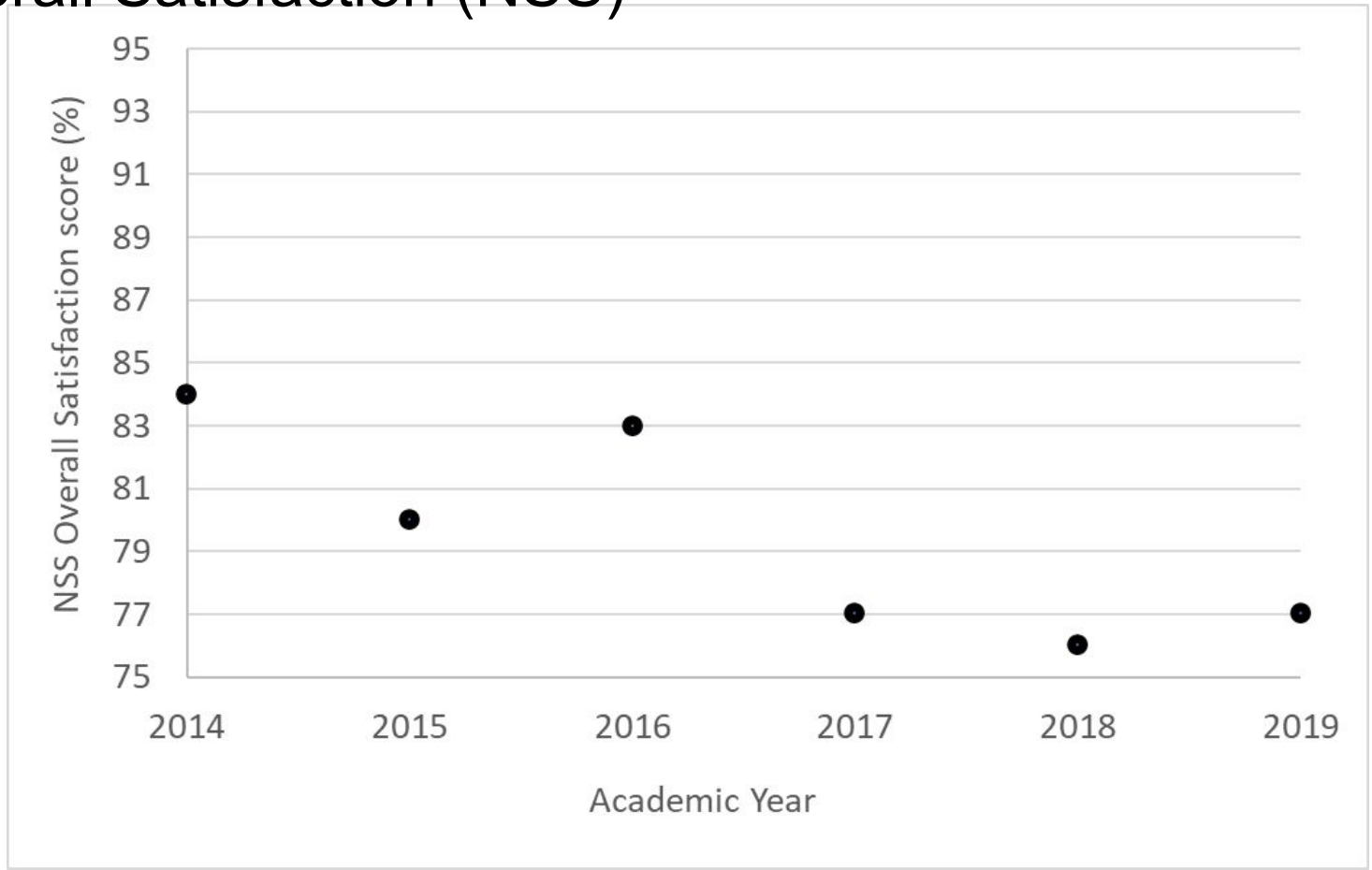
More communication needed between modules

It was carried out poorly

It was not clear what exactly is expected to be done

Module was not compatible with other modules on degree

Overall Satisfaction (NSS)



Once last chance

- Meanwhile Aerospace grew in number…currently 800 UG
- Interdisciplinarity was failing in practice if not in theory.
- Aerospace Engineering was becoming a reputational risk for the Engineering Faculty - particularly Mechanical Engineering due to the link between the two subjects in league tables
- Sticking plaster approach had not worked
- Time had come for a significant changes

New leadership was put in place

Data driven - student feedback

- New Aerospace Leadership team in place
- Major analysis undertaken
  - Talking to students - one to one, townhall feedback events with new leadership team as well as head of the department at the time.
  - Spoke to staff
  - NSS data
  - Feedback scores and text comments from many modules

Major student feedback themes - and no surprises

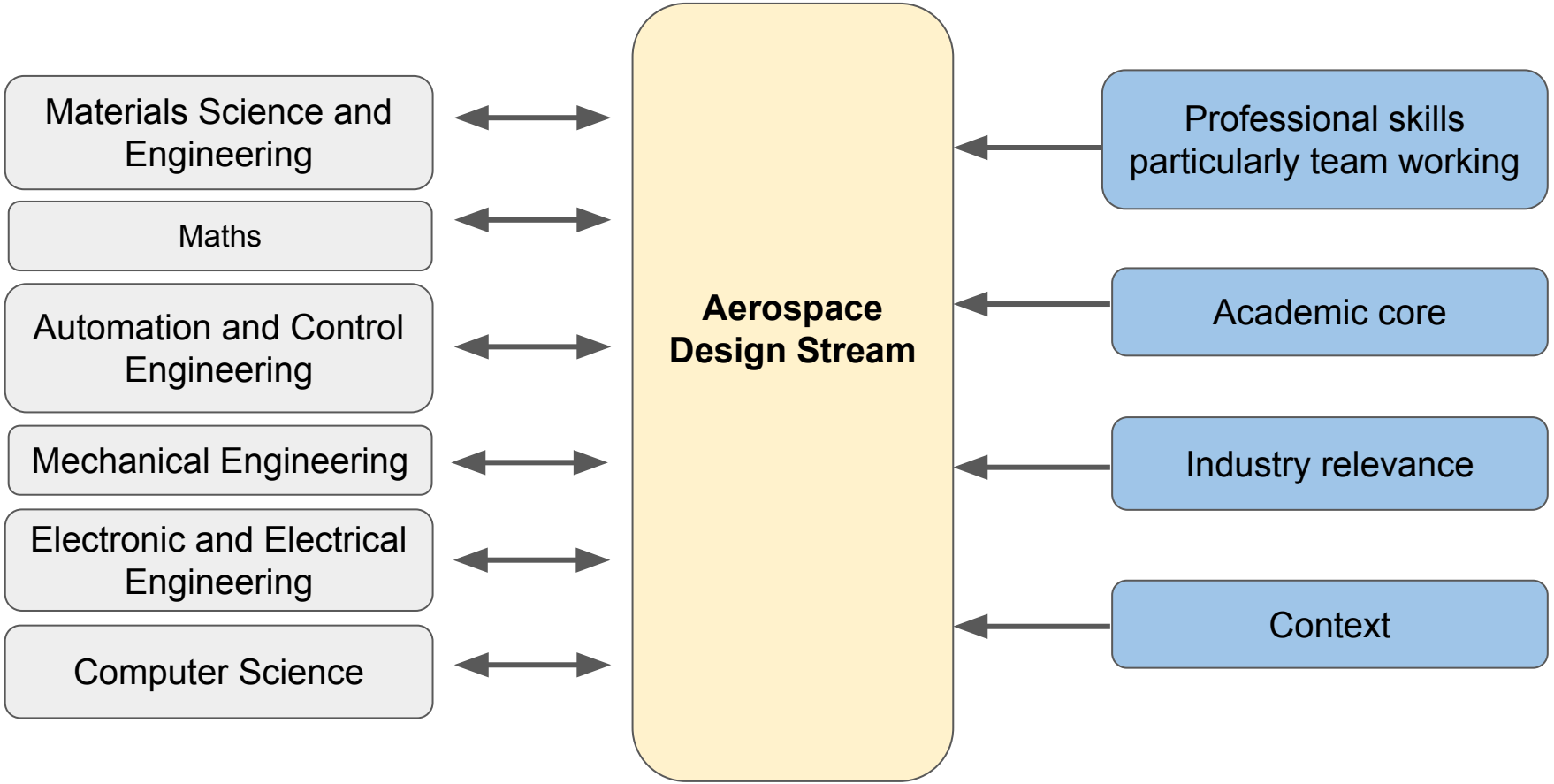
- Lack of coherence between modules, i.e. no intellectual glue to bind the departmental modules together.
- Departmental staff (MEC, EEE, etc.) did not know they were teaching Aerospace students.
    - The result was not enough content/examples for Aerospace students to see the relevance.
- Students still did not see the links between these modules and their own degree programme
- Did not feel part of a student community.
- Not a great deal of pride in their degree and all that comes with that.
- Lack of a core visible Aerospace academic staff team

