Engineering Institute of Technology.

Phase 2: Research Practice (Designing and Executing Research)

DEng Program: Tools of the Trade – Simulation, Experimentation, and Data Analytics

7 May 2026

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Presented by Emeritus Professor Akhtar Kalam

EIT EMERITUS PROFESSOR

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EIT is one of the only institutes in the world specializing in Engineering. We deliver professional certificates, diplomas, advanced diplomas, undergraduate and graduate certificates, bachelor's and master's degrees, and a Doctorate of Engineering.

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Our programs are designed by industry experts, ensuring you graduate with cutting-edge skills that are valued by employers. Our program content remains current with rapidly changing technology and industry developments.

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Our lecturers are highly experienced engineers and subject specialists with applied knowledge. The technologies employed by EIT, both online and on-campus, enable us to source our lecturers from a large, global pool of expertise.

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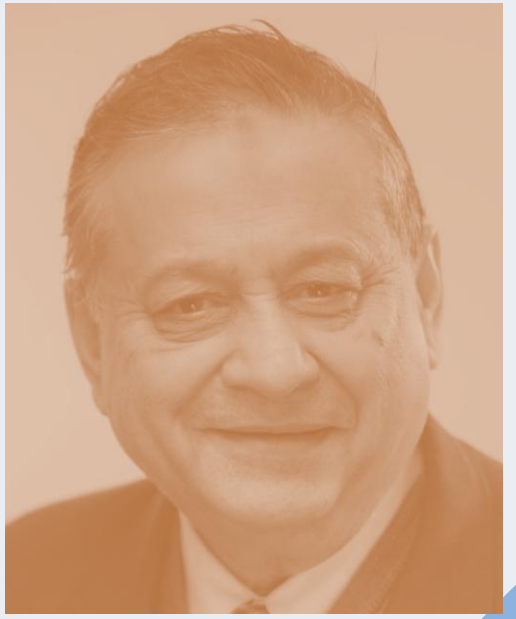
Introduction – Presenter

Professor Akhtar Kalam



Emeritus Professor at Victoria University and EIT.
Academic Director and Chair of the Academic Board - Texila College Australia.
Director of Al-Kalam Educational Solutions.
Editor-in-Chief of AJEEE
Distinguished Professor/Adjunct Faculty in Australia, India, Malaysia and Oman.
He has published over 610 publications in his area of expertise and has written over 29 books.
Supervised 50 postgraduate research students to graduation, including 39 Ph.Ds.' and 11 MEngs. Currently, 15 postgraduate research students (Eight Ph.D., one MEng student at VU, and six DEng students at EIT) are being supervised.
Public, University, and Motivational Lecturer.
Consultant for the electricity supply industries in Australia and overseas.
Assisted in change management plans for Universities and the higher education sector.

Education

The University of Bath, Bath, UK, D.Eng., Electrical Engineering
The University of Oklahoma, Norman, USA, MS, Electrical Engineering
Aligarh Muslim University, Aligarh, India, BSc. Eng., Electrical Engineering
St Xavier's College, Calcutta, India, Applied Science

Professional Society Activities

Australian Institute of Energy – Fellow
Engineers Australia – Fellow
The Institution of Engineers and Technology, UK – Fellow The Institution of Electrical and Electronic Engineers, USA –Life Senior Member.

"My vision is to provide exciting higher education science and engineering courses, research, consultancy and collaborate in development work of the industry and communities within Australia and beyond."

Agenda

1 Overview

2 Research Tools

3 Simulation Mistakes

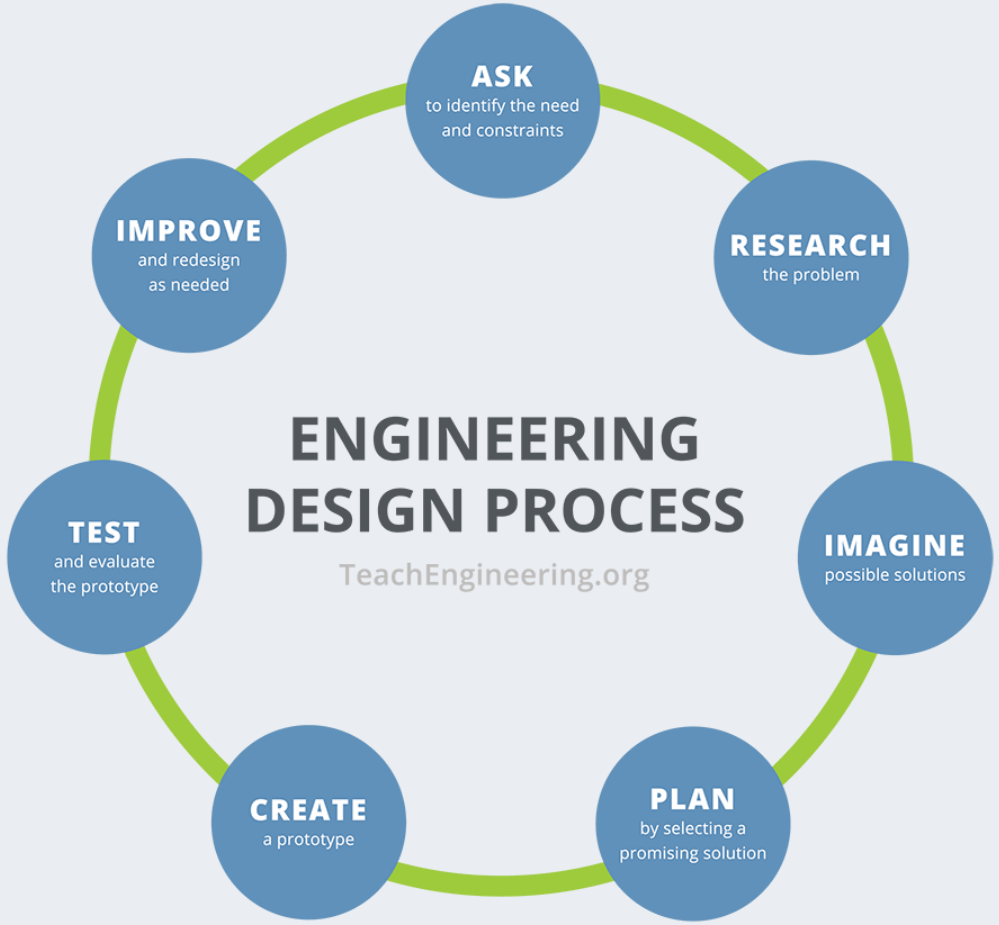
4 Experimentation

5 Lab Safety

6 Resilience in Research

Why Research Practice Matters?

- DEng is not only about knowledge
- It is about creating new knowledge
- Requires rigour, discipline, and method
- Strong research practice determines success

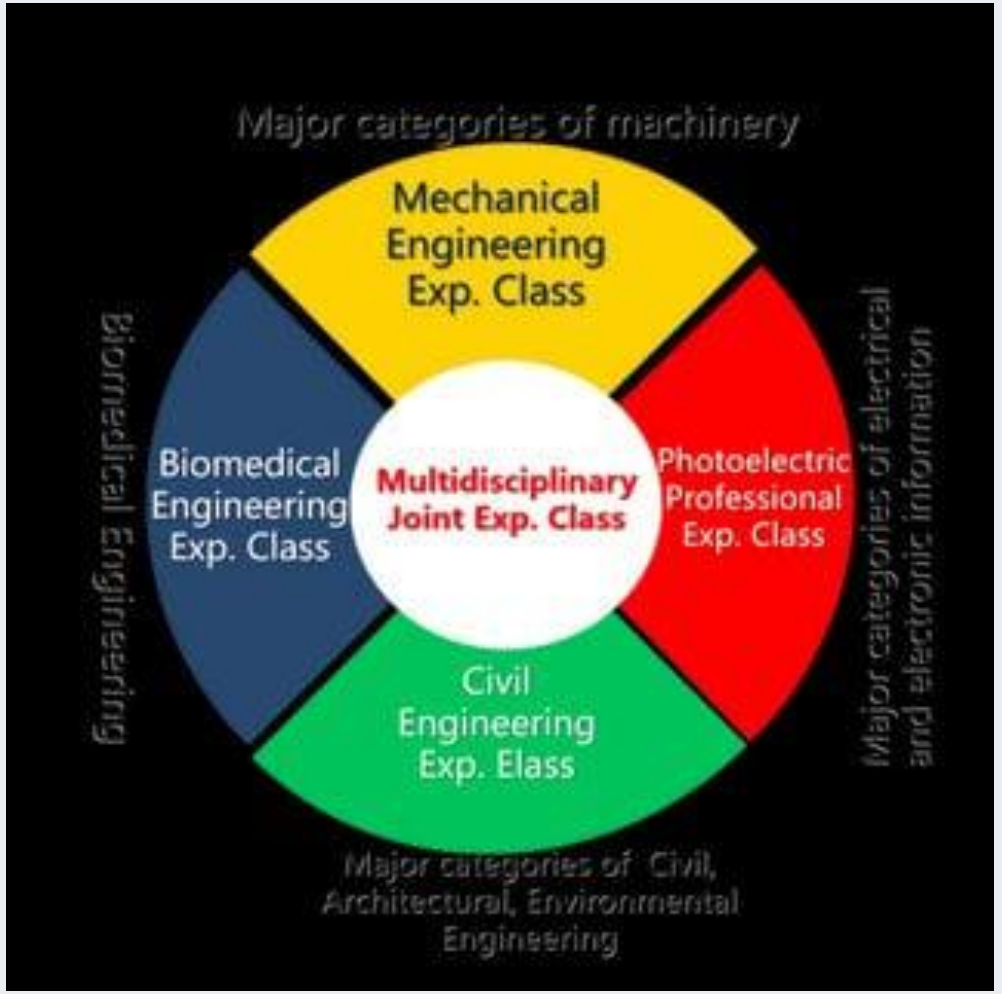


The Doctoral Journey

- Problem identification
- Literature review
- Methodology design
- Simulation and modelling
- Experimentation
- Data analysis
- Publication and thesis

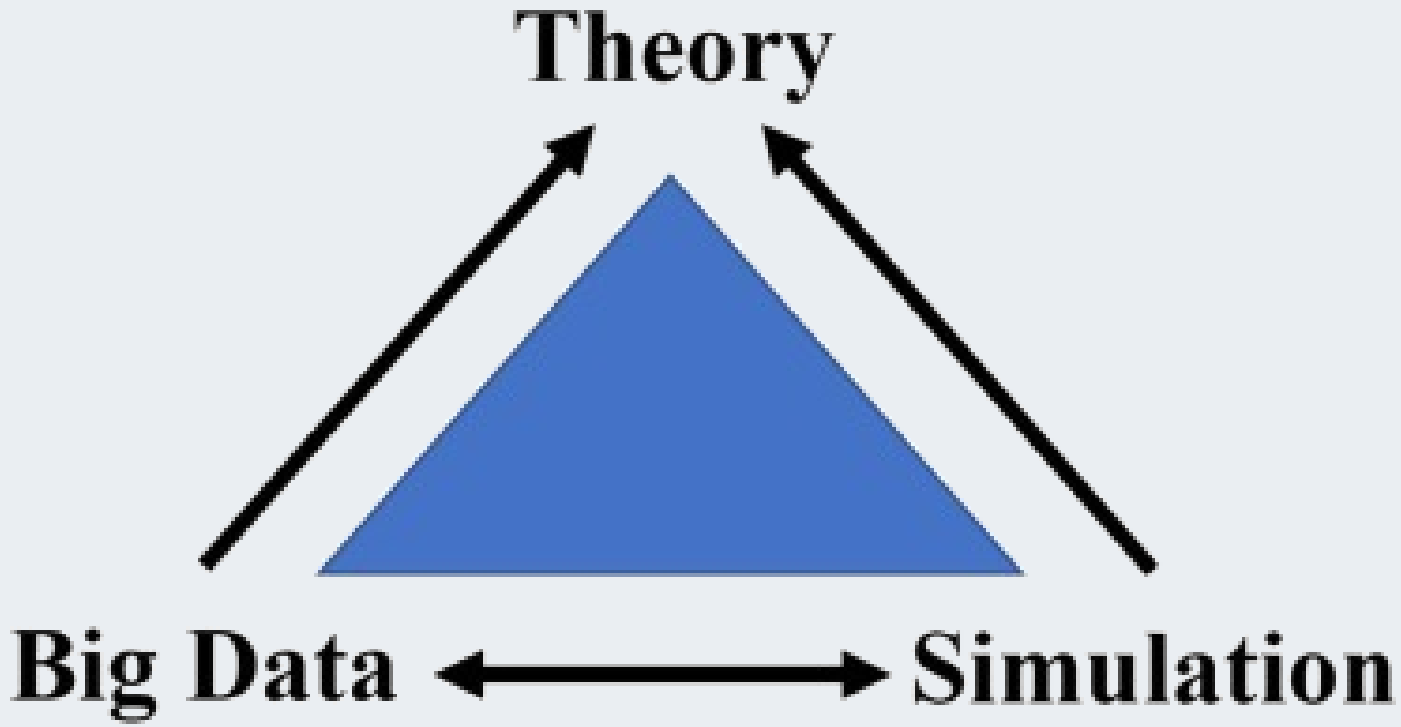
Engineering Research Domains

- Electrical Engineering
- Mechanical Engineering
- Civil Engineering
- Renewable Energy
- Artificial Intelligence
- Robotics and Control
- Biomedical Engineering



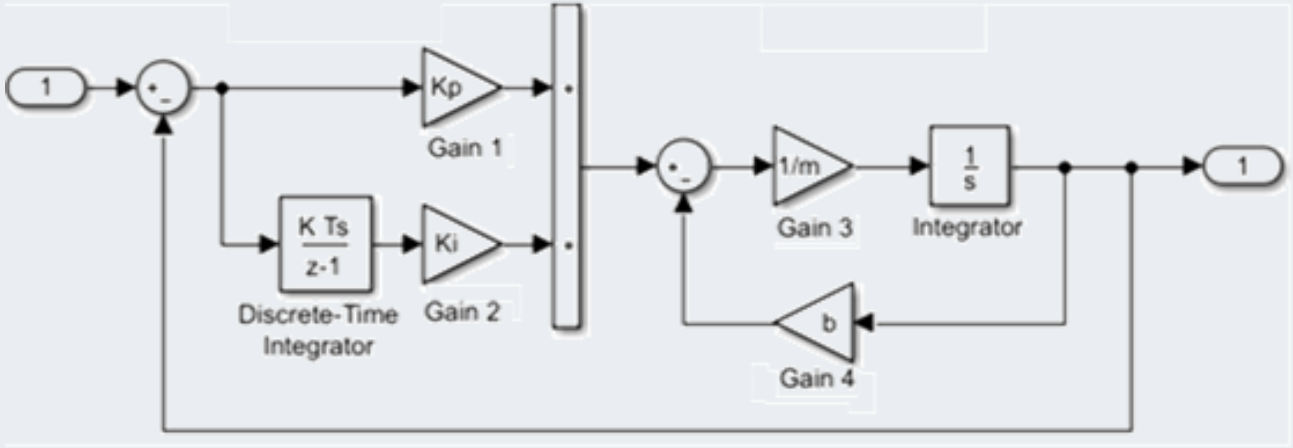
Three Core Research Tools

- Simulation
- Experimentation
- Data Analytics



What is Simulation?

