

Phase 2: Research Practice (Designing and Executing Research)
**DEng Program: Tools of the Trade – Simulation,
Experimentation, and Data Analytics**

7 May 2026

[Watch Webinar Recording Here](#)

Presented by Emeritus Professor Akhtar Kalam

EIT EMERITUS PROFESSOR

About EIT

We are dedicated to ensuring that you receive a world-class education and gain skills that you can immediately implement in the workforce.



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Our vocational programs and higher education degrees are registered and accredited by the Australian Government. We have programs that are also recognized under three international engineering accords.



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Event Conduct



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Breaches may lead to removal.

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.D.s. 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

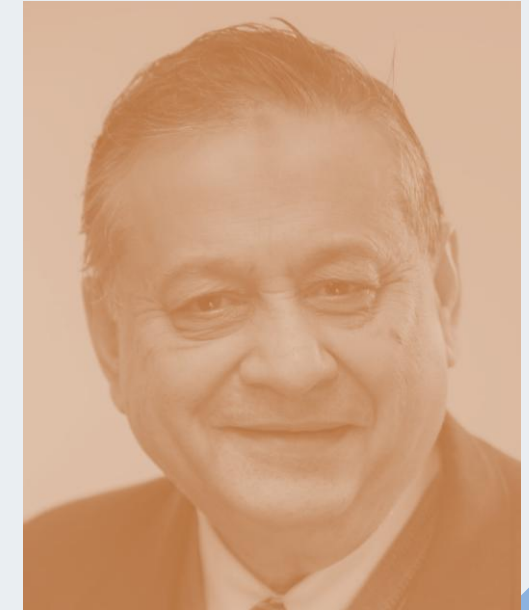
St Xavier's College, Calcutta, India, Applied Science

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.”

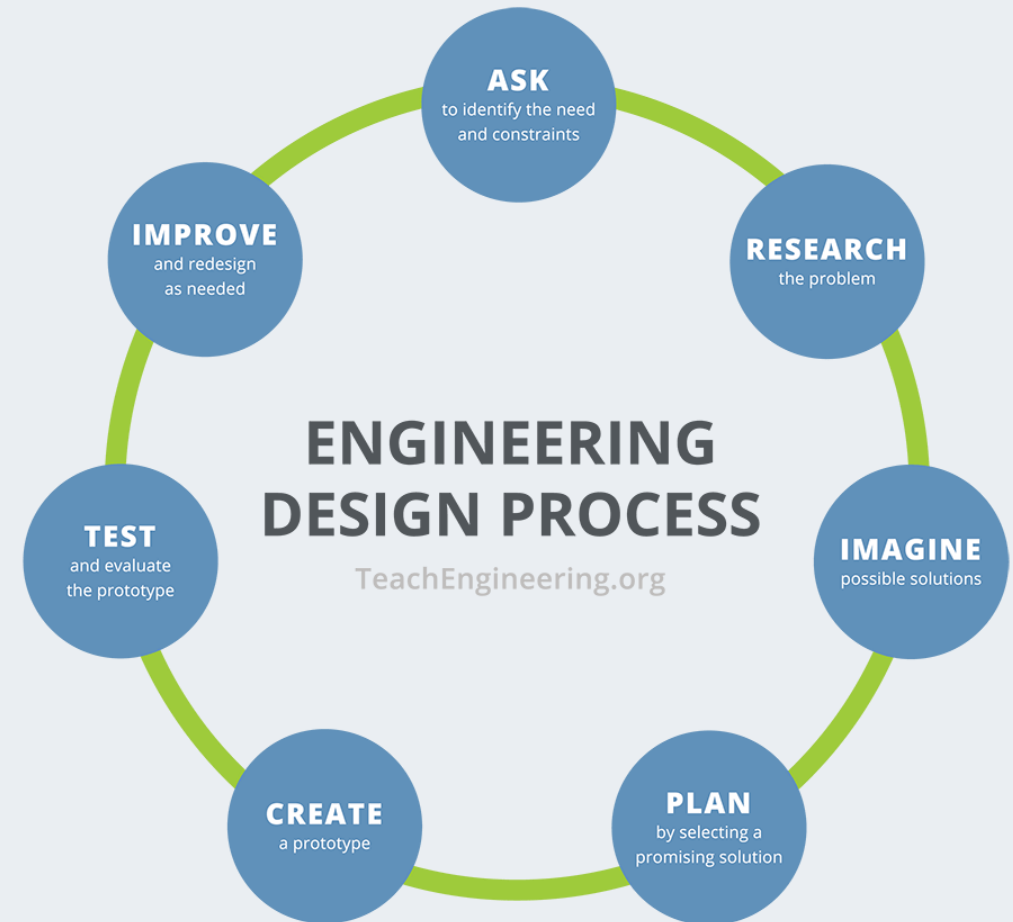
Agenda

- 1 Overview
 - 2 Research Tools
 - 3 Simulation Mistakes
 - 4 Experimentation
 - 5 Lab Safety
 - 6 Resilience in Research
-



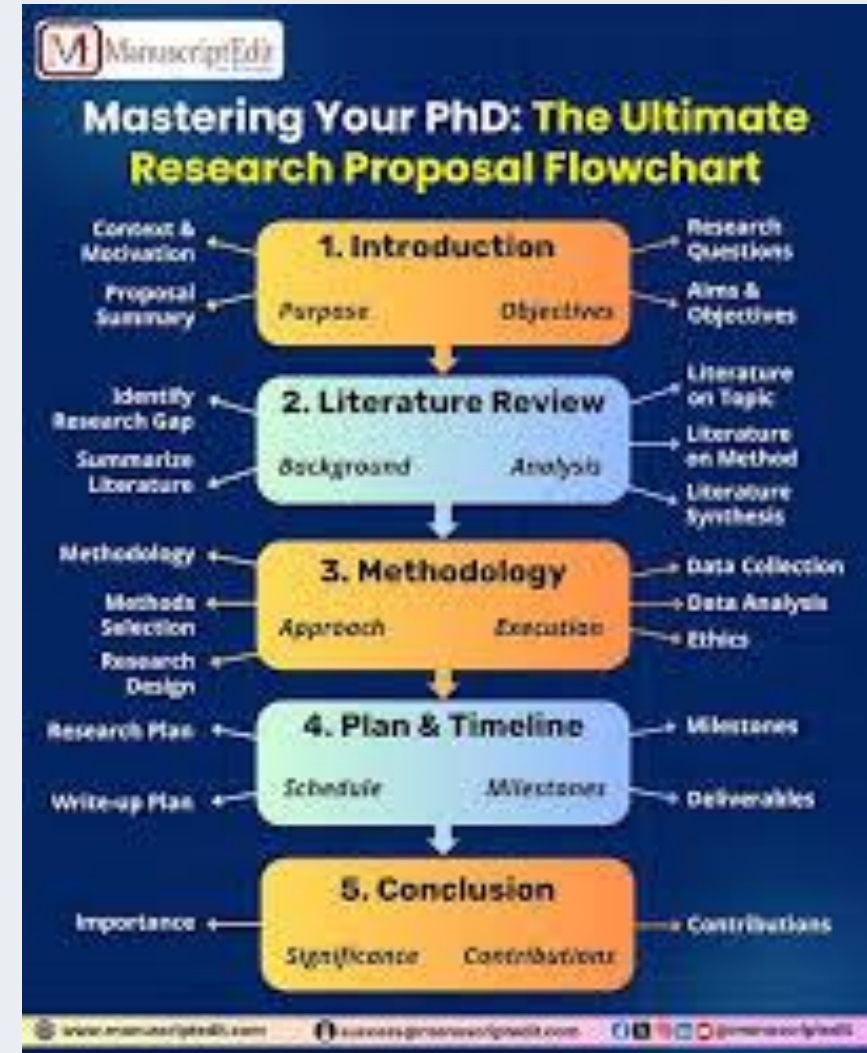
Why Research Practice Matters?