Vision: Aerospace Multi Year Design Stream based around problem based learning (PBL)

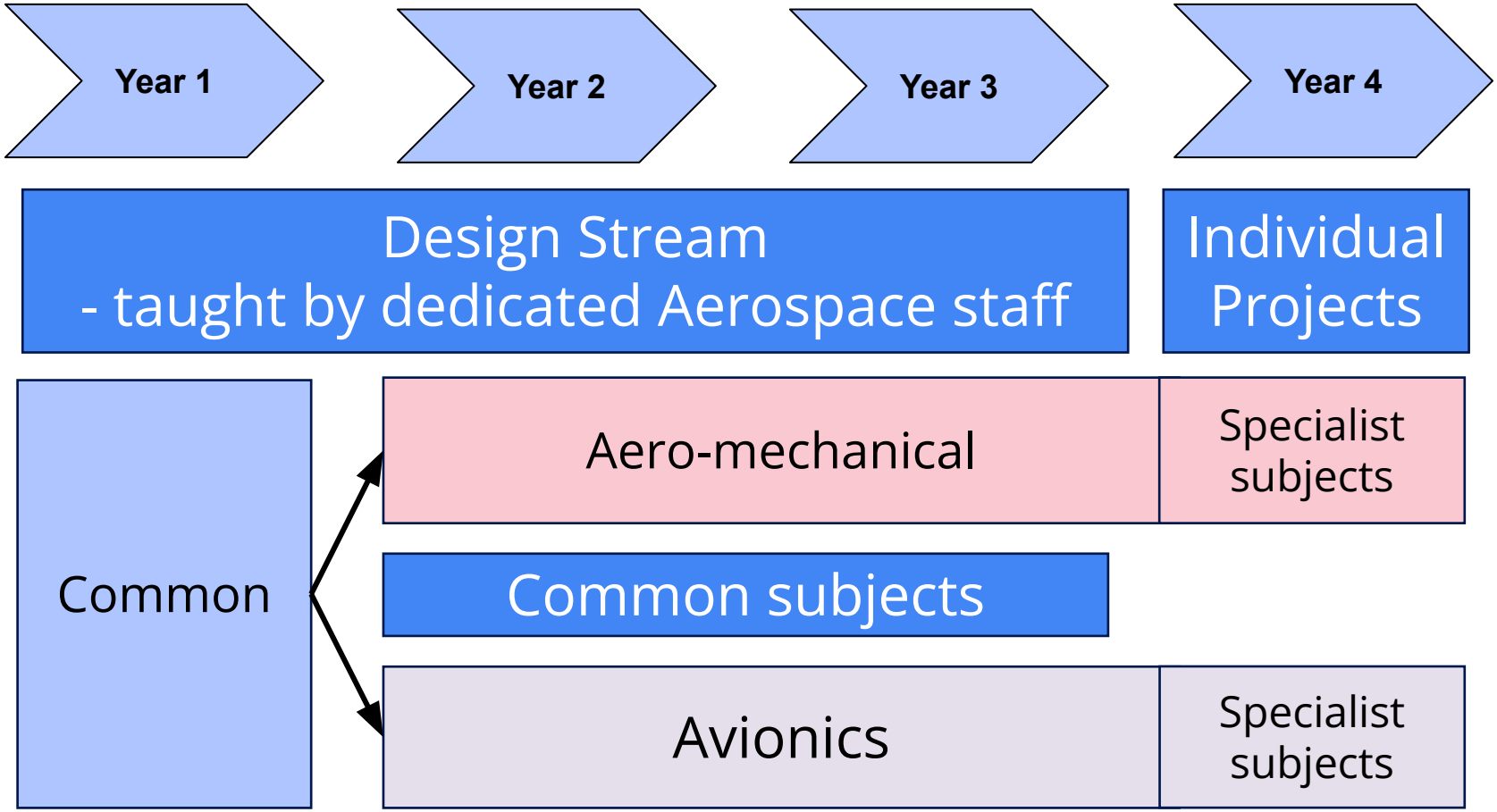
- Provide an intellectual core for the aerospace curriculum with the aim of holistically **integrating** the engineering science from departmental modules and real-world professional skills into one design activity run every year.

- Students design, build and test air systems (gliders, drones, rockets, quad planes etc.) so they see the **context/application** and the result of their academic learning.
- Provides a ‘vehicle’ for **core Aerospace academic team to build a community**.
- **Student working in teams** so students get to know each other from day 1 and continue to work together through the first 3 years.

Vision: Aerospace - Design Stream becomes the Core



Vision Curriculum Design



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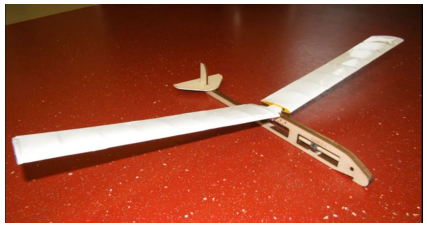
Transformative Community building by design

- Students saw no continuity in staff in previous versions of the programme
- This is a big problem in an interdisciplinary degree where students lack a ‘home’ department
- Recruited 3 University Teachers dedicated to Aerospace engineering.
- Now the same staff deliver:
    - New Year 2 Design (but some teaching in year 1)
    - New Year 3 Design activity is now **explicitly linked** to year 2 Design.
        - Continuity of teaching (style, staff etc.)
        - Continuity of assessment
        - Continuity of experience, i.e aim was to ***provide continuity and a context for supporting academic modules***