- Digital representation of real systems
- Predict performance before implementation
- Reduce cost and risk
- Explore impossible scenarios safely

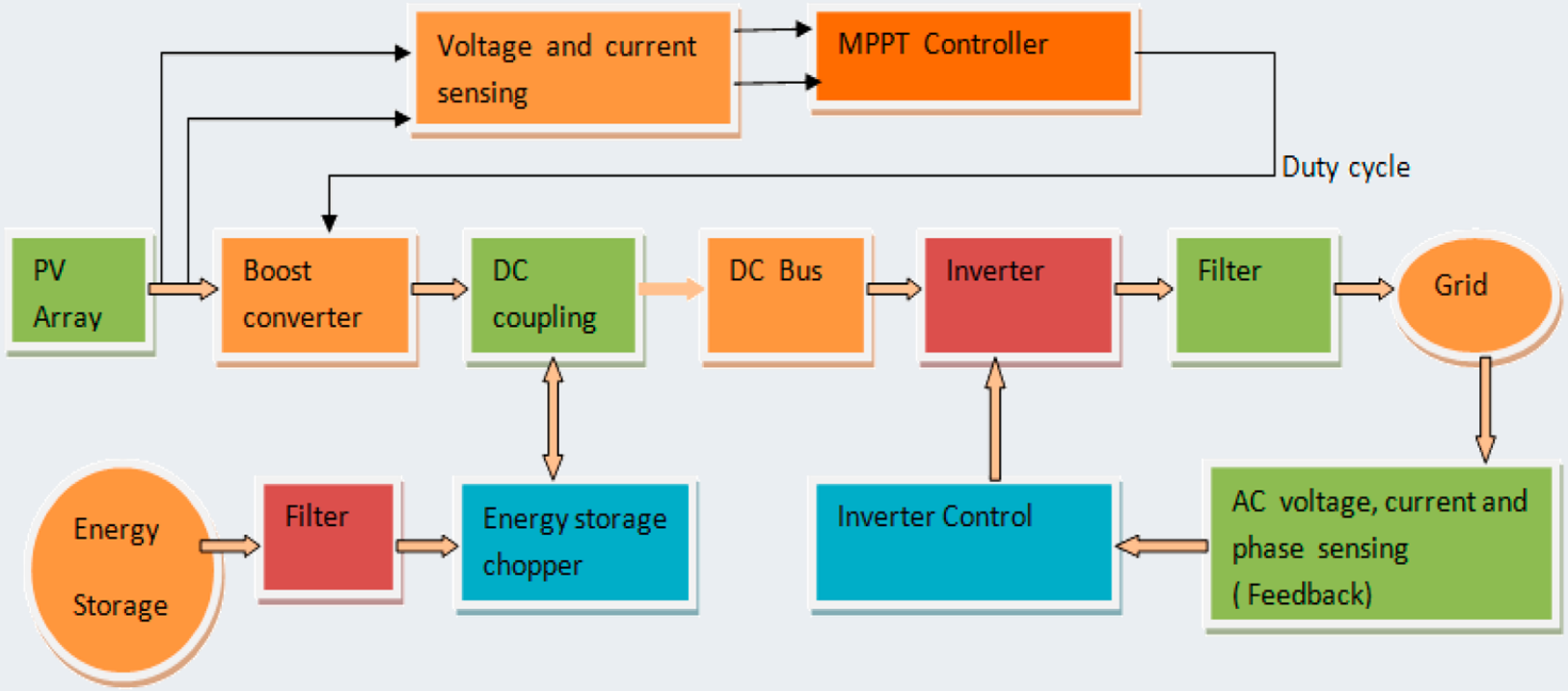


Popular Simulation Platforms

Platform	Primary Focus	Best For
MATLAB/Simulink	System modeling, Control	Multi-domain systems, Control algorithms
PSCAD	Transient Analysis	Power system transients, Power electronics
ANSYS	Engineering Analysis	Structural, CFD, Electromagnetic simulation
COMSOL	Multiphysics Analysis	Coupled physics (e.g., Heat + Fluid)
ETAP	Power System Analysis	Electrical network design, Protection
LabVIEW	Measurement & Control	Instrumentation, DAQ, Industrial control
Python	Custom/Data-driven	AI-driven simulations, Flexibility

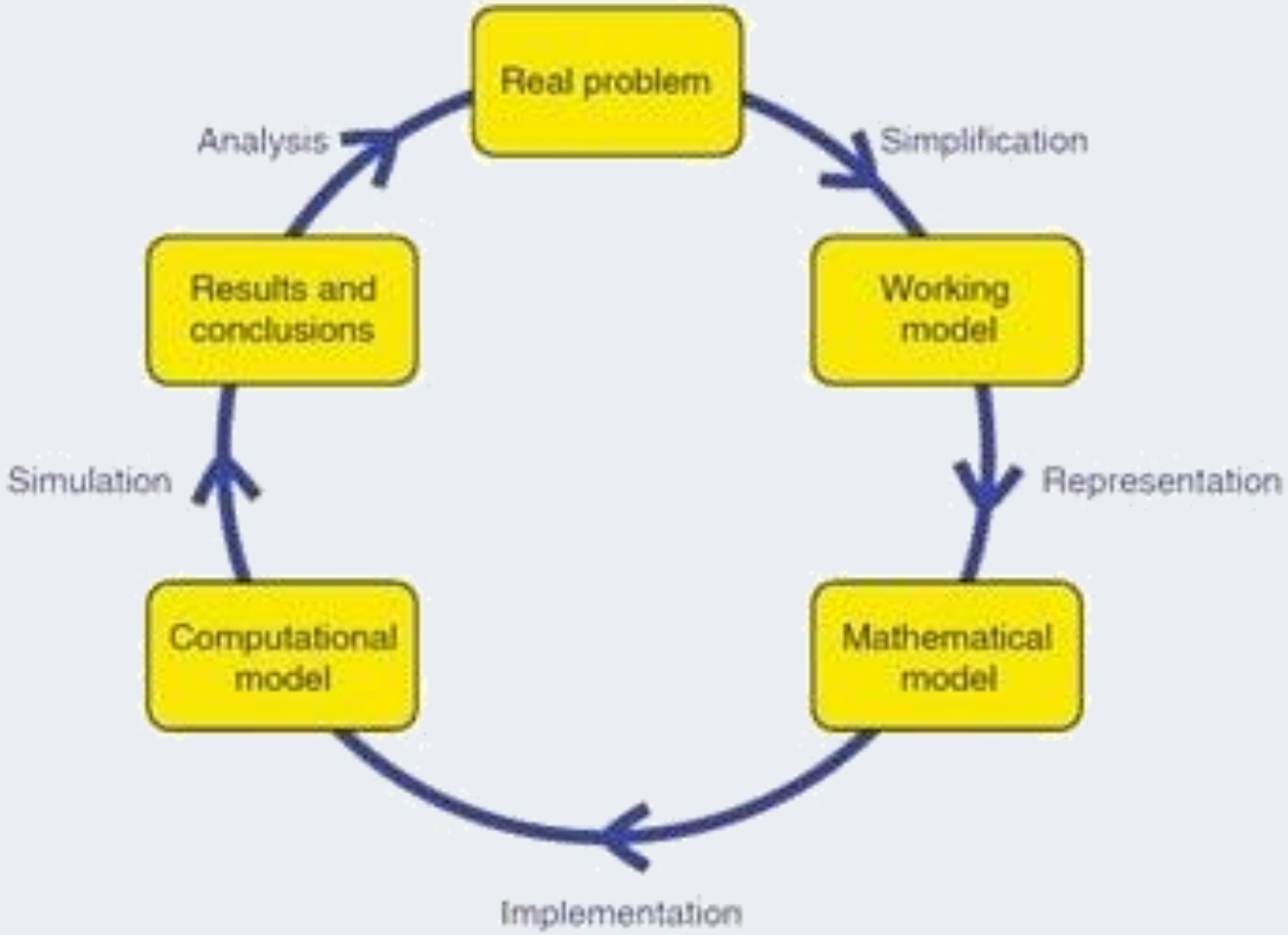
Simulation Example

- Power converter design
- Wireless power transfer system
- Fault analysis in smart grids



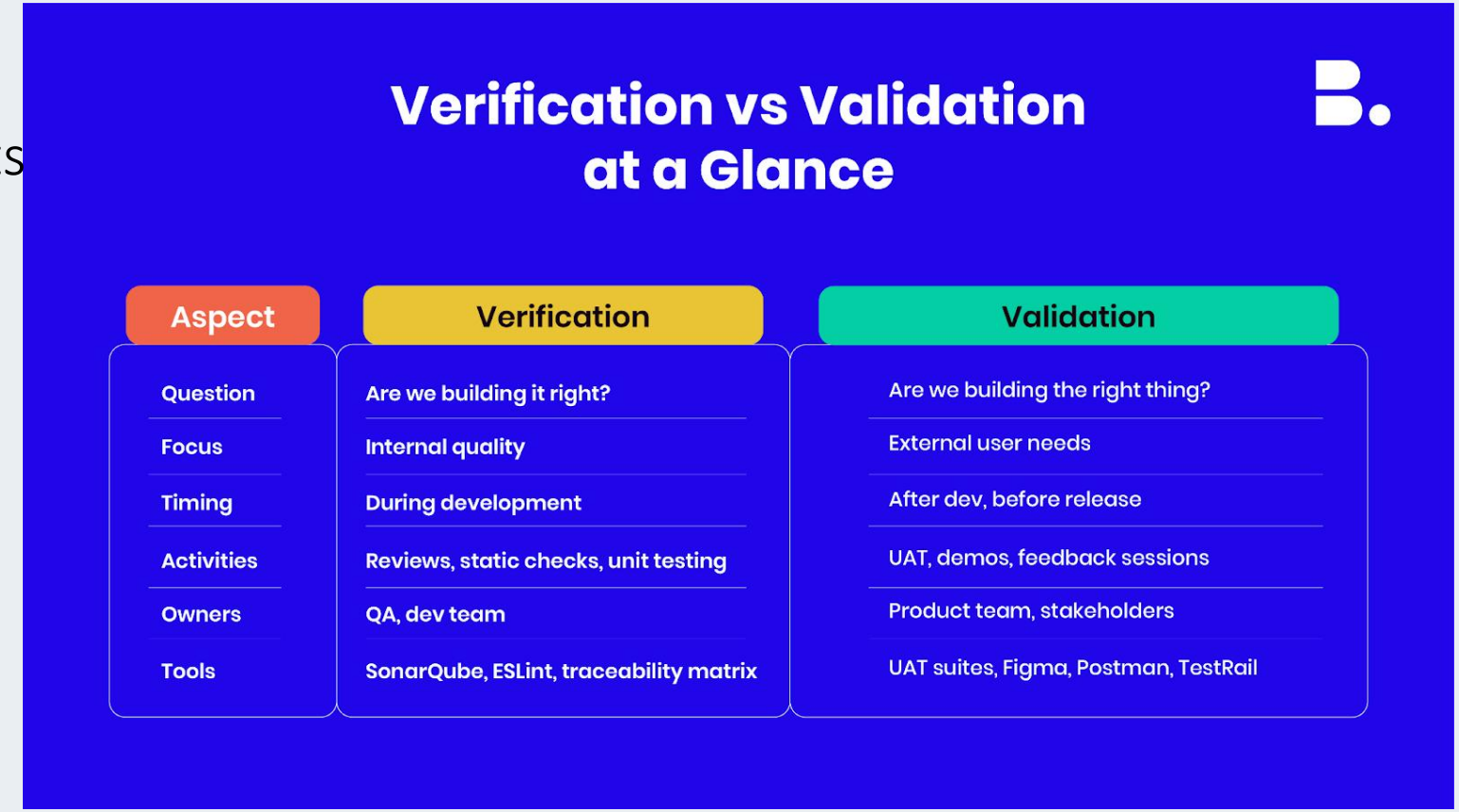
Model Development

- Define assumptions
- Select governing equations
- Set constraints
- Establish operating conditions