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



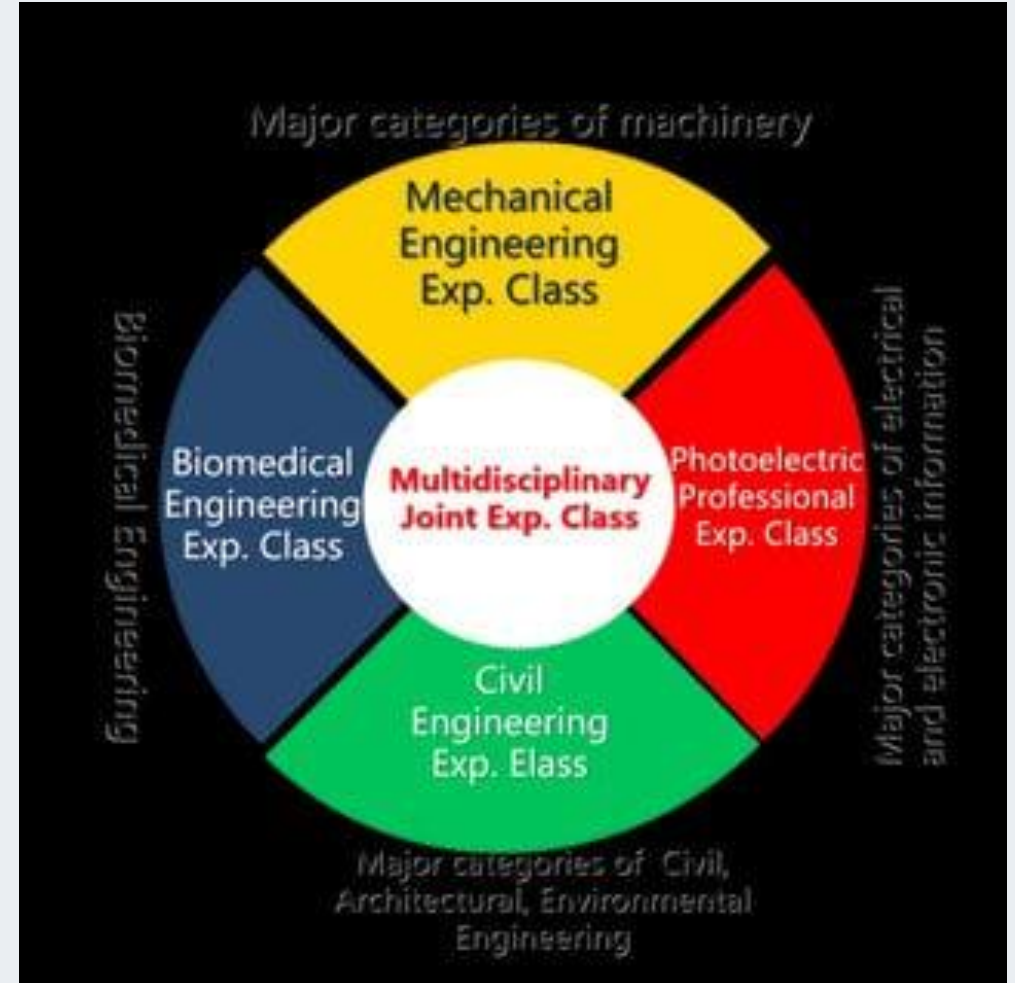
The Doctoral Journey

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



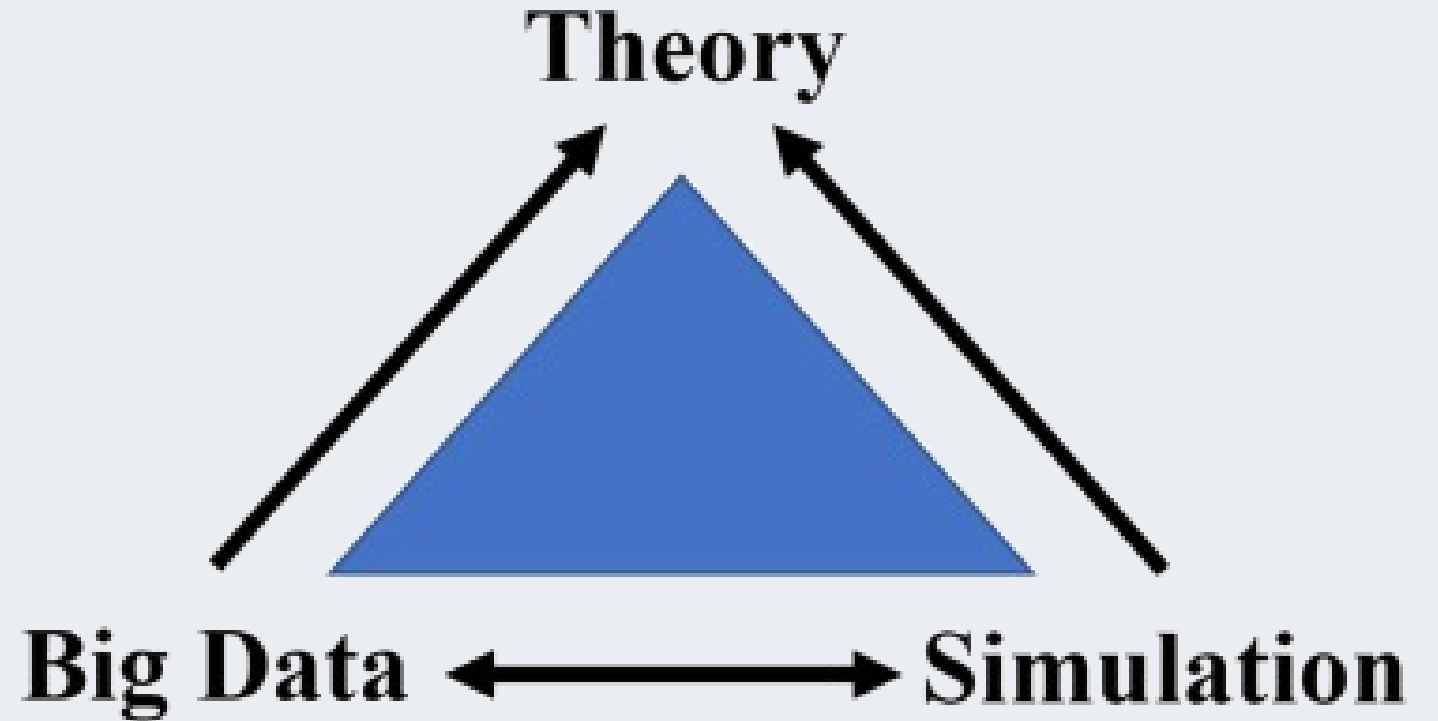
Engineering Research Domains

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



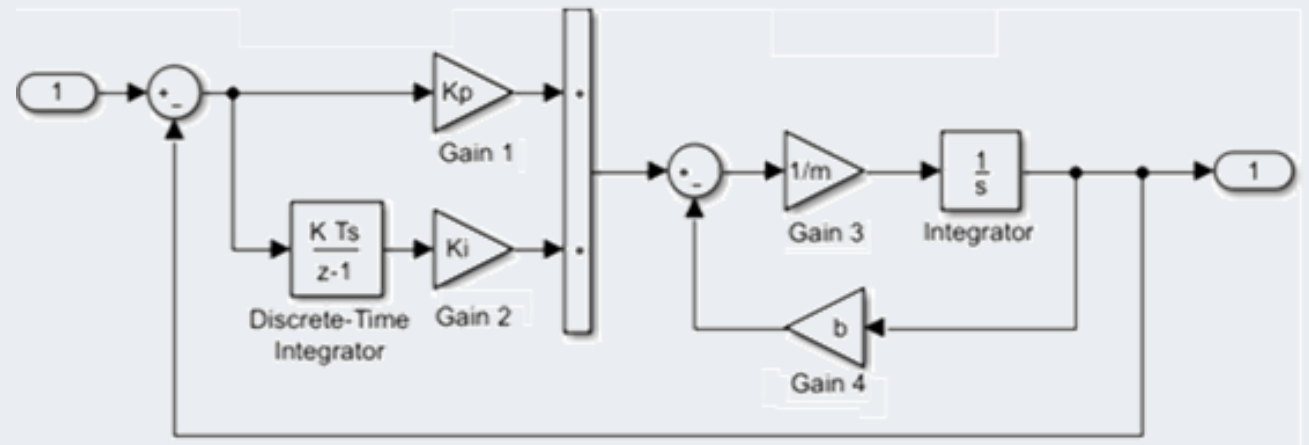
Three Core Research Tools

- Simulation
- Experimentation
- Data Analytics




What is Simulation?