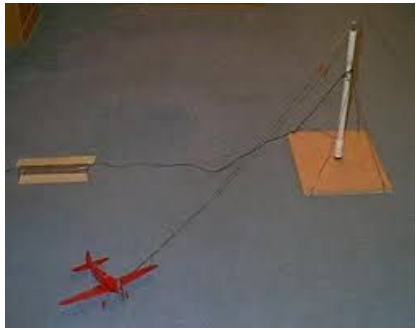
Design stream



L1 Sem 1 Glider
& Sem 2
Round-Pole-Flyer

L2 Sem 2
Quadcopter

L3 Sem 1&2
VTOL Quadplane



- Common framework across years allowed rapid progress
- Year on year **increase in technical complexity**
- Integration of academic and technical competencies
- Practical skills application
- Providing students high quality, relevant experience at scale
- Continually developing - rockets to be added

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Design Stream Implementation

- New scenario-based GDPs using an engineering systems and lifecycle approach - **employability, sustainability**
- ‘Golden Thread’ linking acquired skills, competencies and experience - **continuity, context**
- GDPs incorporate AHEP4 requirements - **professional institution requirements**
- Professional and managerial skills are built-in:
  - Management, decision making, communication, status reporting etc
  - Introduction of industry language and use of current industry practice
- Approach uses taught workshops **and** build sessions - **learning environment**
- ‘Guest lecturers’ (from existing module leaders) provide additional material and support - **improved alignment between modules**
- MySkills and Buddycheck to enable students to capture and record skills and competencies delivered - **self-review**

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Year 3 Group Design Project Feedback 2022-23

Jump in Feedback scores

The lecturers have done an amazing job of **progressively enhancing the module**, incorporating more complex UAS designs, **giving more power and options to the students to design with**

It **uses all of the theory we learn** to produce something cool, designing and manufacturing something like this from scratch feels like I am actually learning some engineering.

Designing something from scratch and then building gave a **great sense of accomplishment**.

Module has seen **many improvements** from the feedback the cohort gave on AER21003 last semester which **helped reduce stress**.

Well structured group project with enough direction to make it achievable but **enough freedom to make our own concepts**.

This is the **closest I can get as a student to actually being in the world of work** in engineering, and it is massively valuable to go through the design process myself, with my group, to understand from the very basics how air systems are built.

Uses all the **knowledge learned from other modules and allows us to apply it in a practical sense**.

Enjoyed the **opportunity to lead**, my learning and the practical aspect.

Set times to complete work allowed us to stay on track. **Nice to see our knowledge being applied. Good team working experience.**

This module **meets every aspect of a real world industry work** environment that I can think of.

Nice to have **practical experience** and apply the knowledge we've learned so far.

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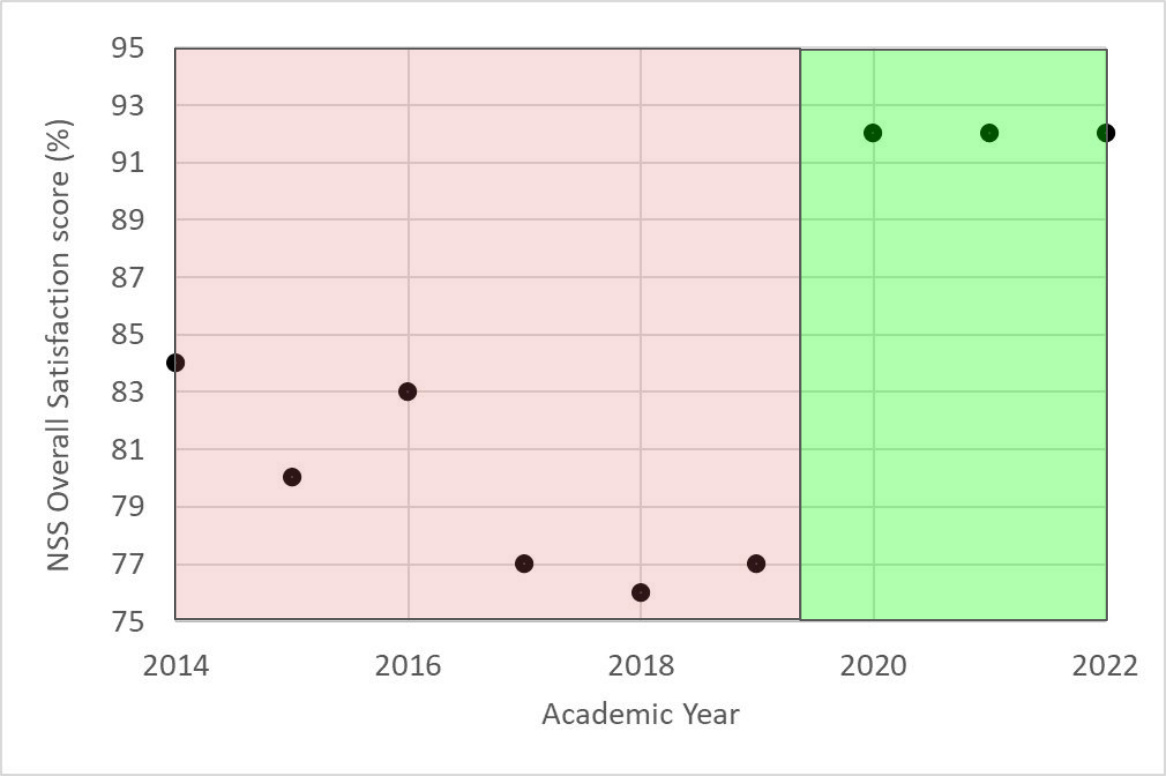
NSS Scores: Overall Satisfaction



ALL NSS questions went up by at least 15% points - some more.

- 2020 finalists filling out NSS didn’t take the new design stream, but believed the promises made by the leadership team.
- Started to feel like a community or ‘Home’ department
- Trust us to make changes

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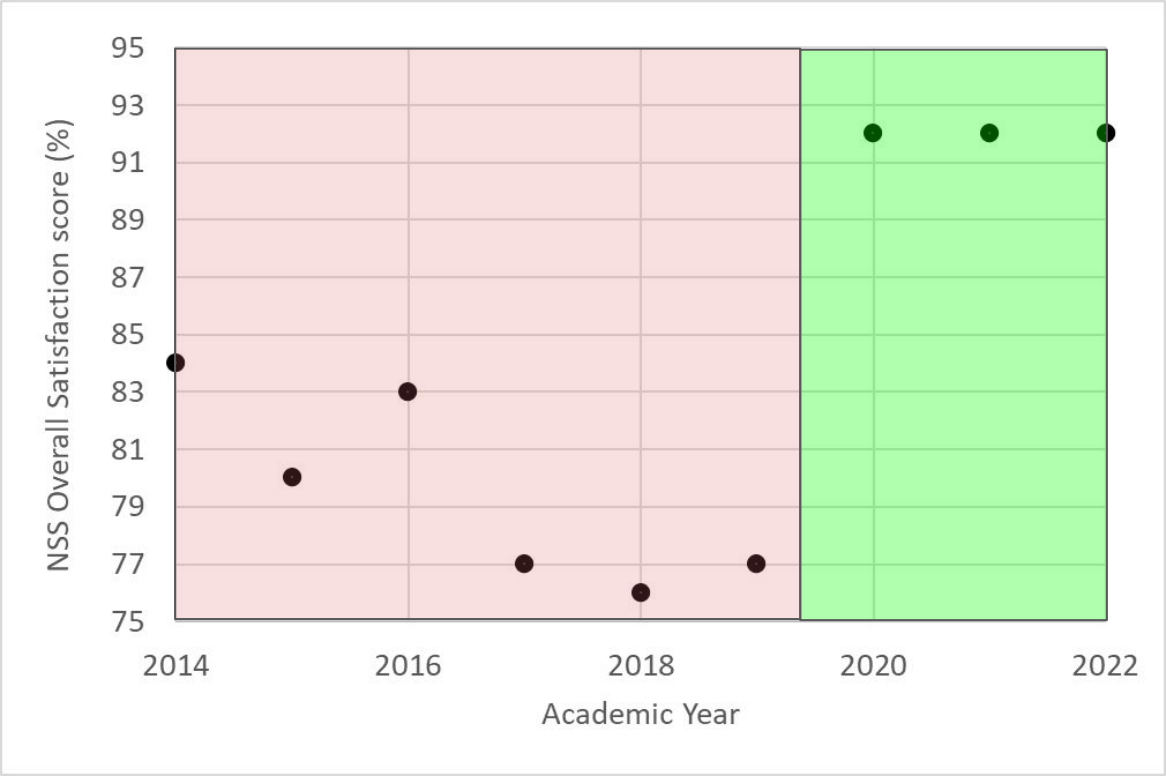
NSS Scores: Overall Satisfaction