Model Validation

- Compare with literature
- Compare with standards
- Compare with experiments
- Sensitivity analysis

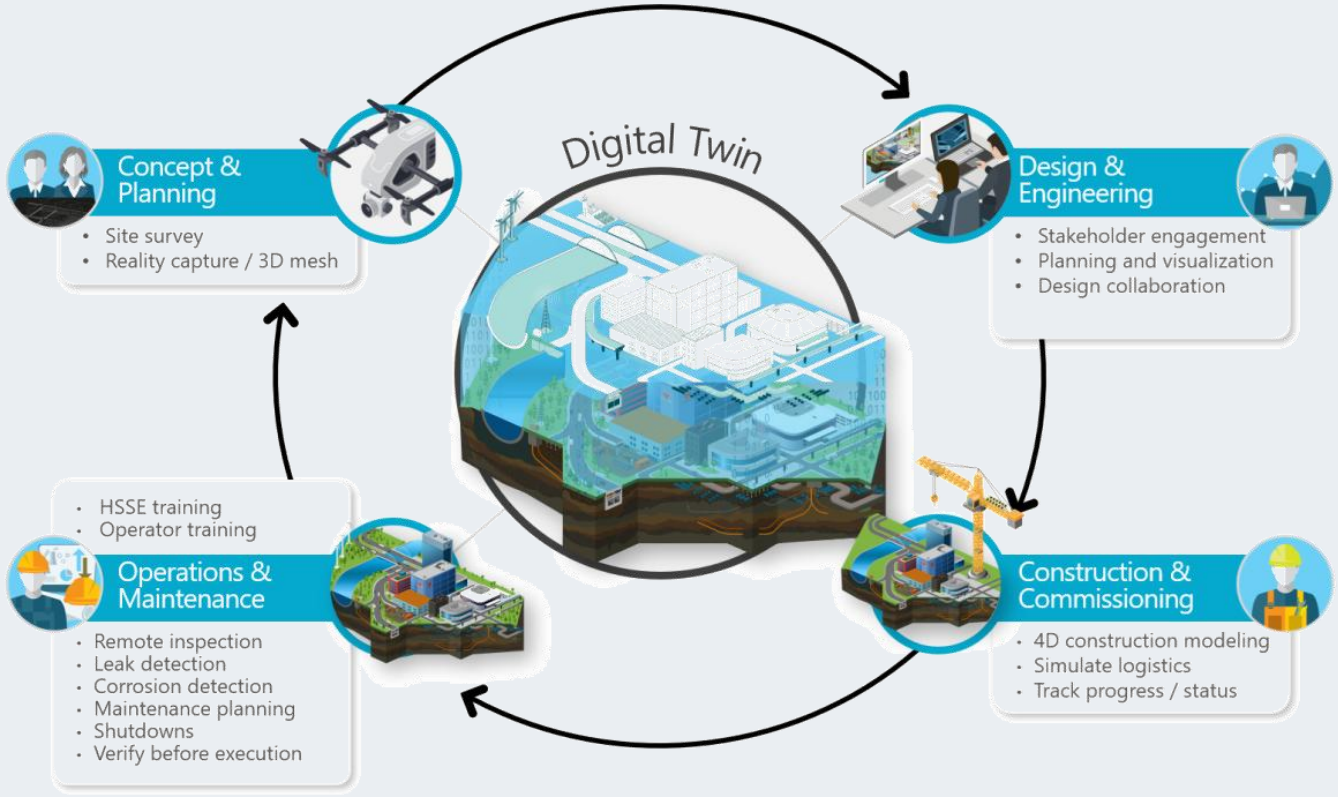


Common Simulation Mistakes

- Unrealistic assumptions
- Poor parameter selection
- Ignoring non-ideal conditions
- Lack of validation

Transition to Experimentation

- Simulations guide experiments
- Experiments verify simulations
- Strong research requires both



What is Experimentation?

- Physical testing of hypotheses
- Prototype development
- Instrumentation and measurement
- Controlled validation

Experimental Design Principles

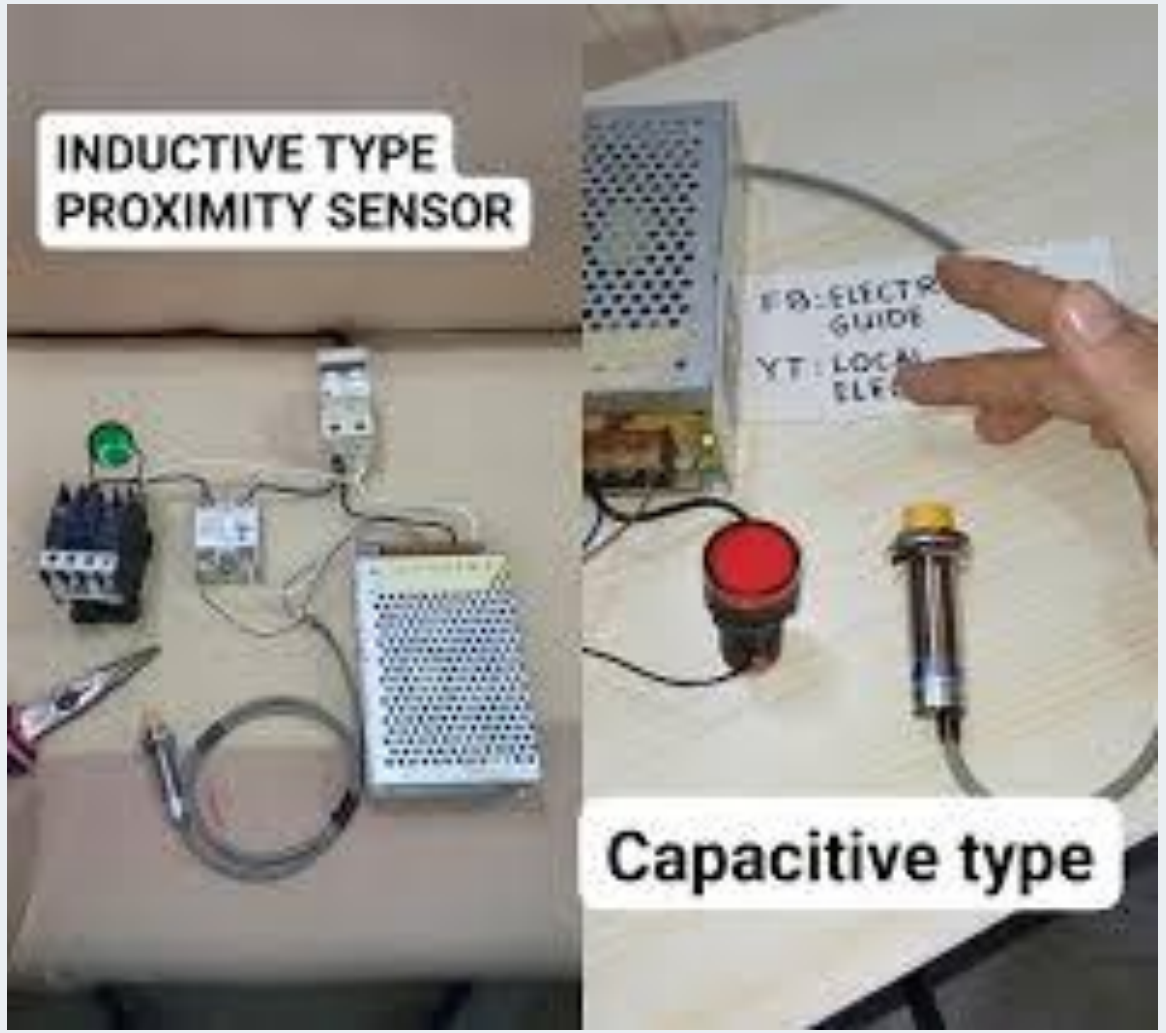
- Clear objective
- Controlled variables
- Repeatability
- Safety
- Reliability

Laboratory Safety

- Electrical hazards
- Mechanical hazards
- Thermal hazards
- Chemical risks
- Ethical responsibilities

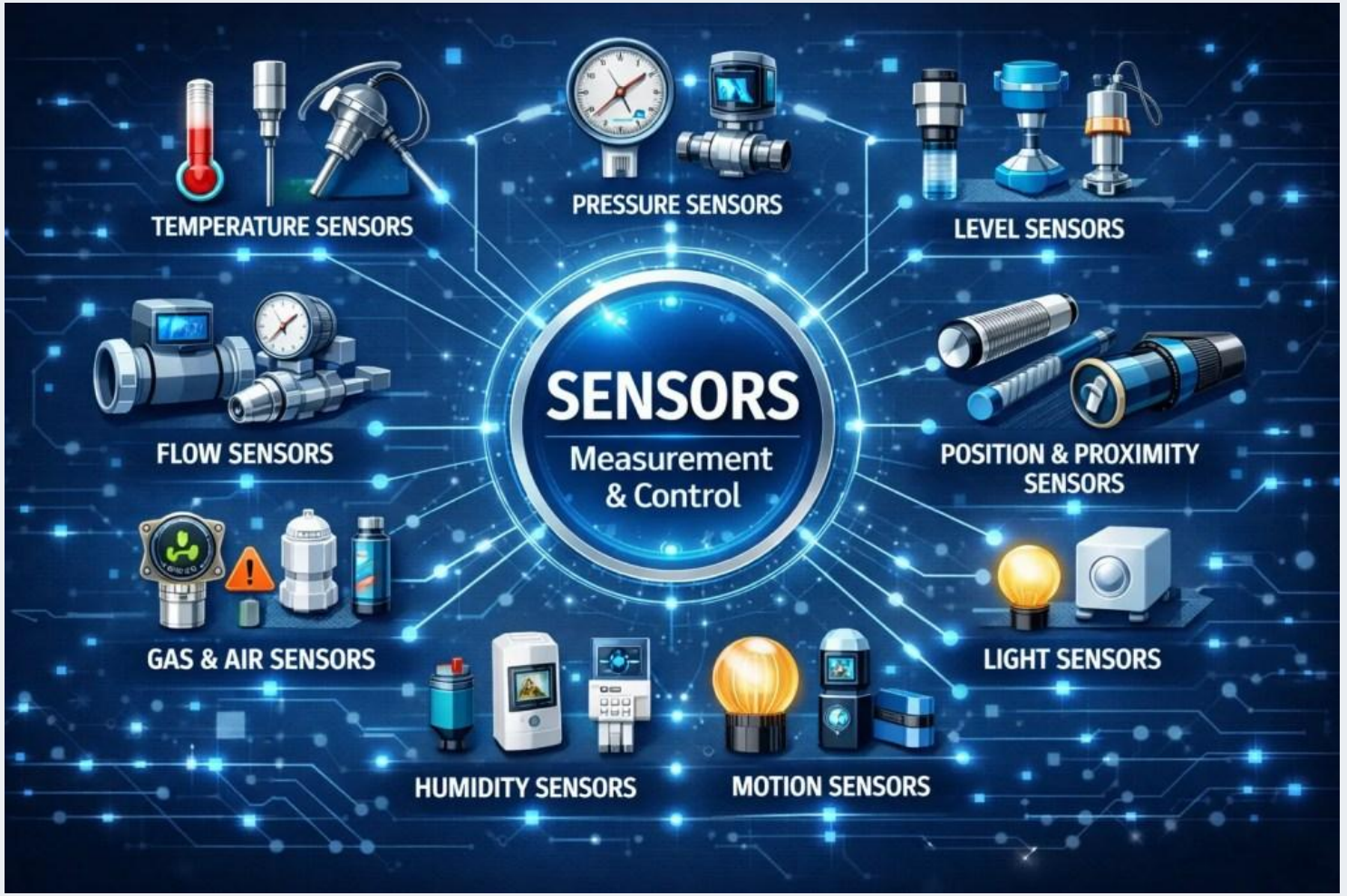
Instrumentation Tools

- Oscilloscope
- Power analyser
- Spectrum analyser
- DAQ systems
- Thermal camera