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



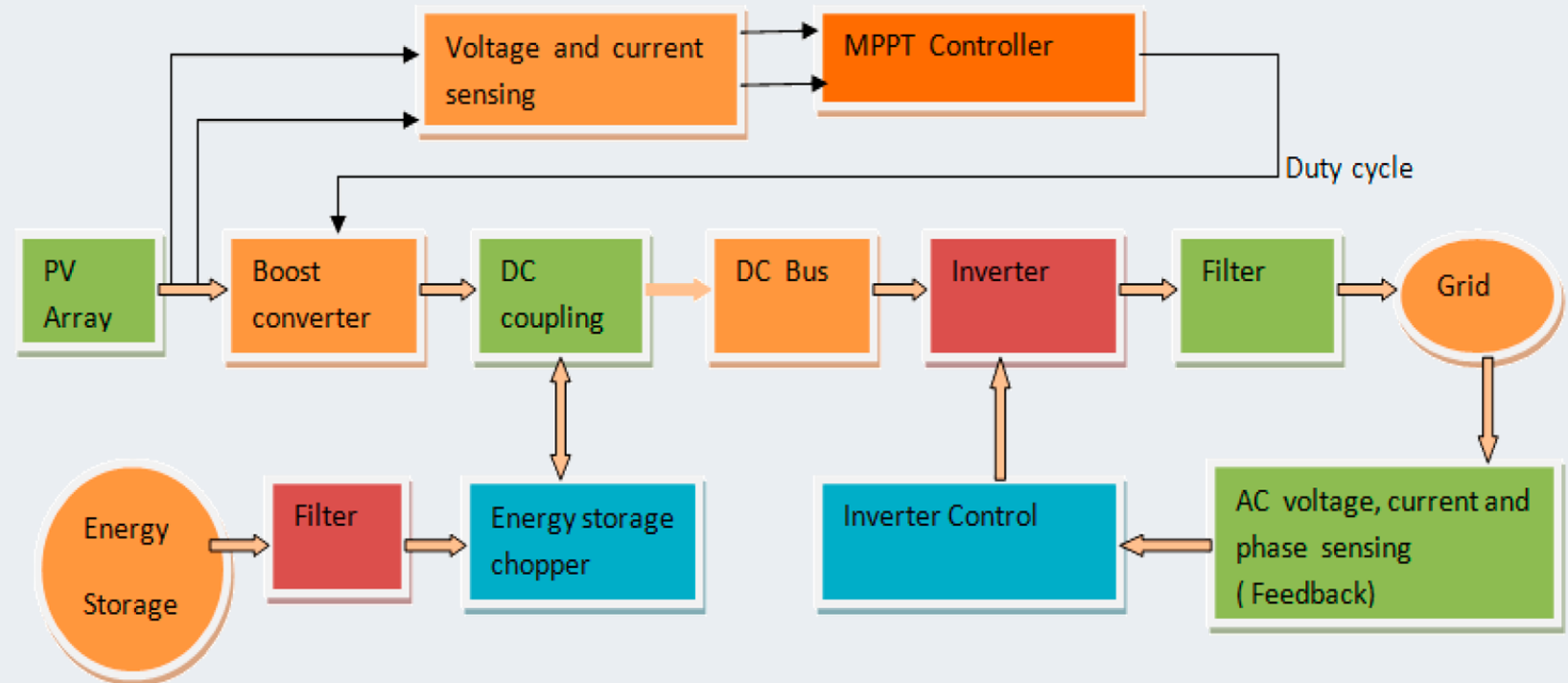
Popular Simulation Platforms

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



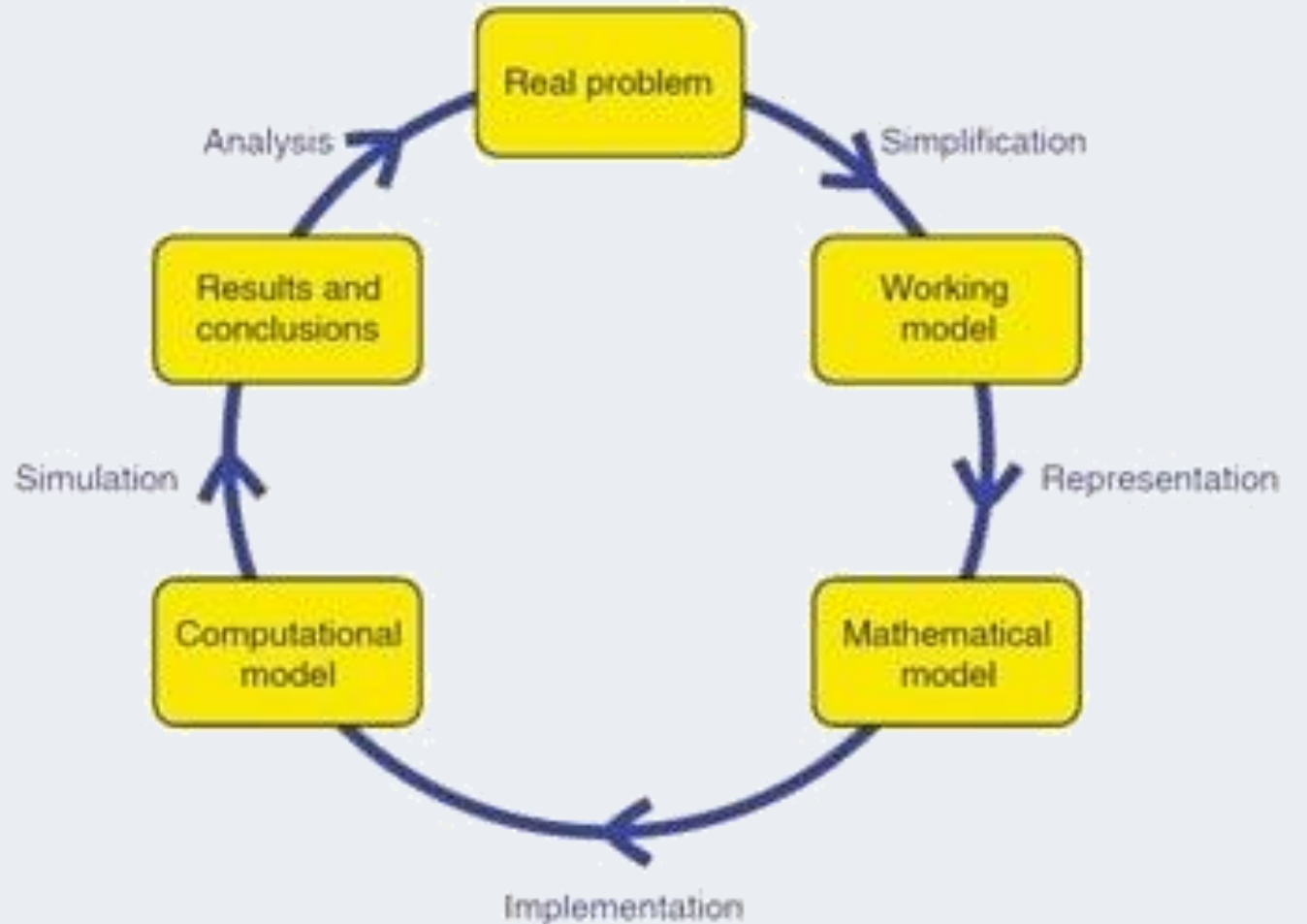
Simulation Example

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



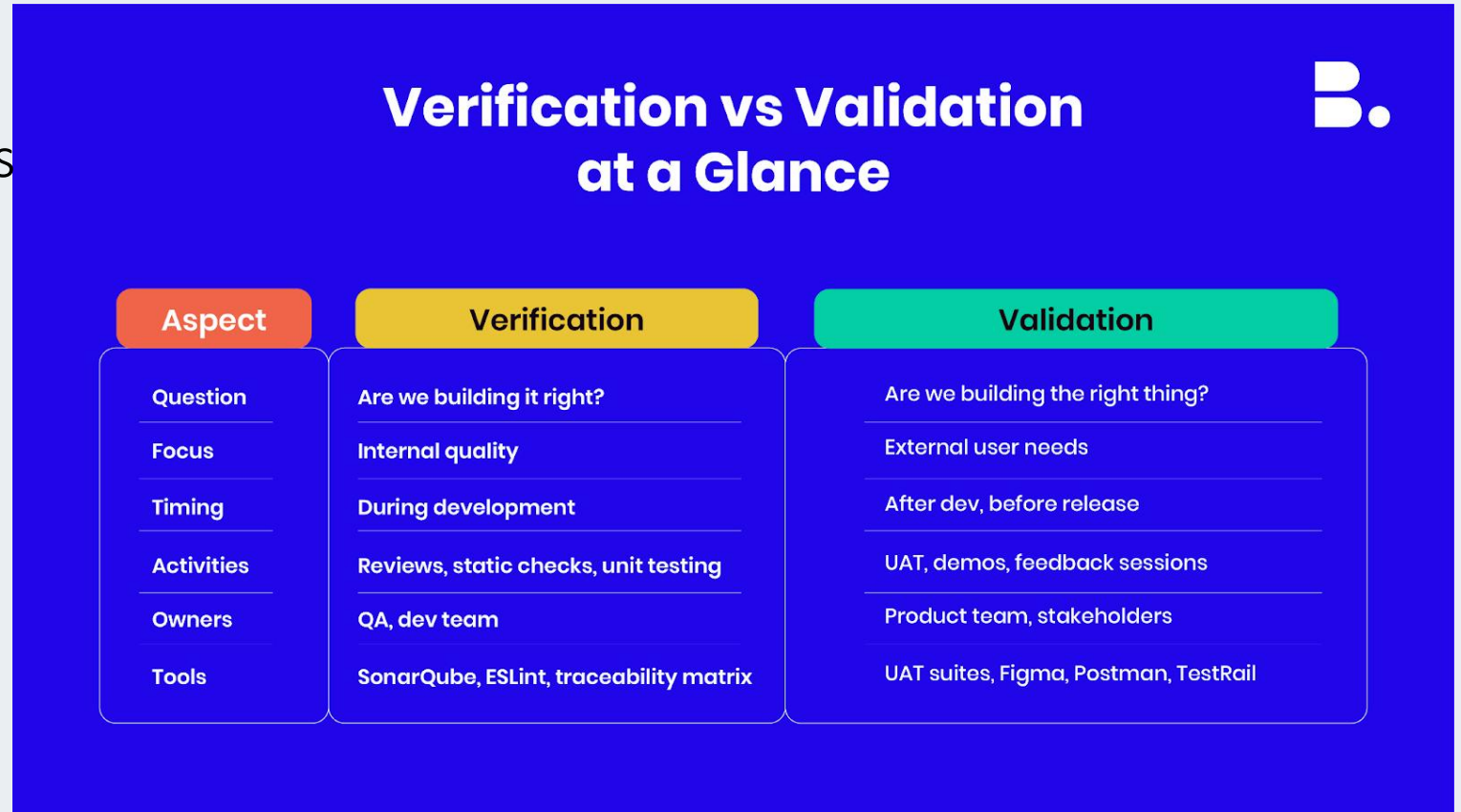
Model Development

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



Model Validation

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



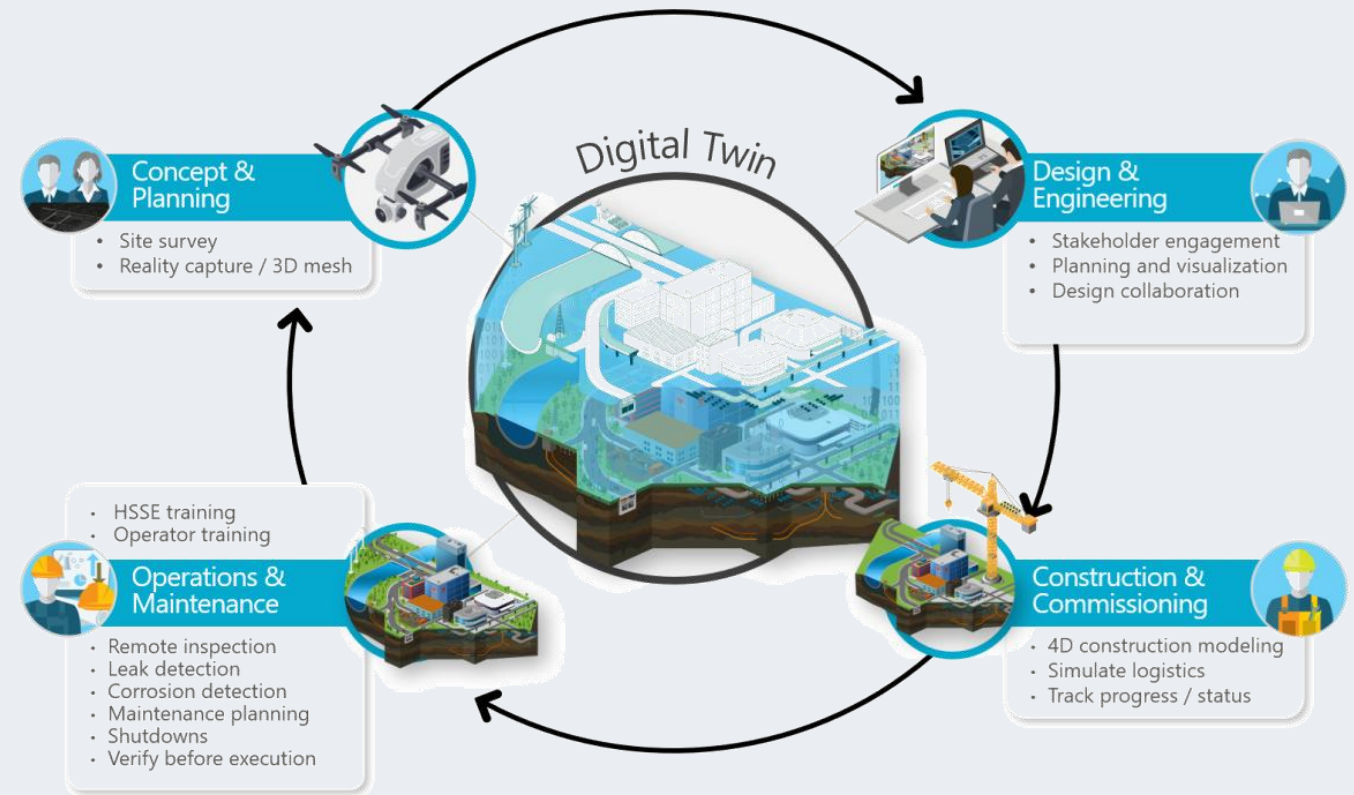
Common Simulation Mistakes

- 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



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LAB SAFETY RULES

- 
 - Always follow instructions and stay focused on your work.
 - No running, playing, or distracting others in the lab
- 
 - Wear goggles, gloves, and lab coats at all times.
 - Keep food, drinks, and personal items outside the laboratory
- 
 - Label all substances clearly and use only as instructed.
 - Never taste, smell, or touch chemicals with bare hands
- 
 - Inspect tools and glassware before use.
 - Report broken or damaged equipment immediately
- 
 - Know where safety equipment and exits are located.
 - Report all accidents or spills to your teacher without delay
- 
 - Always dispose of waste properly, clean your workspace, and return equipment after use to keep the lab safe and organized for everyone