- 2021 finalists filling out NSS didn't take the new design stream, but
- Saw appointment of new University Teachers and the start of their impact in Covid.
- Saw our delivery on our promises
- Feeling positive about themselves and their degrees

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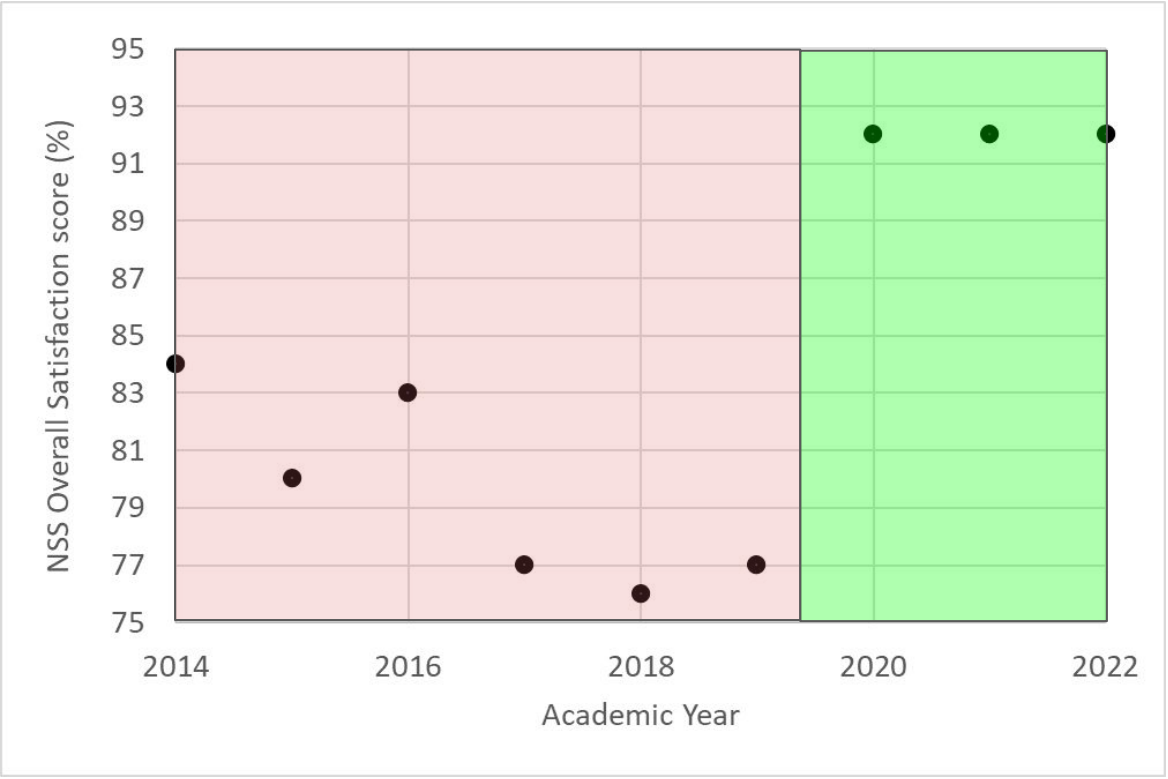
NSS Scores: Overall Satisfaction



- 2022 finalists NSS didn't take all the new design stream.
- But feedback between years, saw implementation of design stream in prior years
- Saw the *impact* of new University Teachers.
- Transformation of the feeling of belonging in Aerospace engineering

Conclusions

- Design stream is worked very hard in terms of learning outcomes (i.e. professional skills as well as academic skills)
- Provides a clear intellectual framework students understand
- Consistency of teaching and assessment approach across years 1, 2 & 3
    - Students know what to expect - less context switching
- Consistency of the academic team
    - Students feel they belong to part of a team with staff and between themselves
- It has transformed Aerospace Engineering at Sheffield