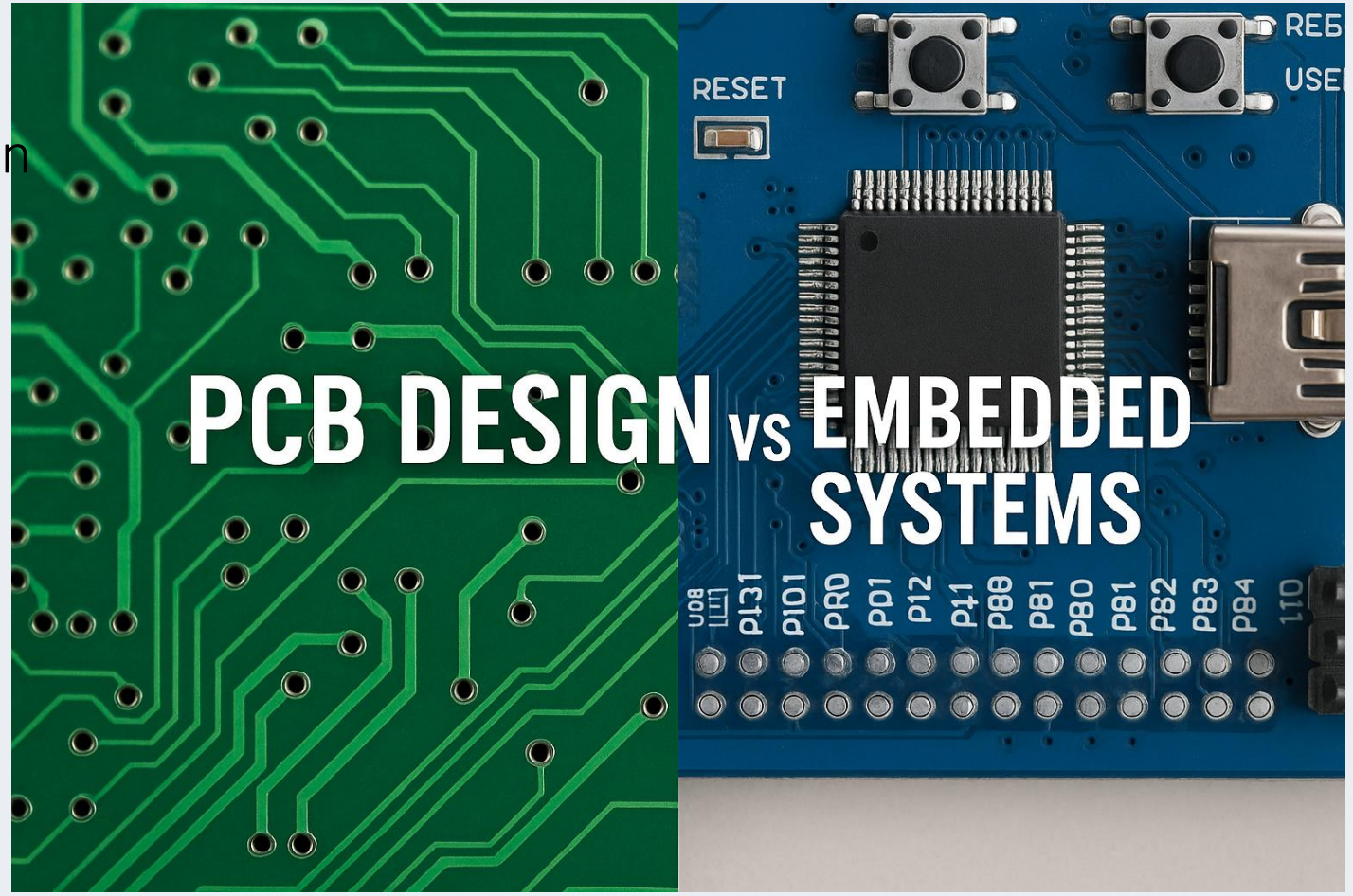
Sensor Selection

- Accuracy
- Precision
- Response time
- Calibration needs
- Environmental suitability



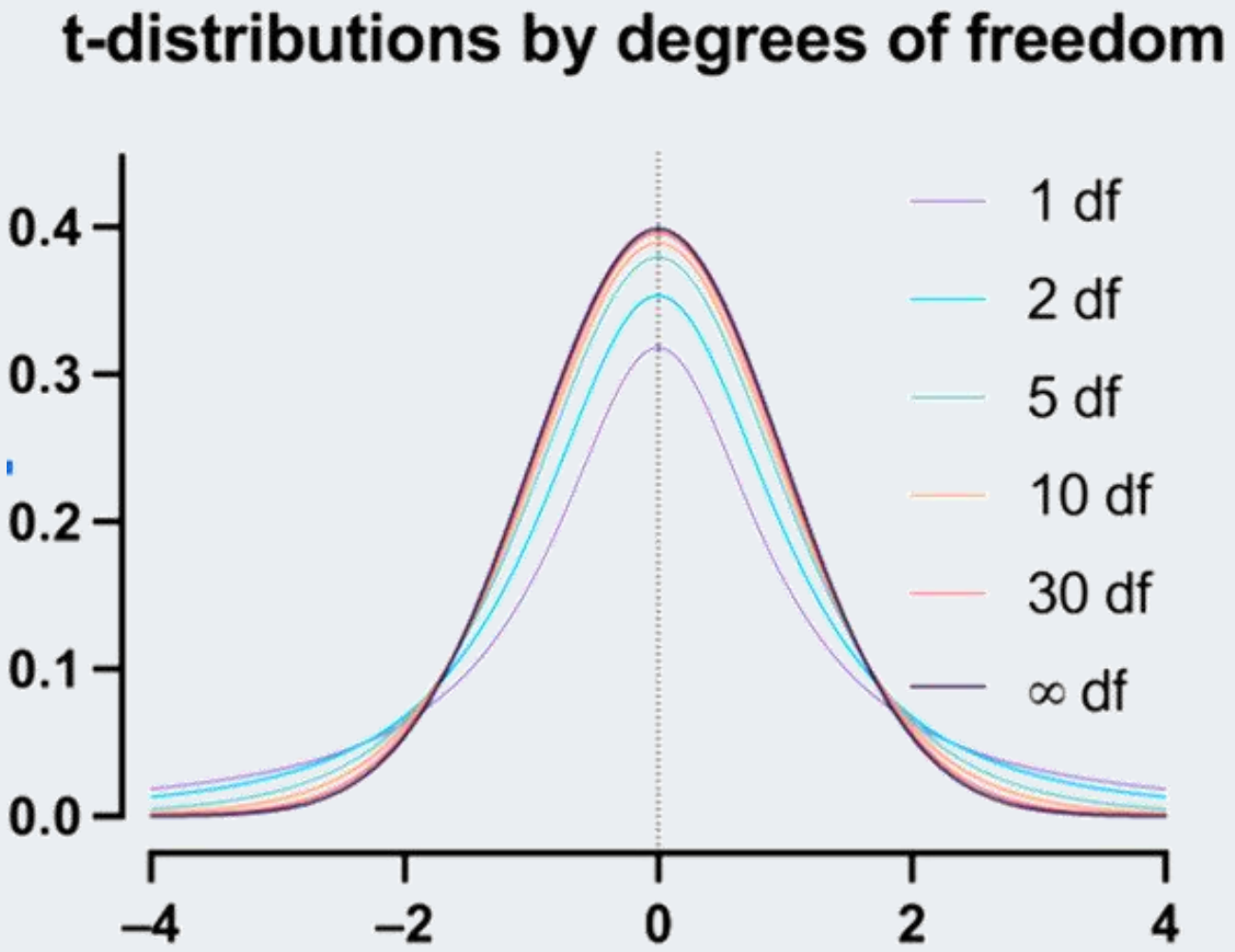
Prototype Development

- Breadboard to prototype
- PCB development
- Embedded systems integration
- Reliability testing



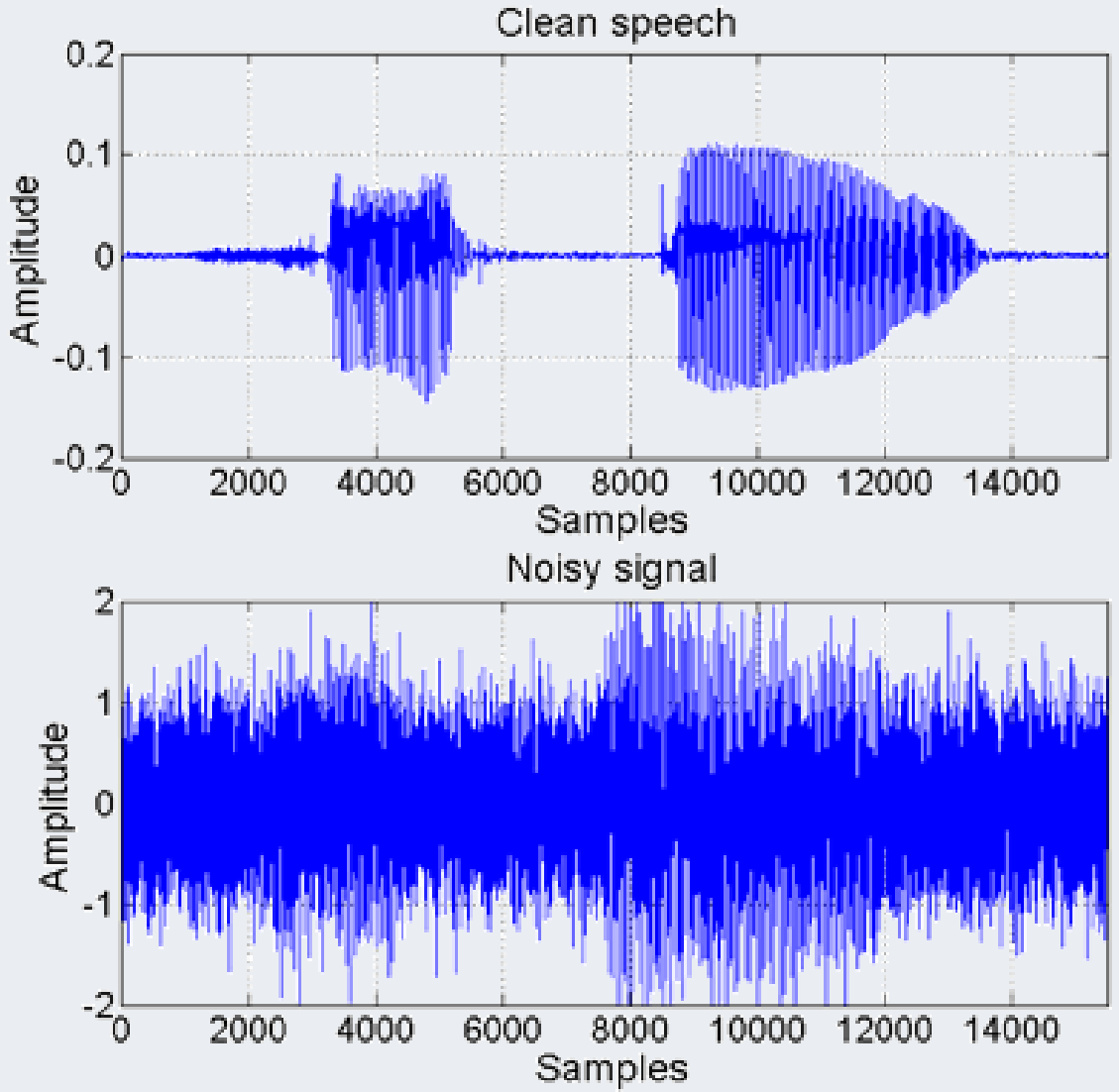
Experimental Repeatability

- Same conditions
- Same outputs
- Statistical confidence



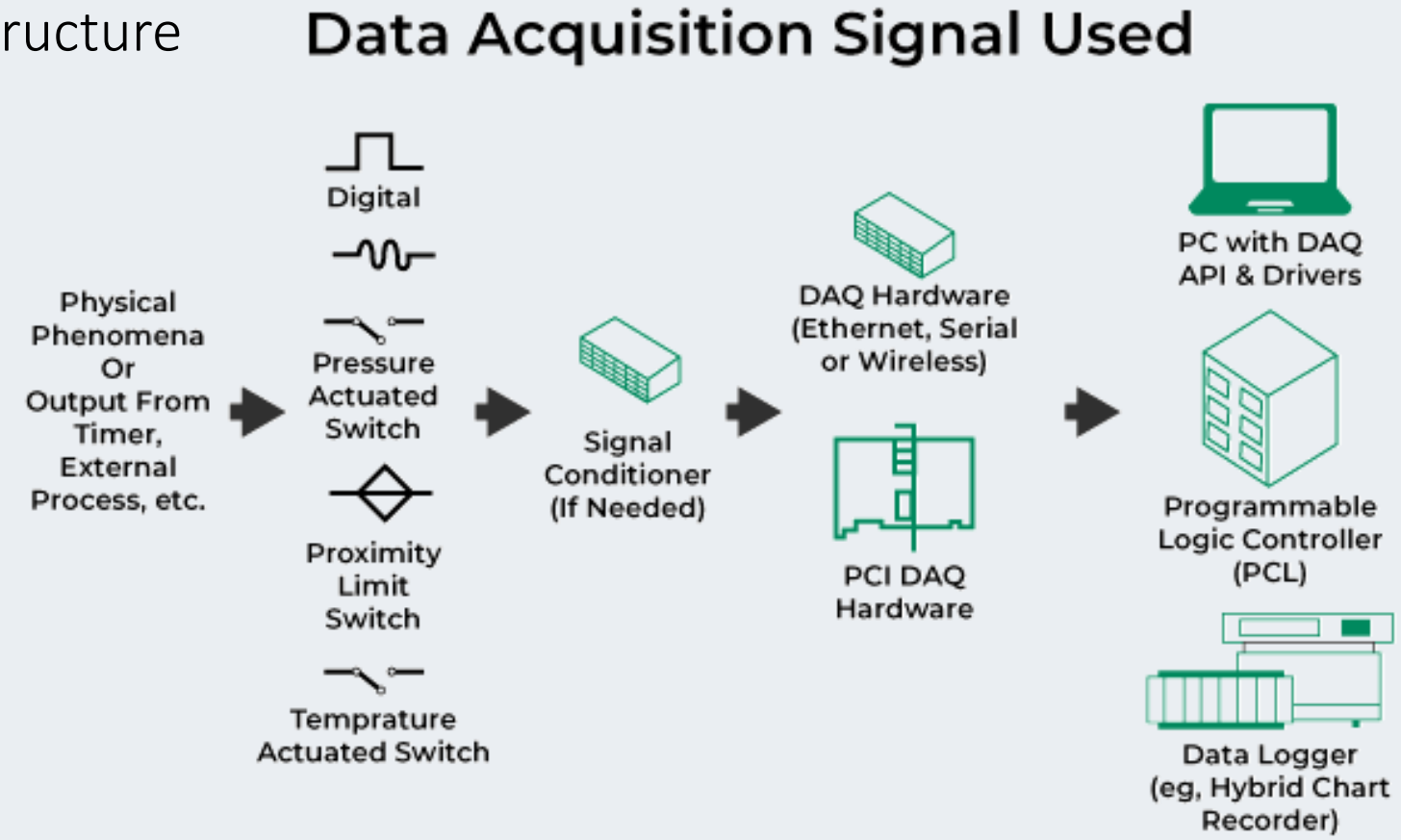
Common Experimental Problems

- Noise
- Grounding issues
- Sensor drift
- Human error
- Environmental interference



From Results to Data

- Raw measurements become datasets
- Need organisation and structure



What is Data Analytics?