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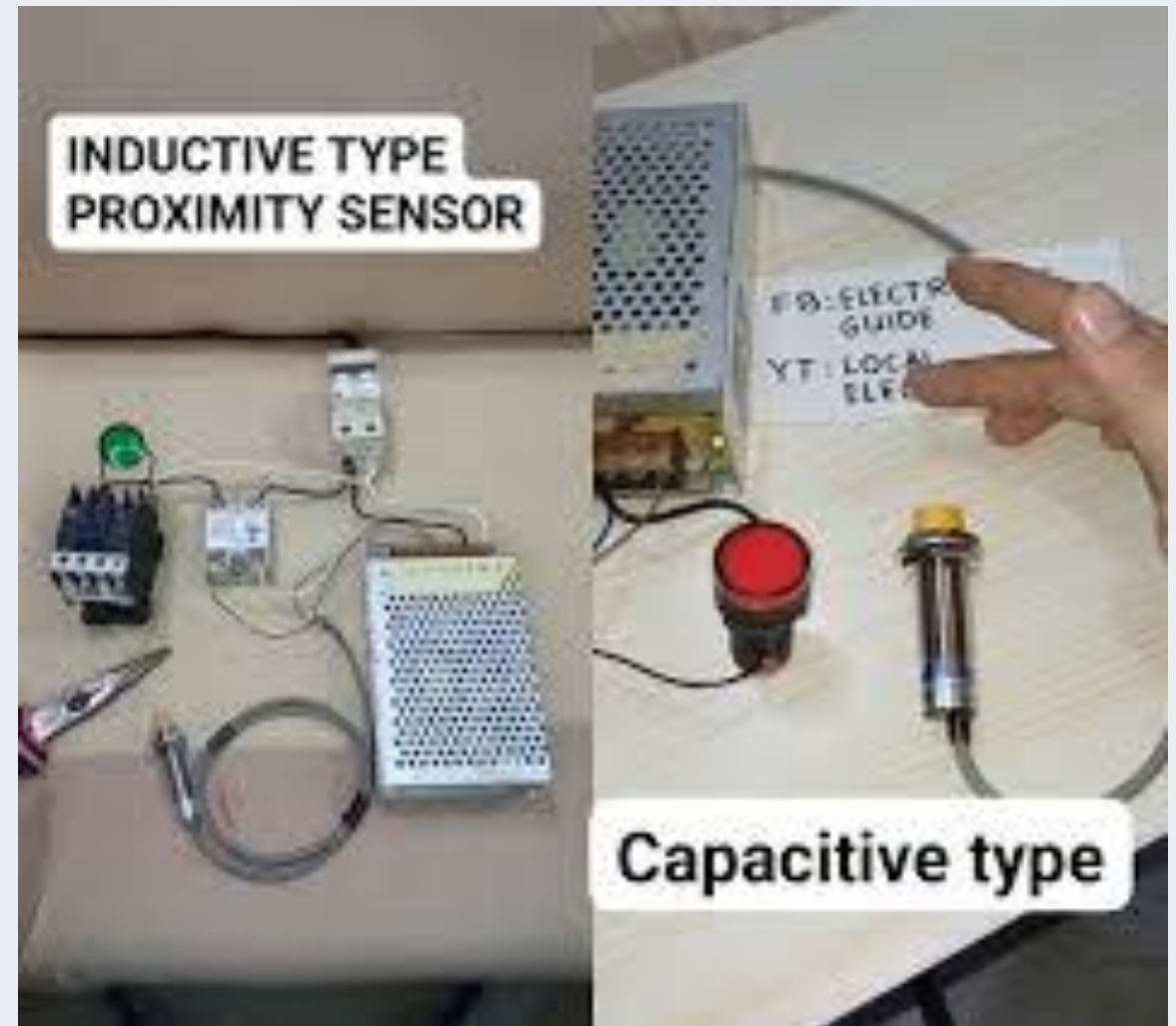
Laboratory Safety