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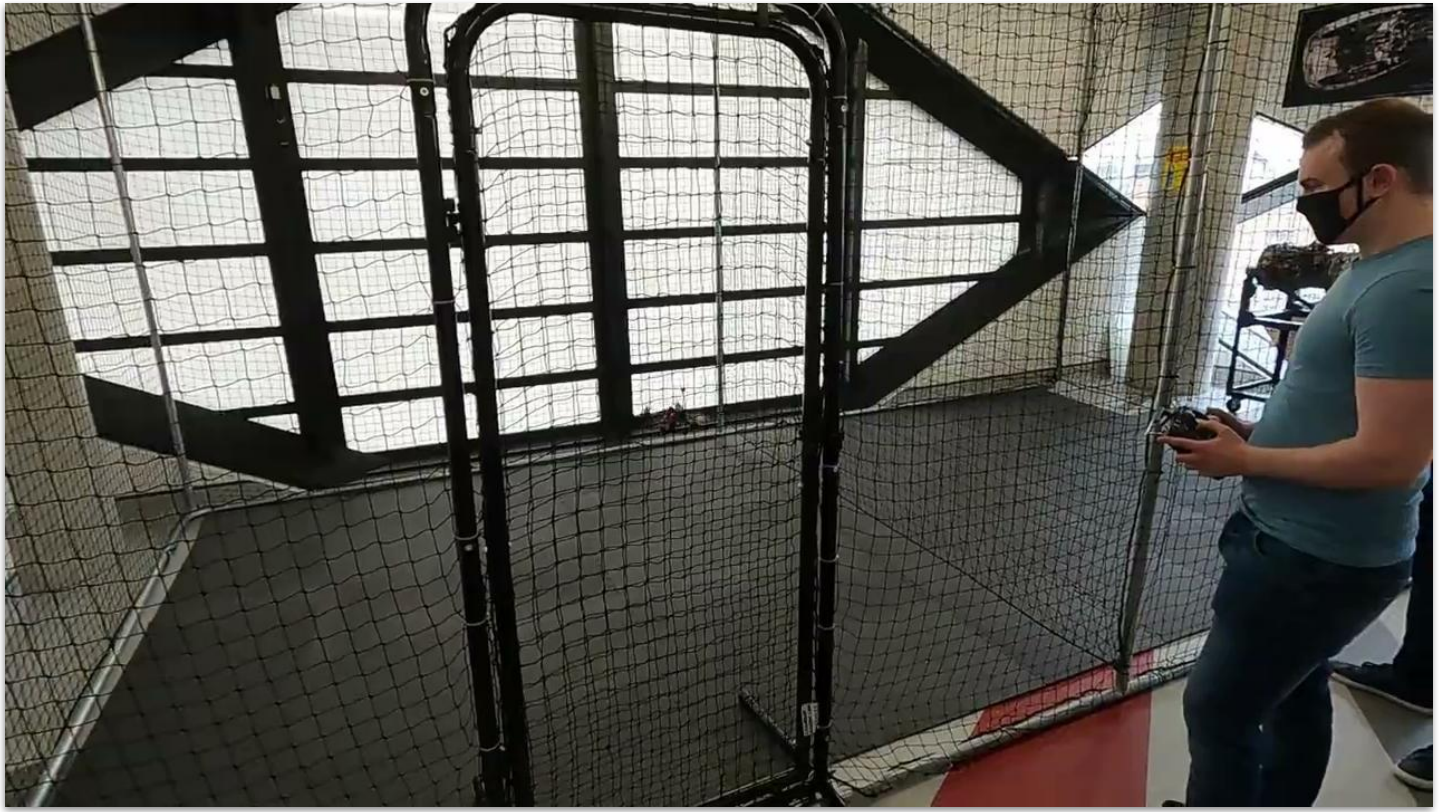
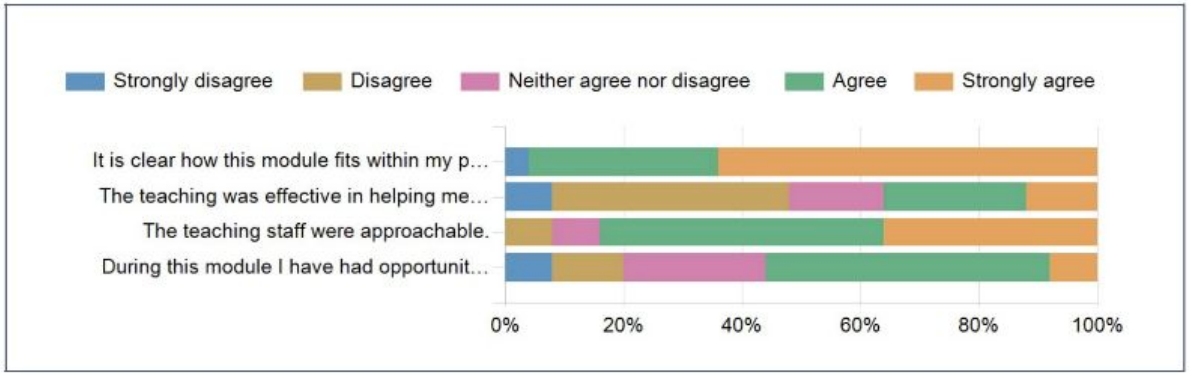
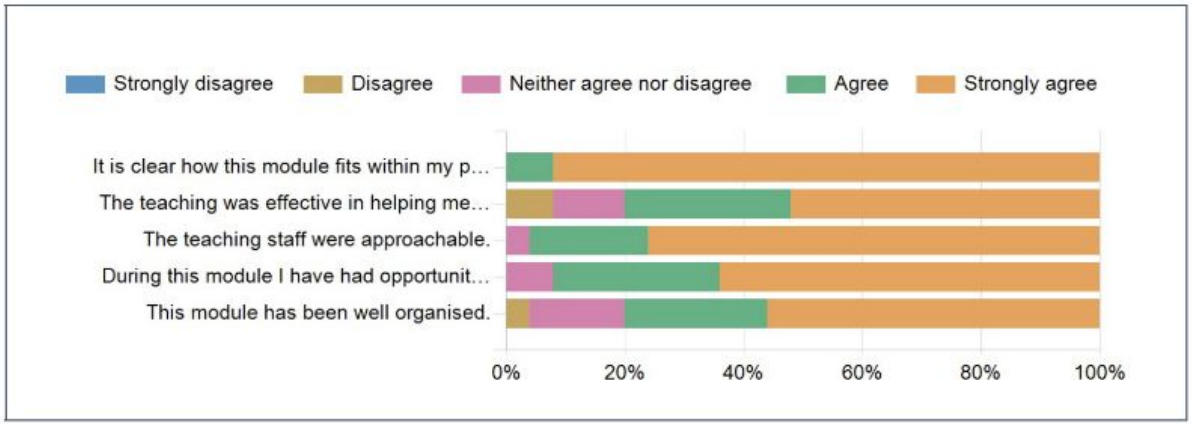
L2 Group Design Project (GDP) Implementation



L3 Group Design Project (GDP) Feedback





To add

- AER21003 feedback, no direct ‘before’ to compare to but can show success of the module compared to faculty/department average etc
- L2 in 2022 deliberately selected and then used as framework for L3 - provided continuity for same student cohort progressing from L2 to L3 as well as making managing modules easier for staff
- Common BB site layout
- Combination of taught workshops as well as build sessions provided ideal learning environment
- Video? Or part of
- Clarify skills being developed through each design module, building on each other, same format etc, AHEP tick boxes
- Professional and managerial skills built-in to modules eg PM, RM, stakeholder and resource management, decision making, teamwork, communication, status reporting etc
- Includes a system approach to PBL - engineering lifecycles
- Benchmarks and utilises industry practice within the modules
- Introduction of industry language - SOR, SOW, TOR, NPA etc
- Enables staged increase in project content and technical complexity from L1-L3
- A GDP module each year gives focus and application to student learning
- Need to justify NSS increase when finalists filling out NSS didn’t take the new design stream
- Explicit explanation of how module links to AHEP4 requirements
- Introduced MySkills and Buddycheck into GDP to enable students to capture and record skills and competencies delivered by modules

Introduction

- History
- Aerospace engineering - small, but grew rapidly
- One or two core aero modules in years 1 and 3
- The rest were modules from other departments - MEC, control, EEE etc.

The idea was that students was the fluid mechanics is fluid mechanics and is the same for Aerospace and Mechanical Engineering, that Ohms law should be the same for EEE and for Aerospace.

Wrong!

Student were expected to see the links between those department modules and their own study.