- Extracting meaning from data
- Detecting patterns
- Supporting conclusions
- Enabling prediction

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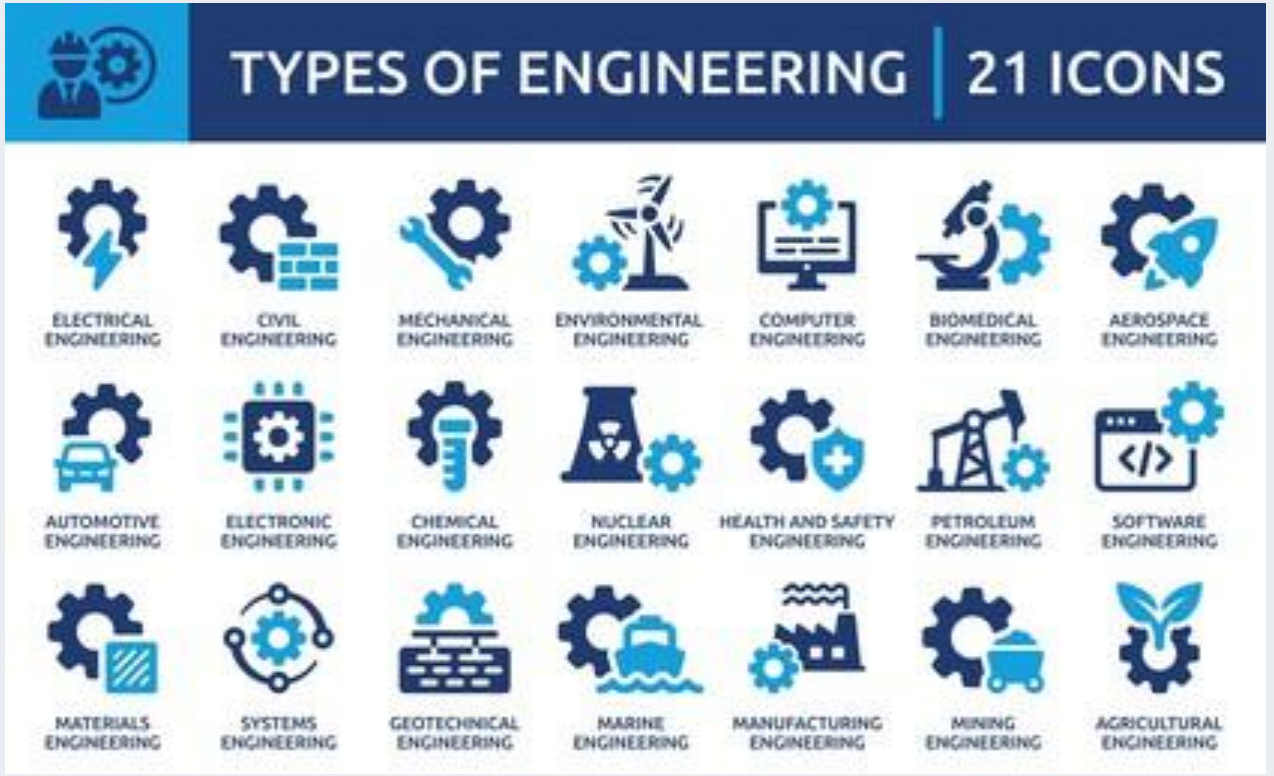
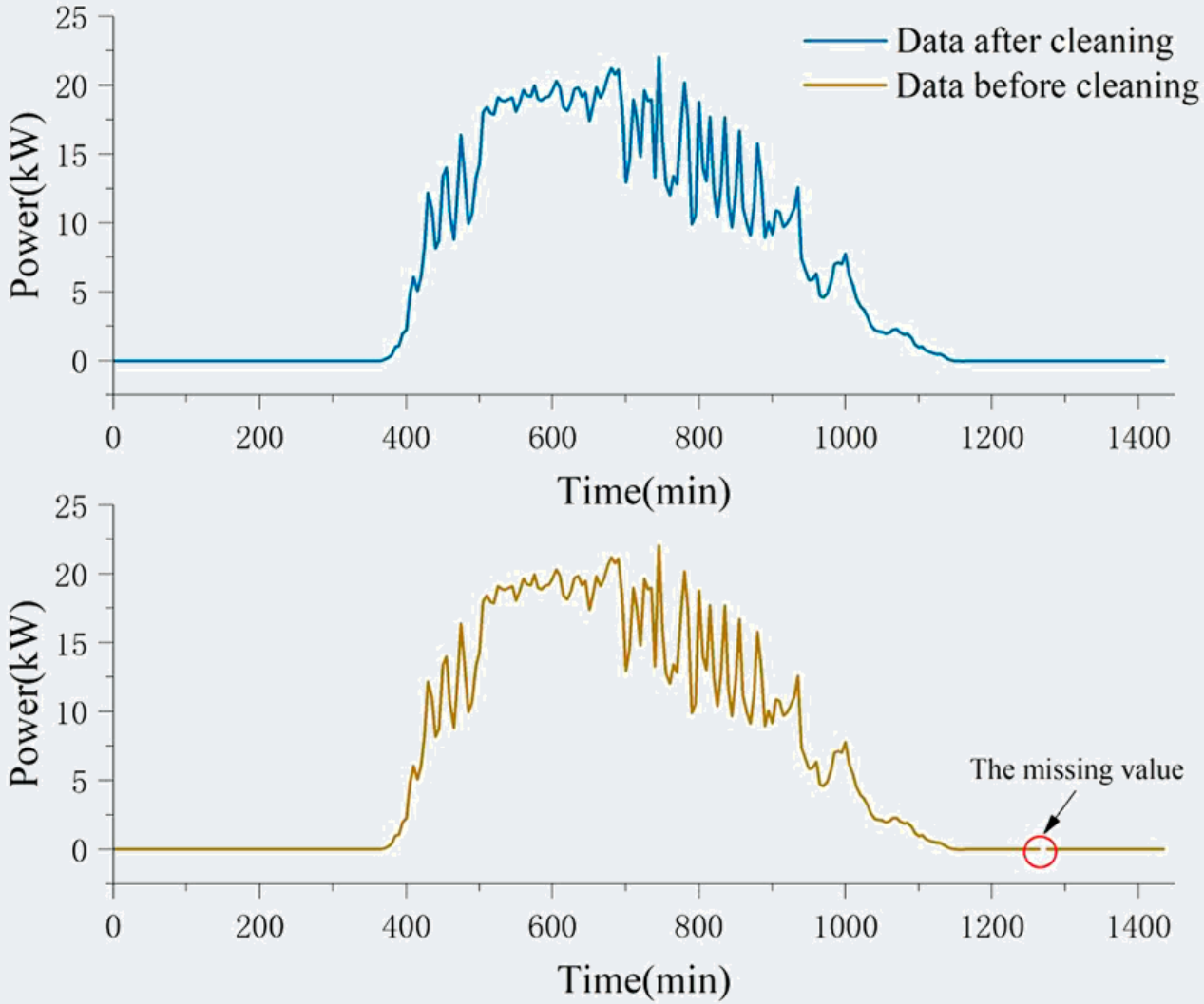
Types of Data

- Time-series data
- Frequency-domain data
- Image data
- Sensor data
- Survey and qualitative data