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



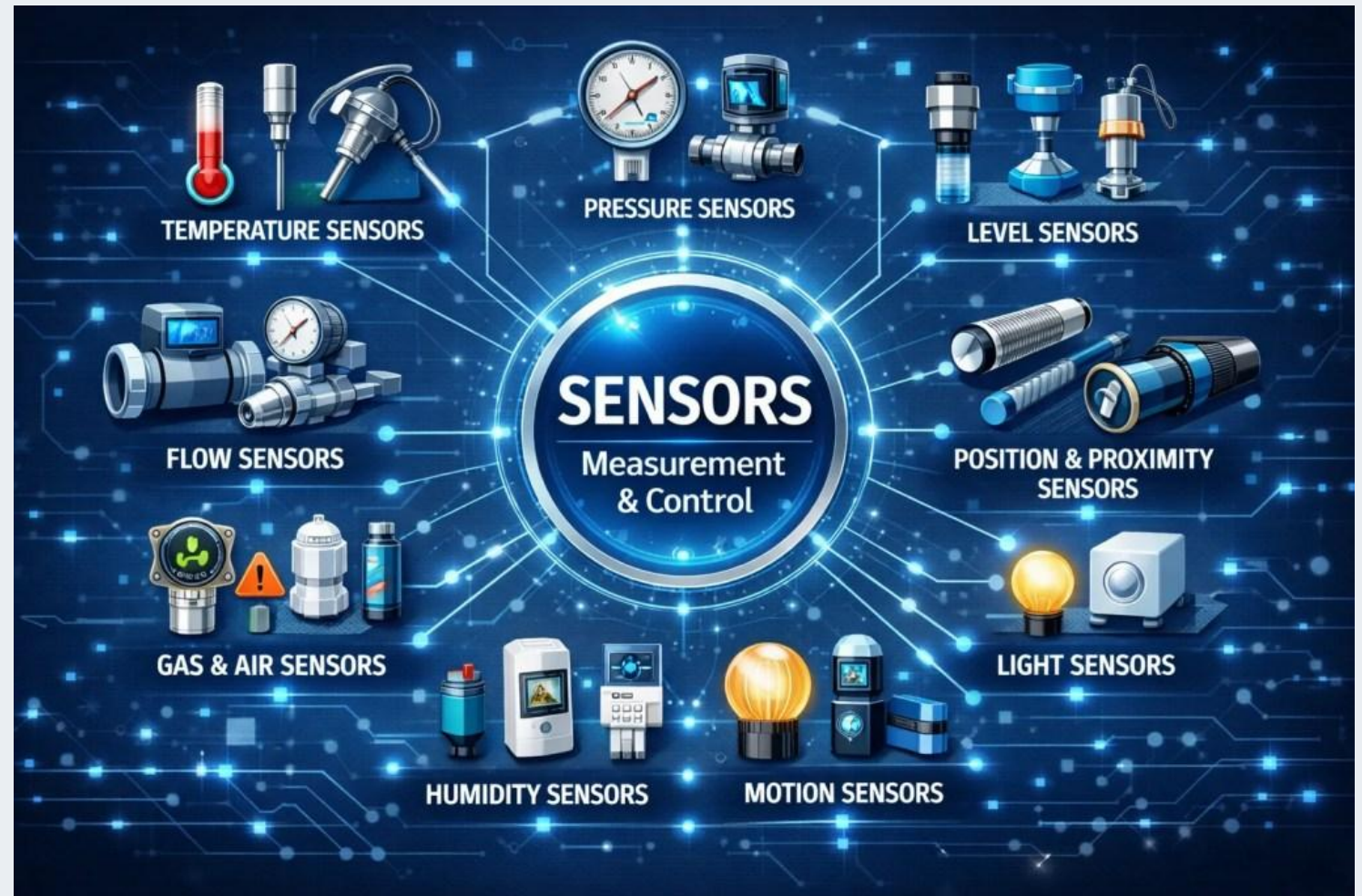
Instrumentation Tools

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



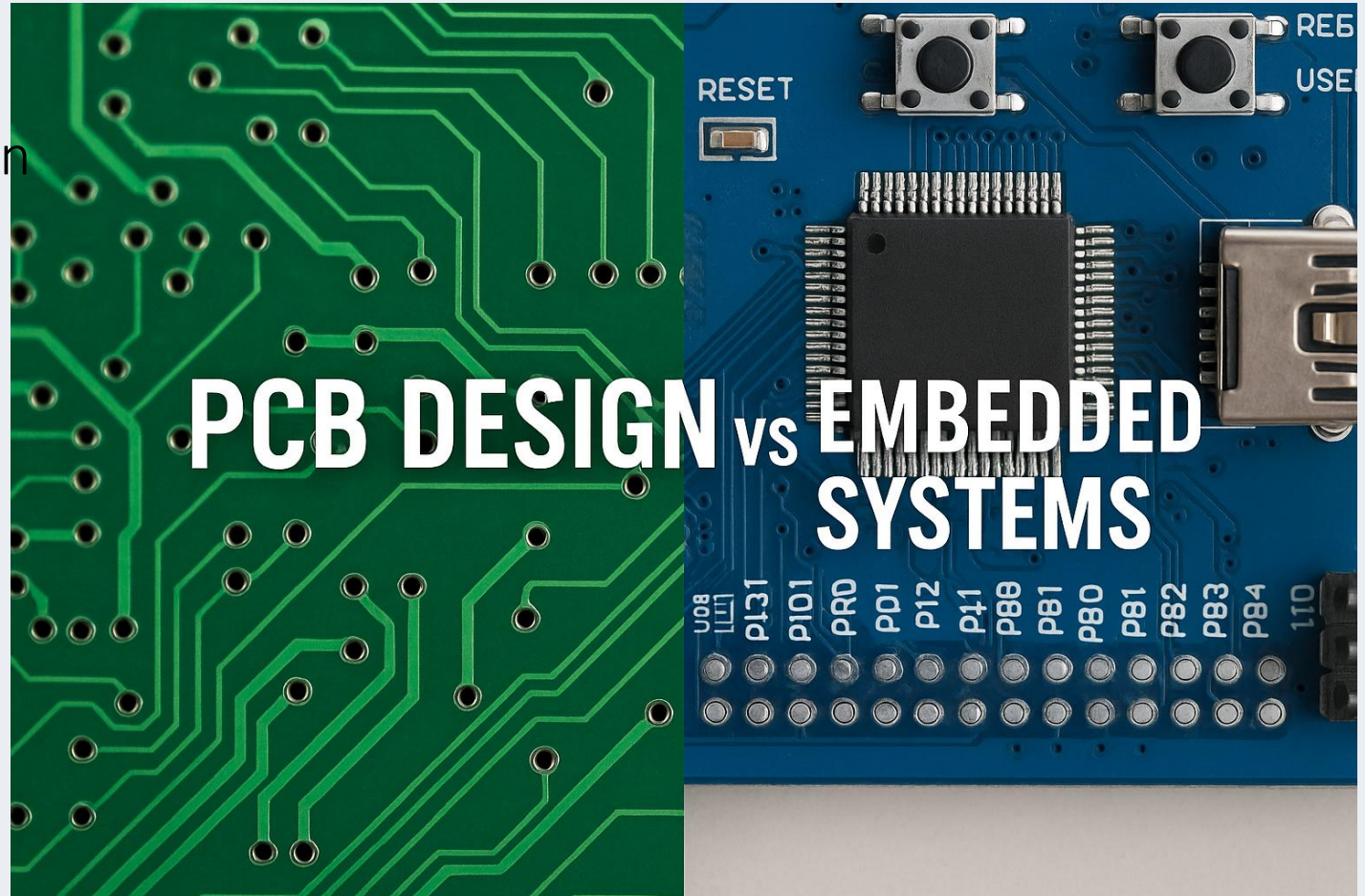