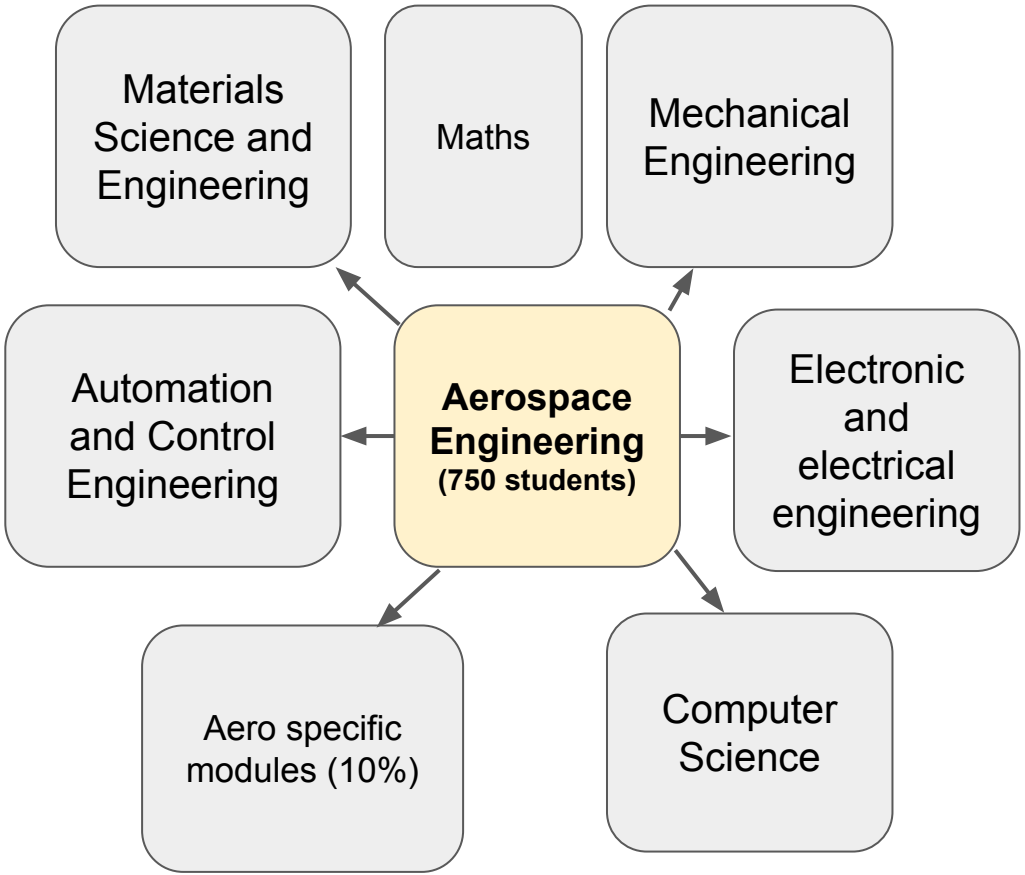


FIGURE 1 Academic Framework for Interdisciplinary Aerospace Engineering at Sheffield

Interdisciplinary Engineering degrees are high connected across the Departments of the Faculty

Students take modules from degree programmes in other departments and together they form the Aerospace Engineering degree.

Some specialist modules inc. Year 3 Group Aerospace Design Module, but not many others.

THe problem

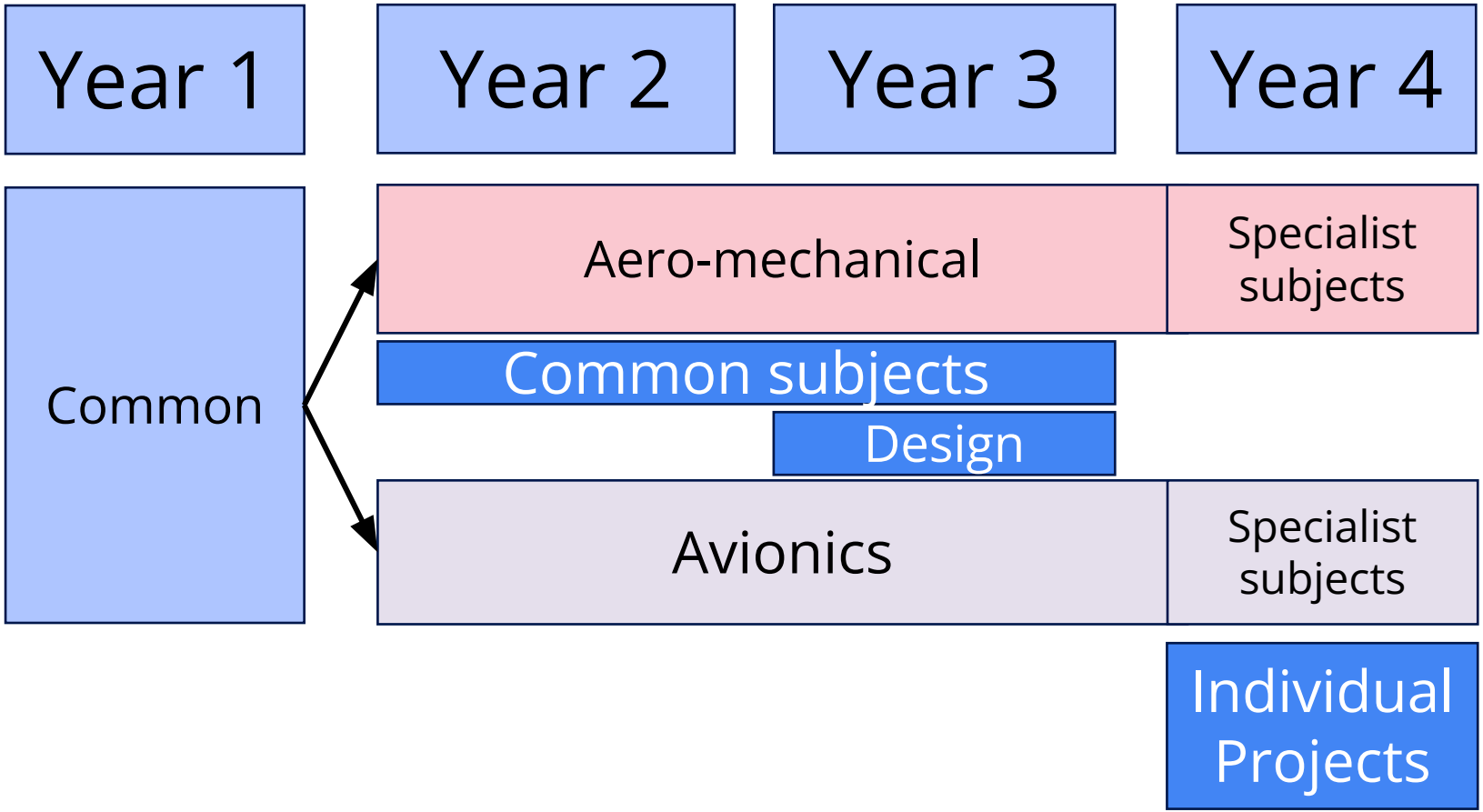
- Staff in other departments - MEC, control, EEE etc. did not know their audience. Often assumed they were only talking to their own department students.
- Not enough content/examples for Aerospace students to see the relevance.
- Lots of work to try to improve this, but little impact.