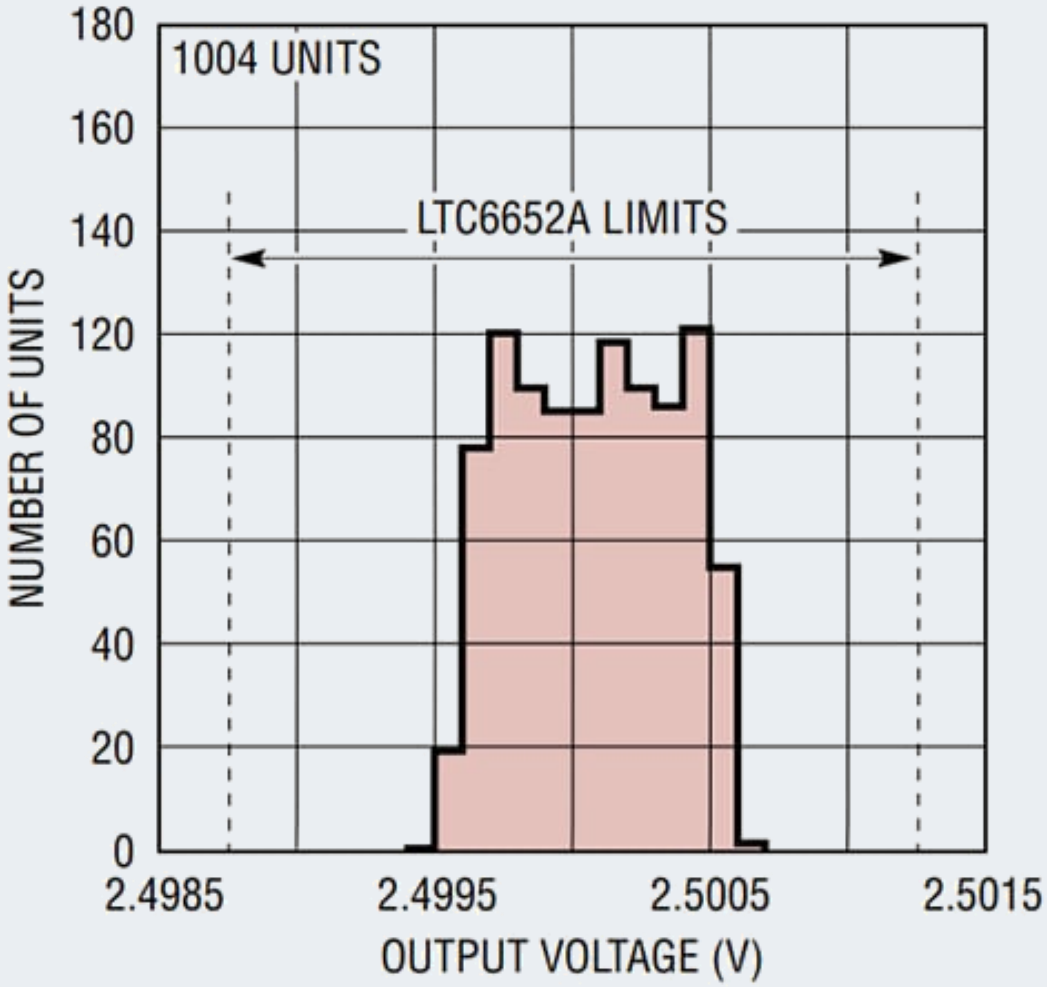
Data Cleaning

- Missing values
- Outlier detection
- Signal filtering
- Normalisation



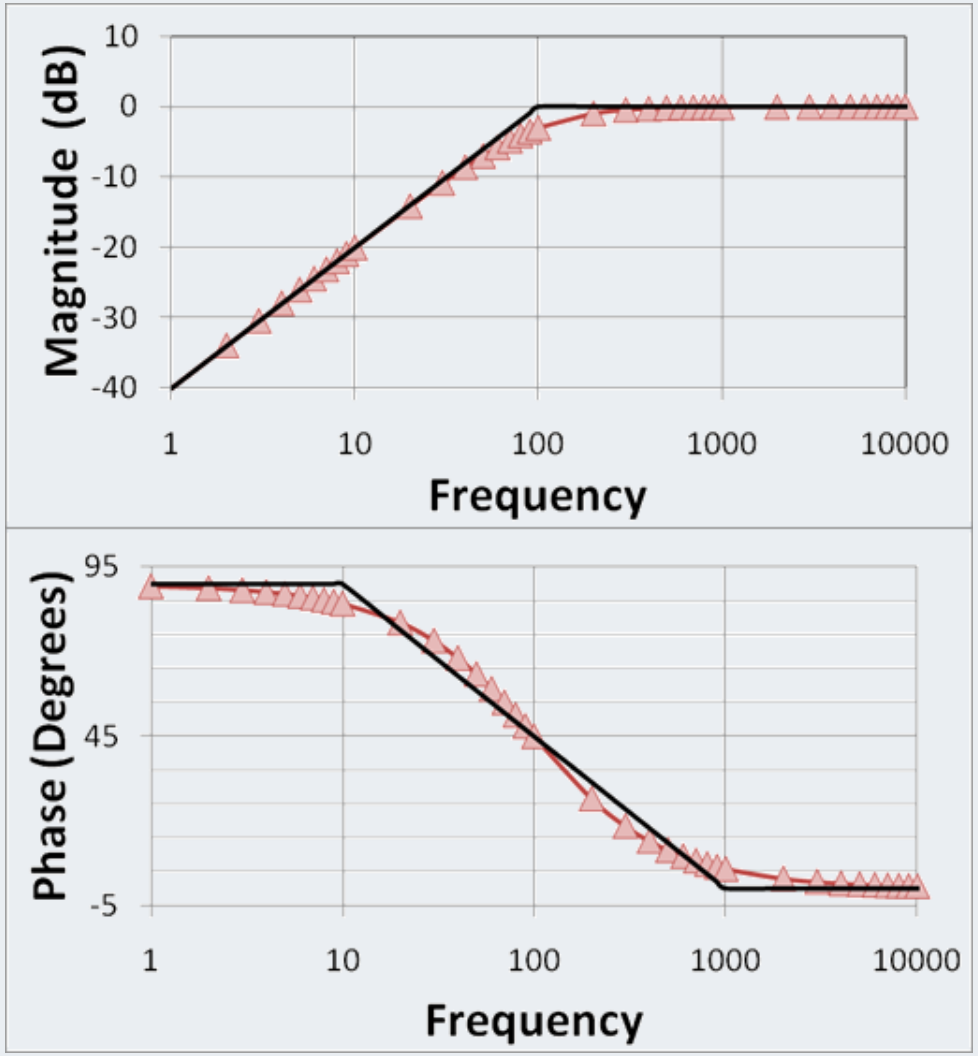
Statistical Foundations

- Mean and variance
- Confidence intervals
- Regression
- Hypothesis testing



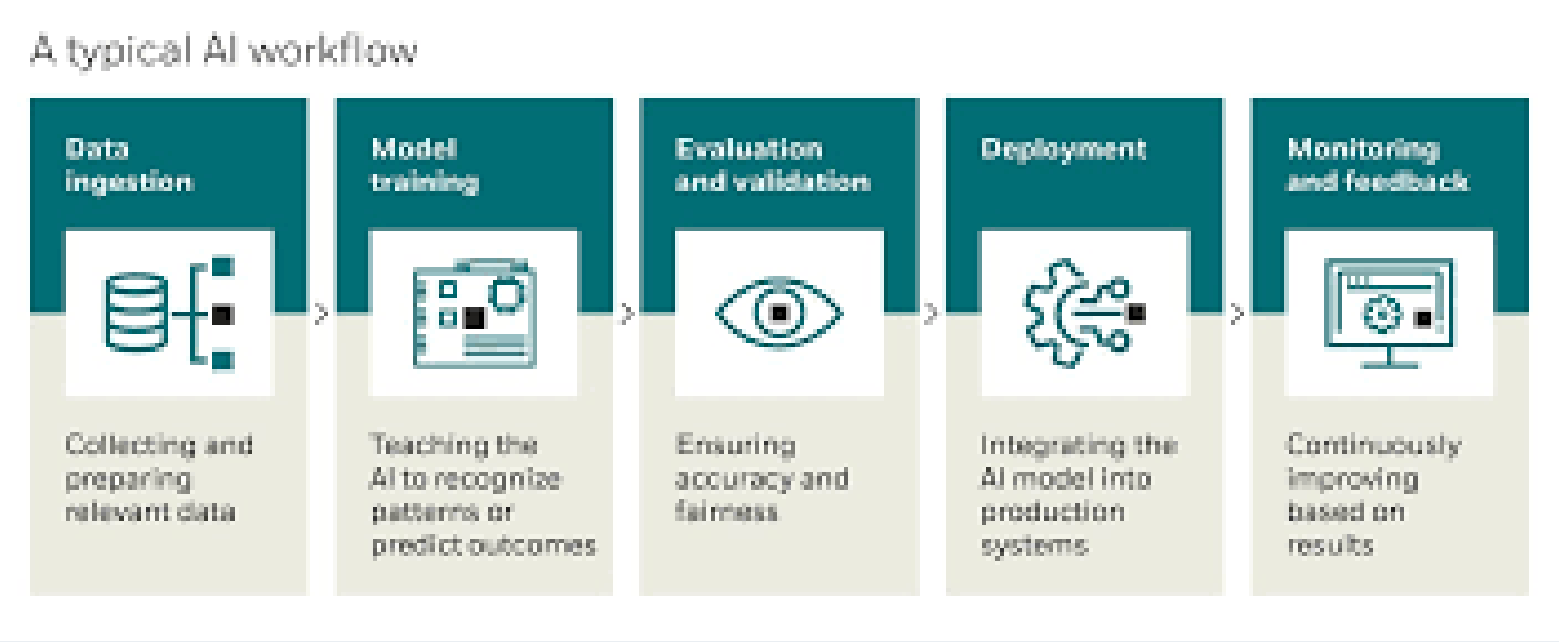
Visualisation Matters

- Graphs tell stories
- Better than tables alone
- Clear communication of results



Machine Learning in Research

- Pattern recognition
- Fault detection
- Predictive maintenance
- Optimisation



Tools for Analytics

- Python
- R
- MATLAB
- SPSS
- Power BI

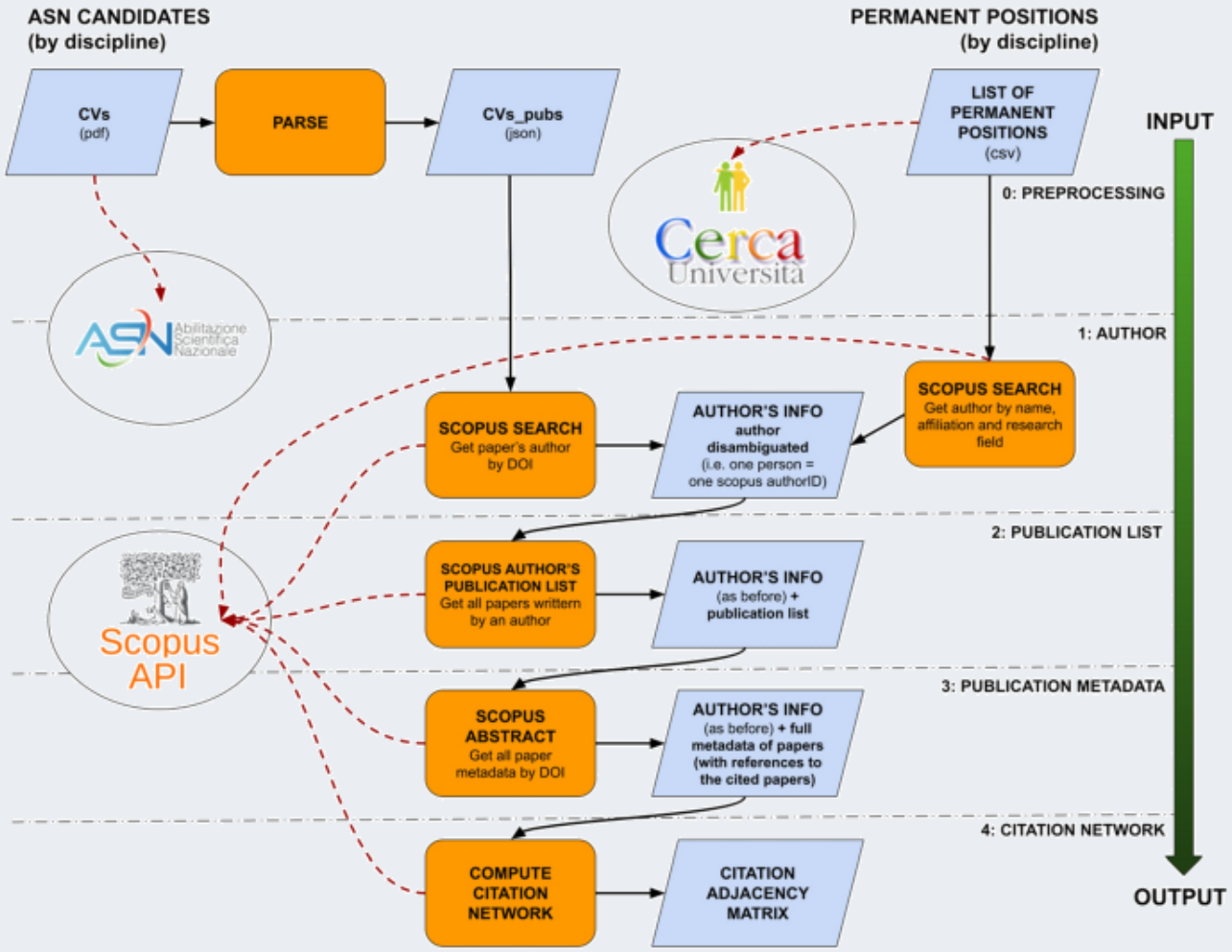
Feature	Python	R	MATLAB	SPSS	Power BI
Primary Use	ML & Automation	Deep Statistics	Engineering	Survey Research	Business Reporting
Skill Level	Coding required	Coding required	Coding required	Point-and-click	Low-code / No-code
Cost	Free (Open Source)	Free (Open Source)	Expensive License	Expensive License	Subscription based
Flexibility	Extremely High	High	Moderate	Low	Low (for modeling)

Research Integrity

- Honest reporting
- Reproducibility
- No data manipulation
- Ethical publication