Sensor Selection

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



Prototype Development

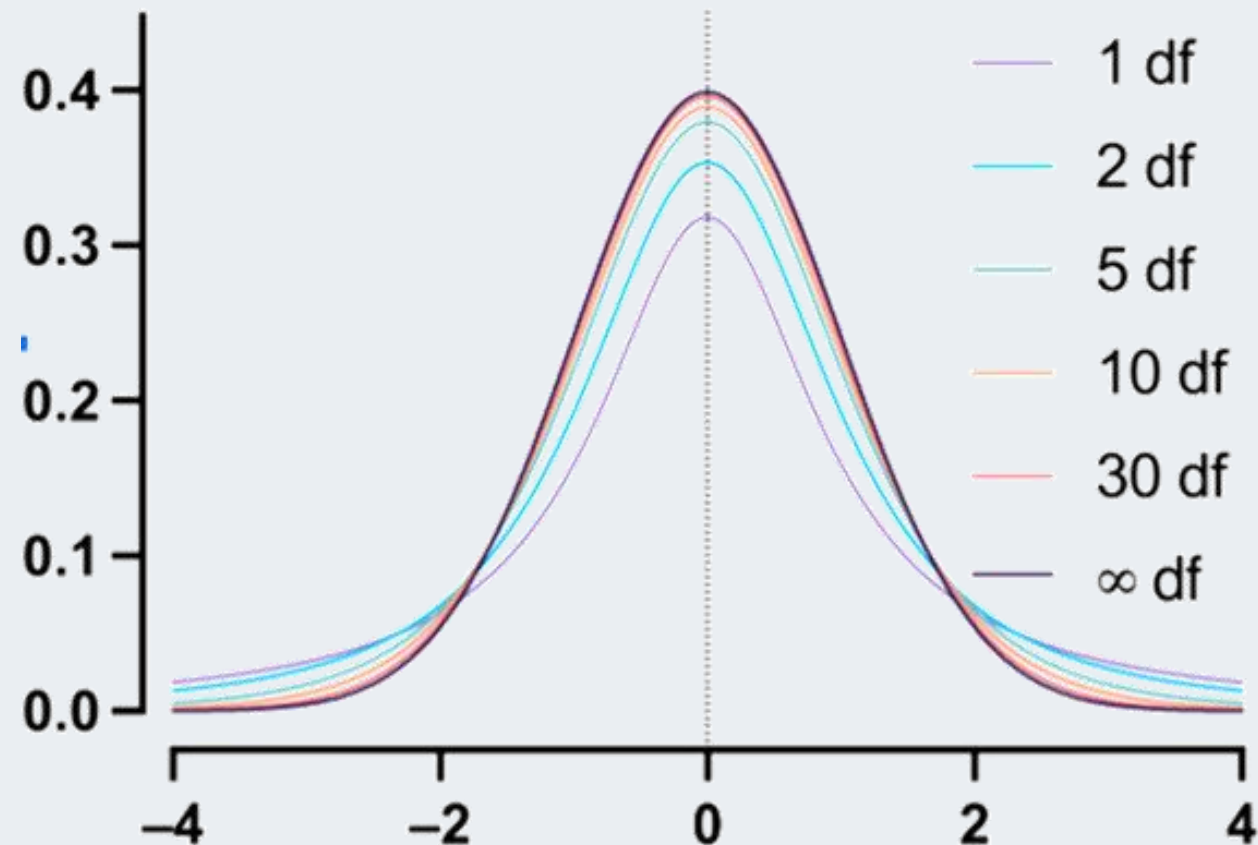
- Breadboard to prototype
- PCB development
- Embedded systems integration