Meanwhile Aerospace grew in number…

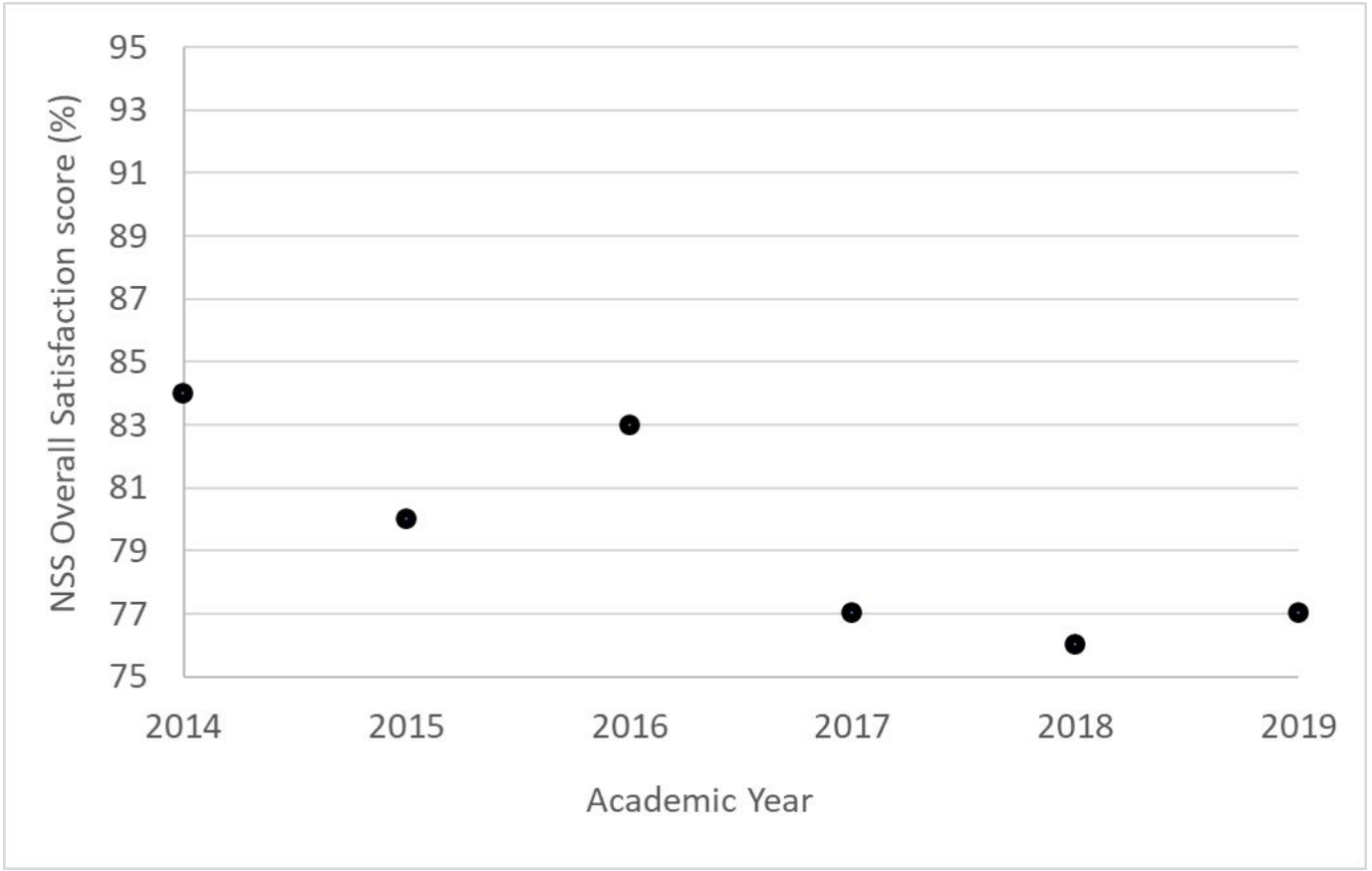
Students still did not see the links between these modules and their own degree programme

Interdisciplinarity was failing.

Original Curriculum Design



Result- Poor Satisfaction (using NSS as measure)



Result- Poor Satisfaction

- Lack of community
- Space
- Lack of core Staff group
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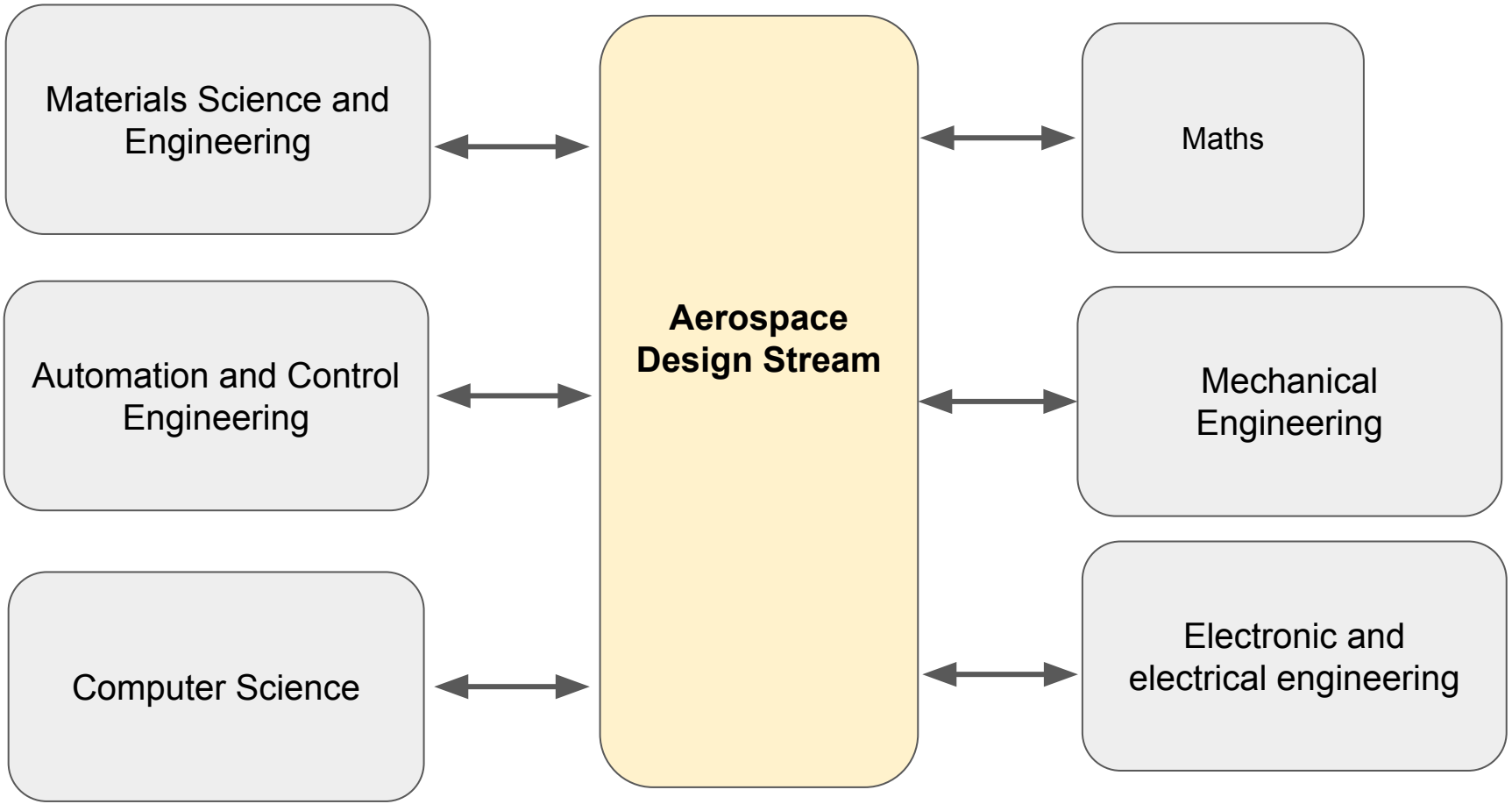
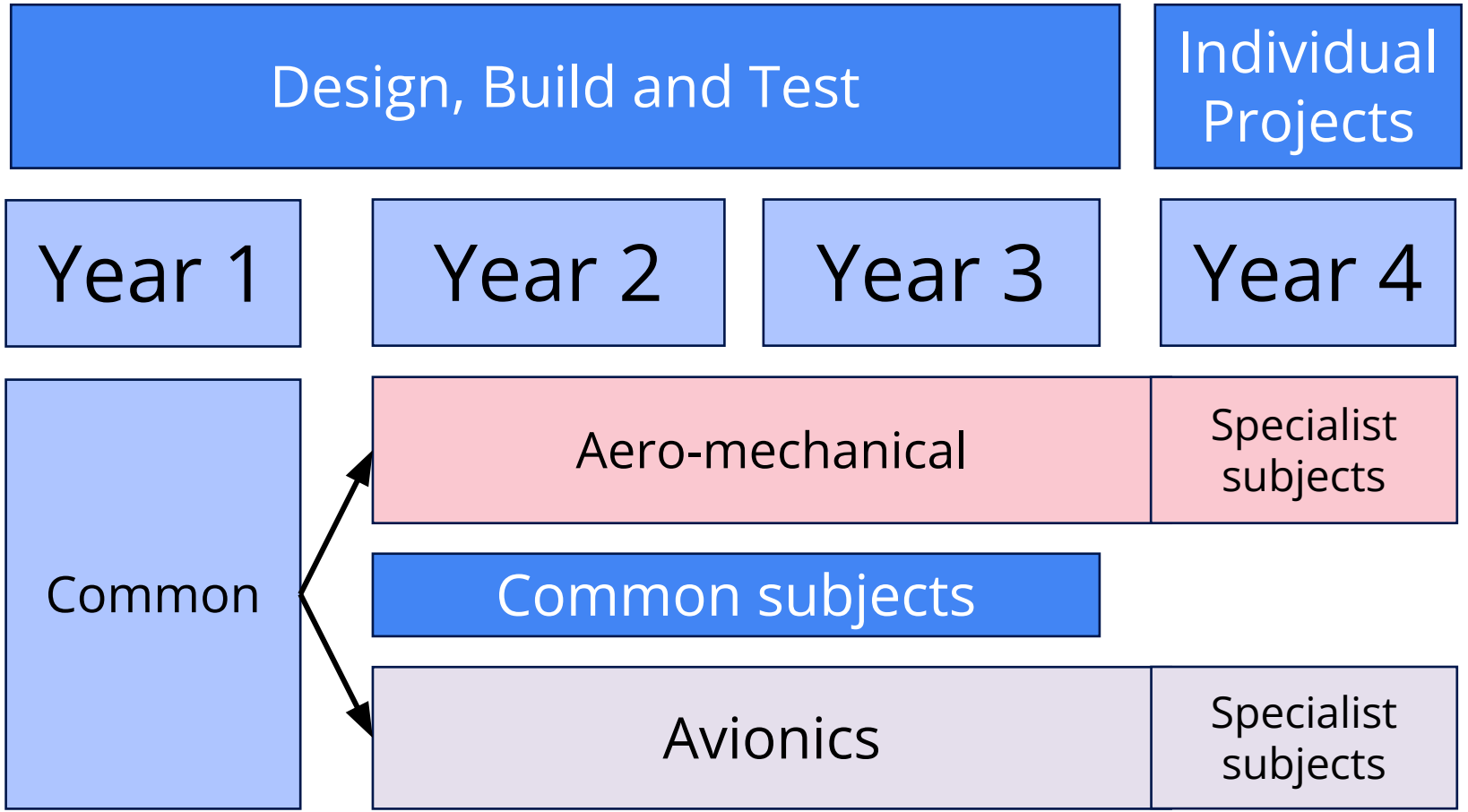
Vision: Aerospace - Design, Build and Test at the core