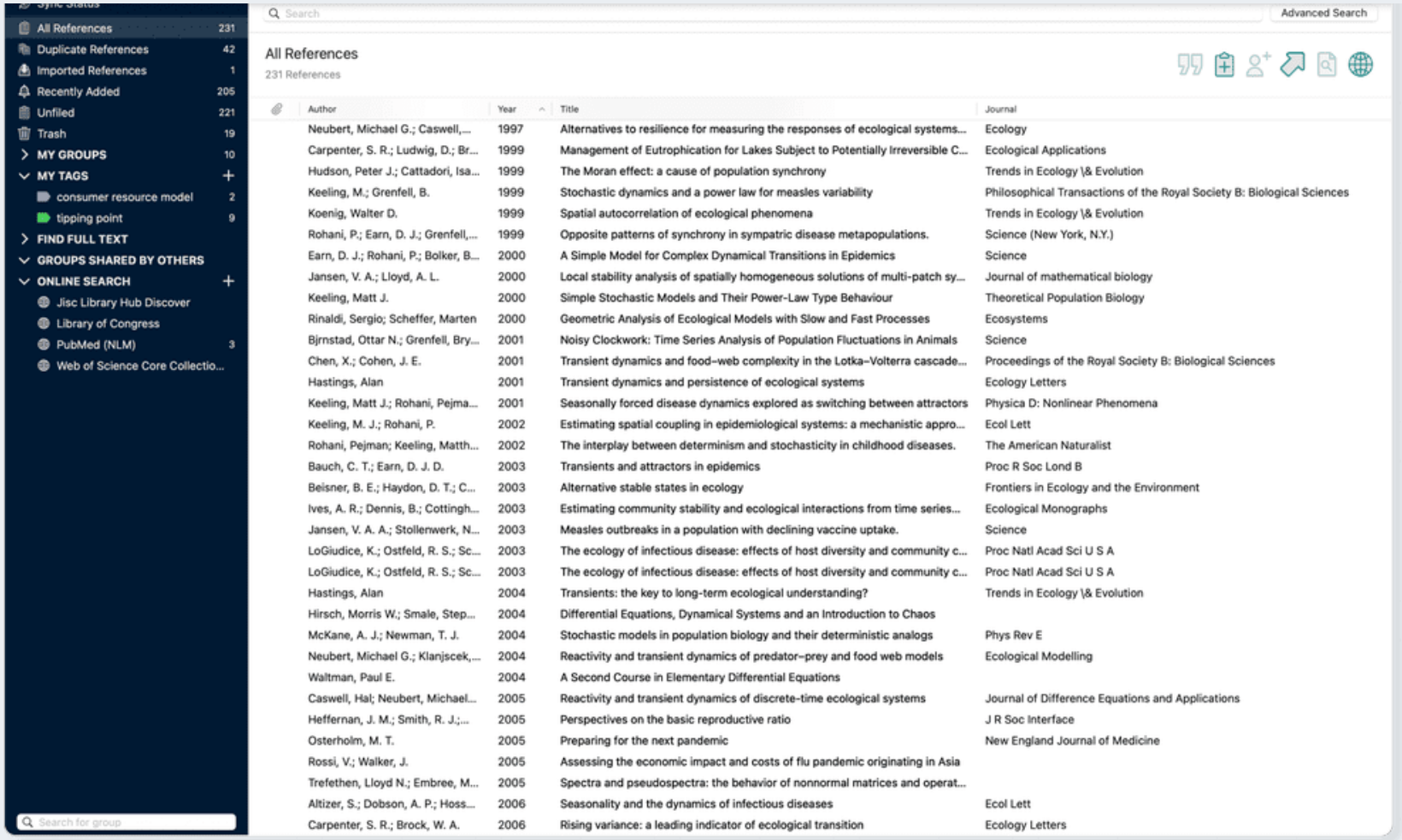
Literature Review as a Tool

- Identify gaps
- Avoid duplication
- Build methodology
- Benchmark results



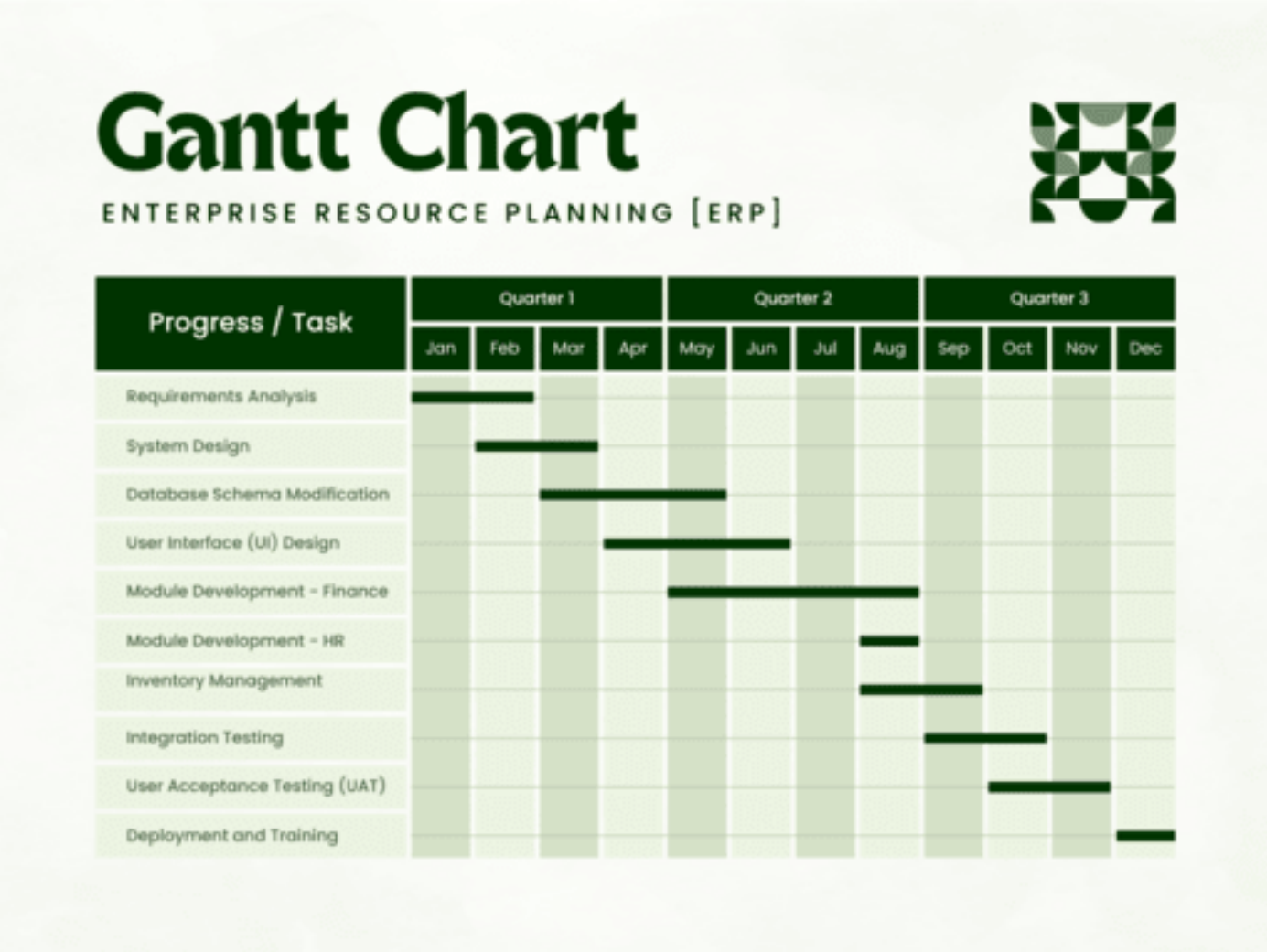
Reference Management

- EndNote
- Zotero
- Mendeley
- Citation discipline



Research Planning

- Gantt charts
- Milestones
- Deliverables
- Risk management

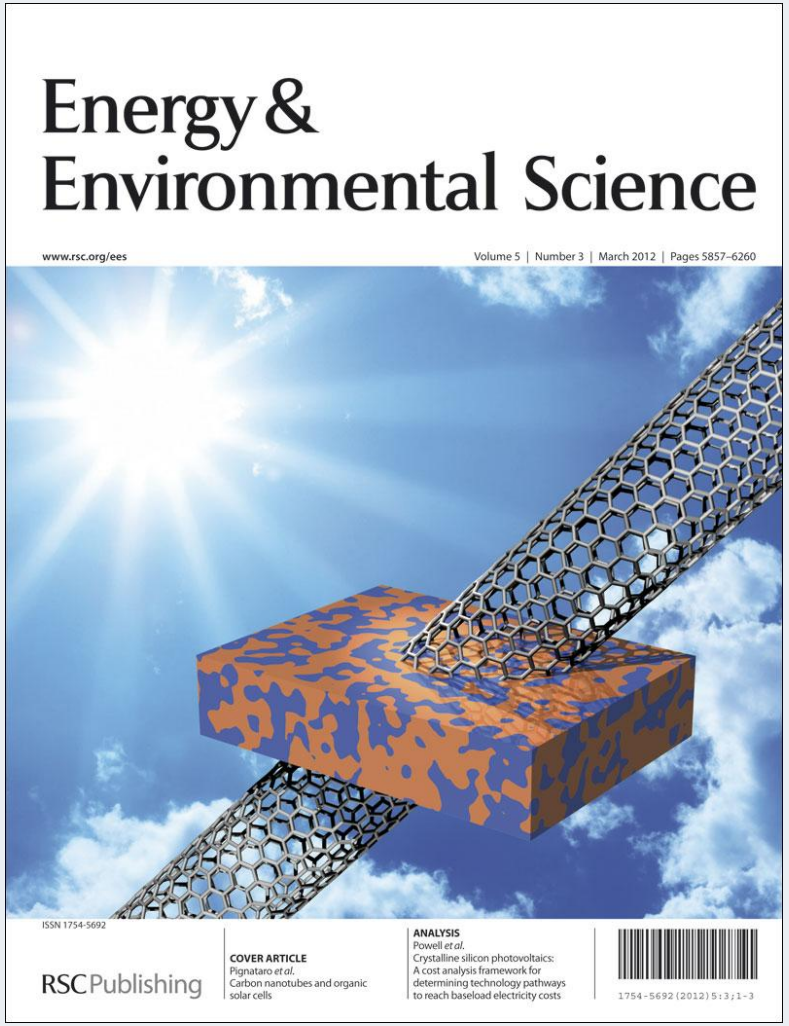


Working with Supervisors

- Clear communication
- Meeting discipline
- Progress reporting
- Feedback acceptance

Publication Strategy

- Conference papers
- Journal papers
- Patent opportunities
- Thesis by publication

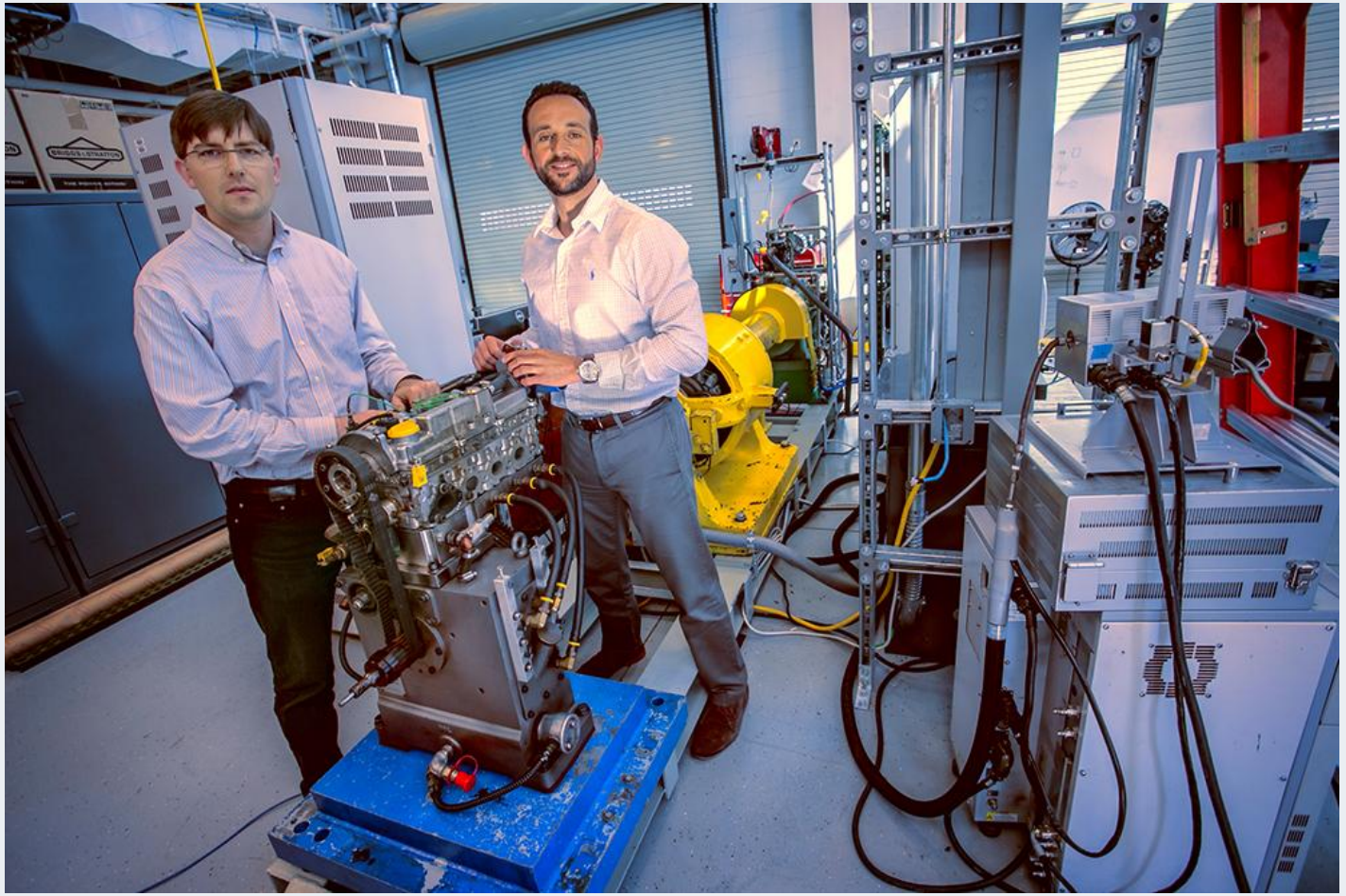


Conference Participation

- Presenting work
- Networking
- Feedback from experts
- Career opportunities

Funding and Grants

- Scholarships
- Industry funding
- Government grants
- International collaboration



Industry Collaboration

- Real-world problems
- Access to equipment
- Employment pathways
- Applied impact

Interdisciplinary Research

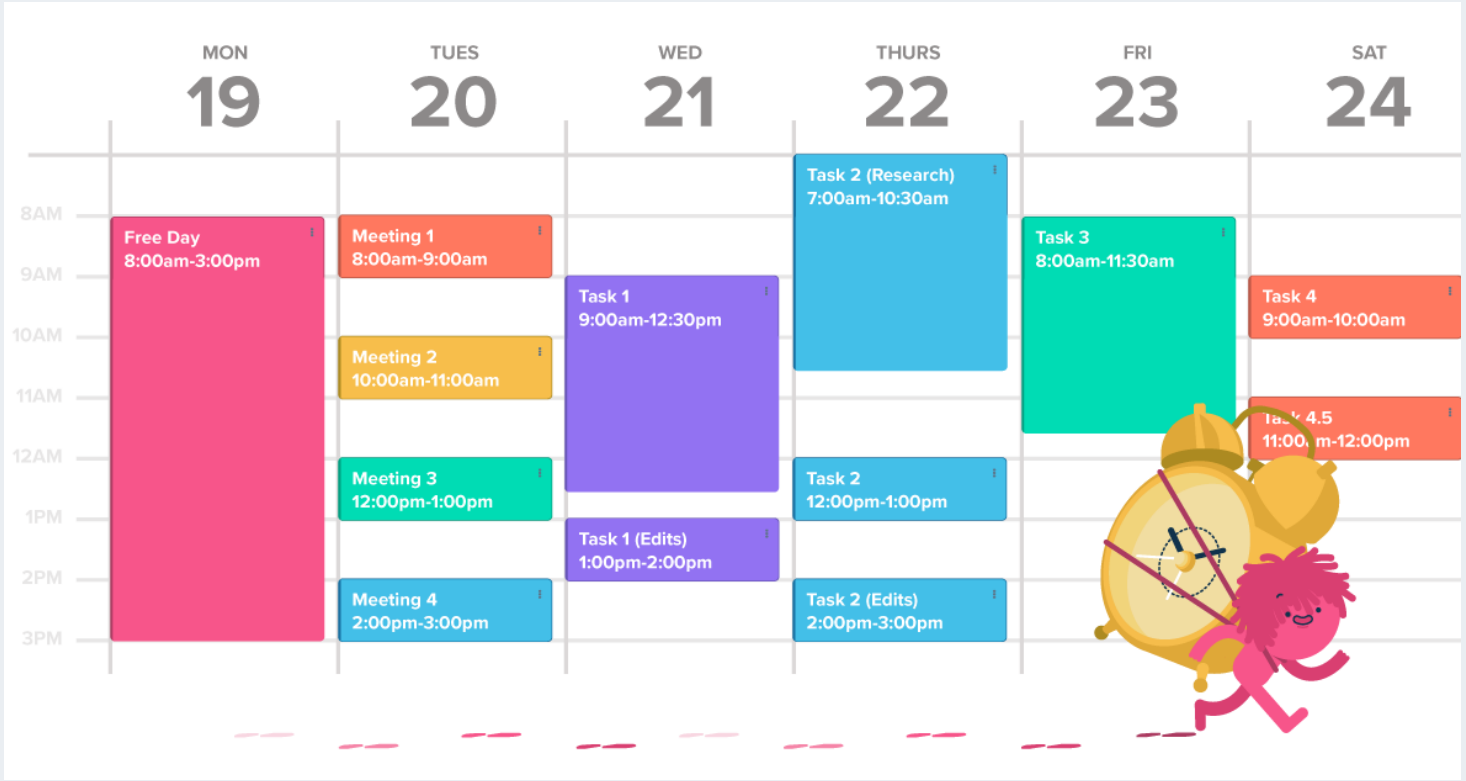
- Engineers + data scientists
- Engineers + health experts
- Engineers + environmental scientists

Resilience in Research

- Failed experiments happen
- Simulations break
- Papers get rejected
- Persistence matters most

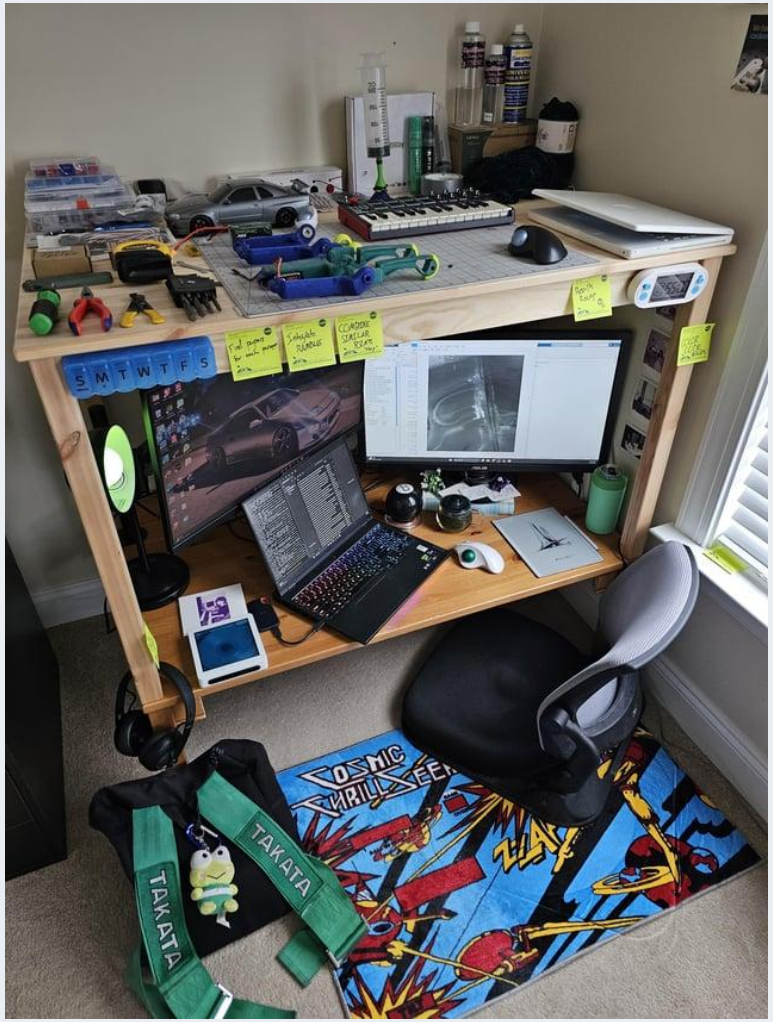
Time Management

- Daily progress
- Weekly targets
- Writing early
- Avoid perfection paralysis



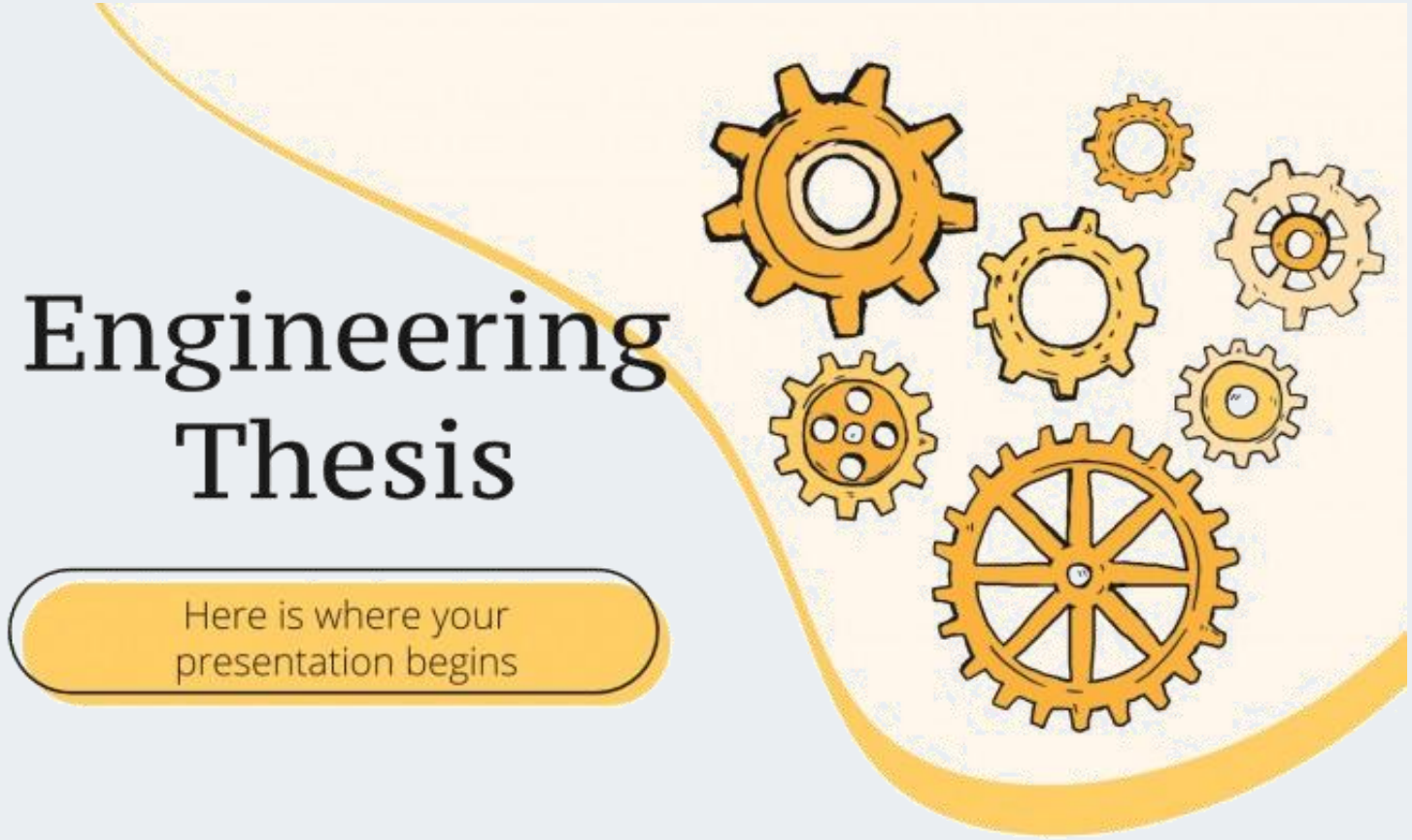
Thesis Writing

- Start early
- Write continuously
- Maintain version control
- Keep evidence organized



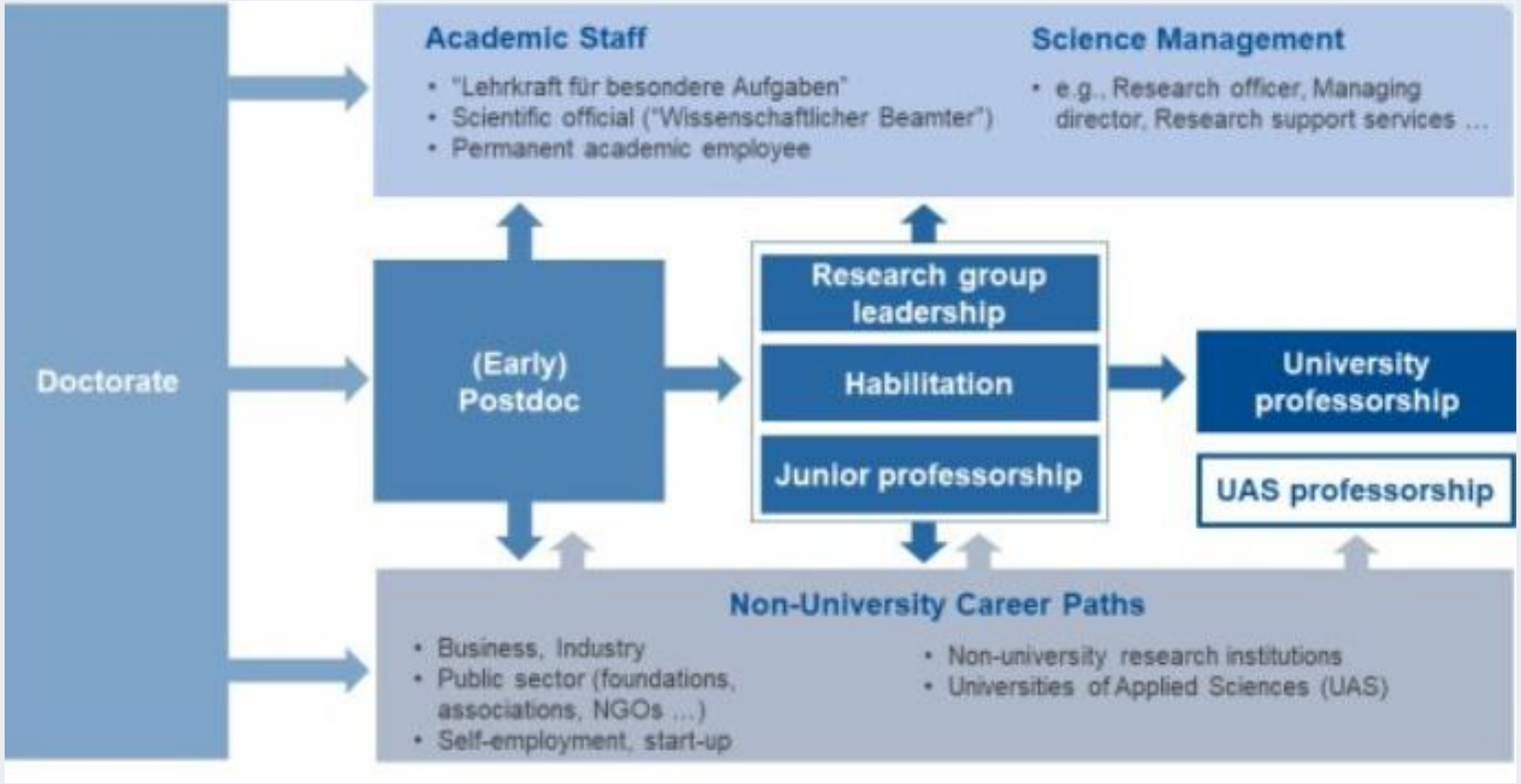
Viva/Defence Preparation

- Know your contribution
- Defend your decisions
- Explain limitations
- Show confidence



Career Pathways After PhD

- Academia
- Industry R&D
- Consulting
- Entrepreneurship
- Government research

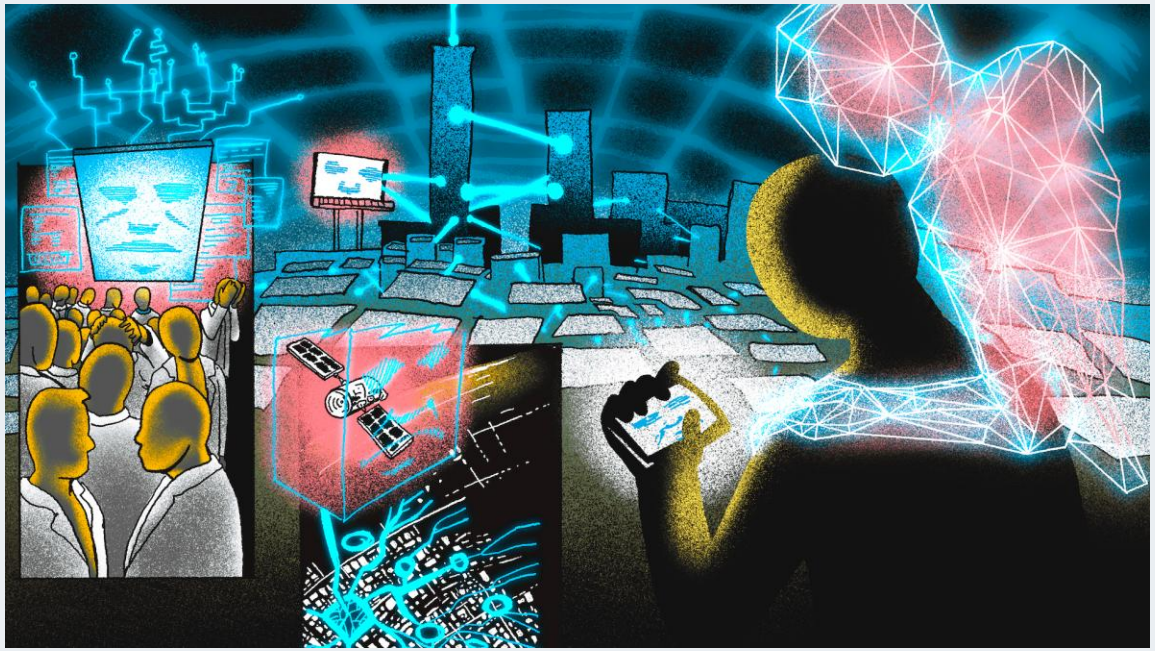


Key Success Formula

- Curiosity
- Discipline
- Integrity
- Communication
- Persistence

Final Message

Your DEng is not just a degree.
It is your contribution to the future of engineering.



Q&A

Thank You!

Upcoming courses

Courses	Start Date
Doctor of Engineering (online) 36 months	20 July 2026
On-Campus – Doctor of Engineering 36 months Perth/Melbourne	27 July 2026

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Upcoming Doctoral Webinars

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4 June: Research Integrity, Safety, and Ethics in Engineering
2 July: Supervisory and Industry Collaboration: Working as a Research Engineer
6 August: Managing the DEng: Planning, Time, and Resources
3 September: Communicating Engineering Research: Writing and Presenting Effectively
1 October: From Lab to Field: Translating Research into Real-World Engineering Applications
5 November: Resilience, Reflection, and the Doctoral Mindset
3 December: Building Your Research Identity: Patents, Publications, and Professional Pathways

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