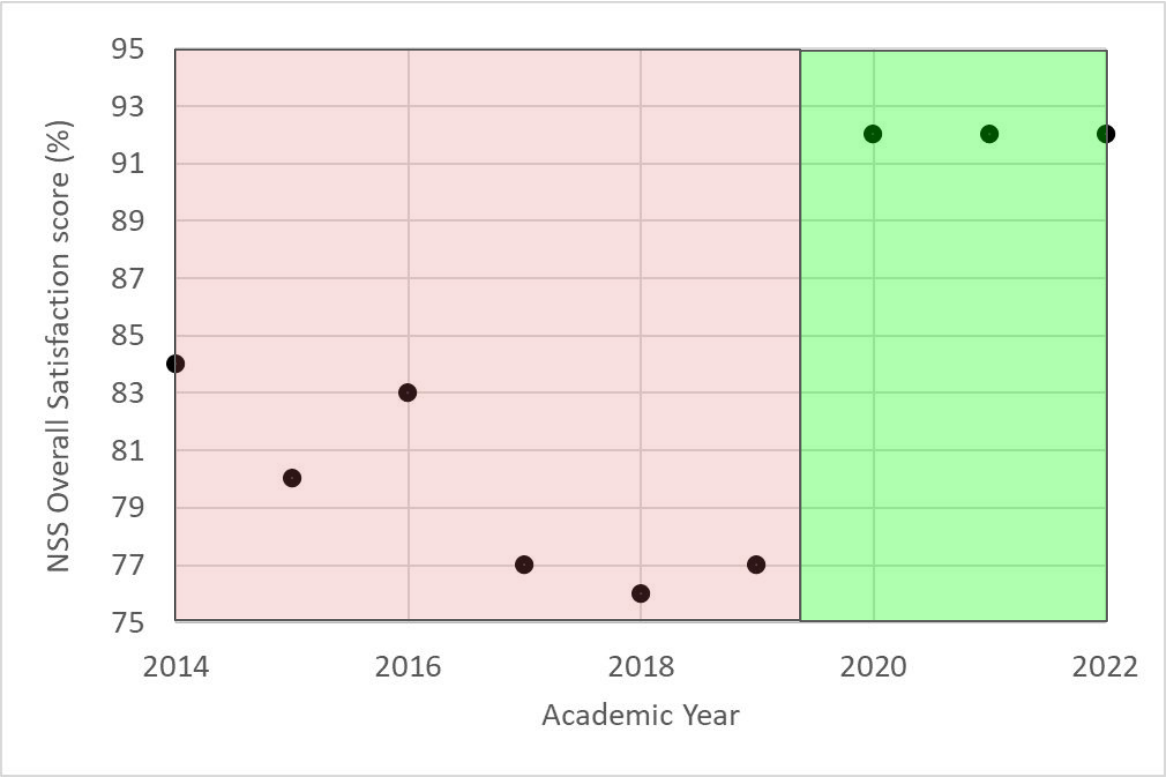
Vision Curriculum Design



Vision: Aero Design Stream at the programme core

- Provide an academic focus for the curriculum.
- Integrates engineering science from department modules into one design activity.
- Students design, build and test air systems so they see the application and the result of their learning.
- Provides a regular *communication path for a core Aerospace academic team.*

NSS Scores: Overall Satisfaction



Scores for ALL NSS questions went up by at least 15% points - some more.

Especially:

- Student voice
- Assessment and feedback

New Curriculum Design