- Reliability testing



Experimental Repeatability

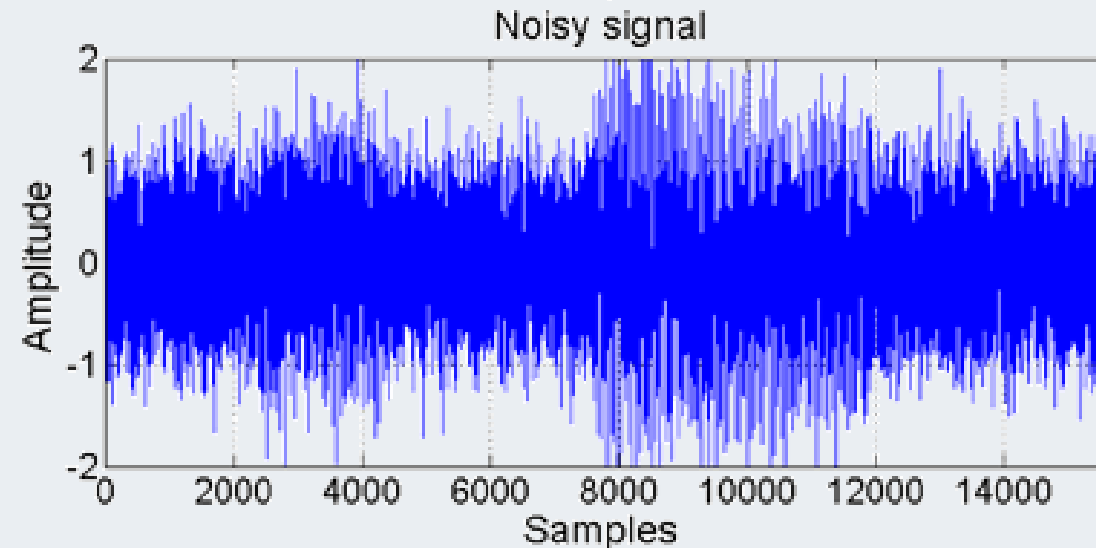
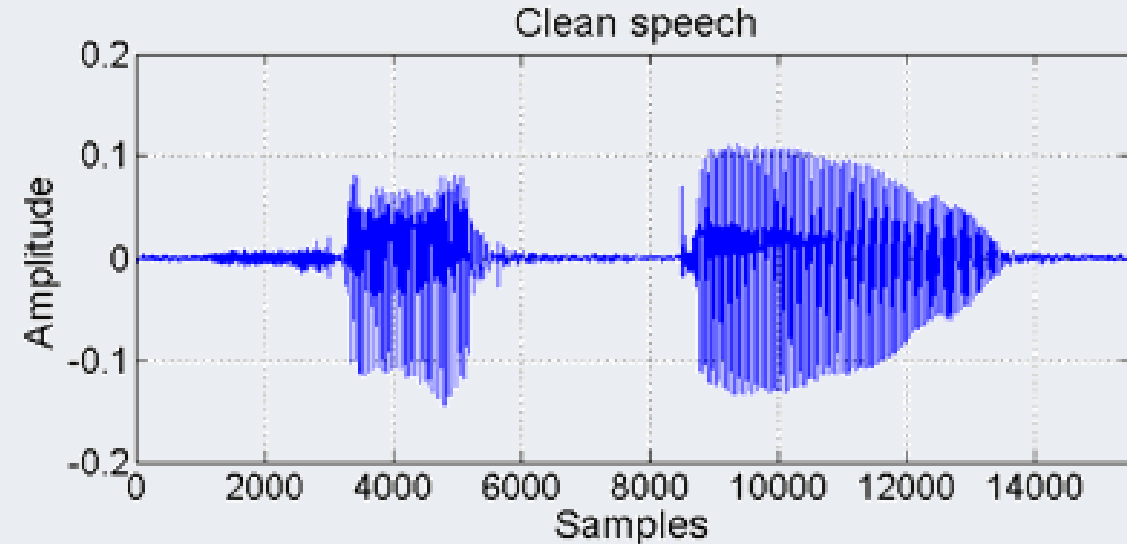
- Same conditions
- Same outputs
- Statistical confidence

t-distributions by degrees of freedom



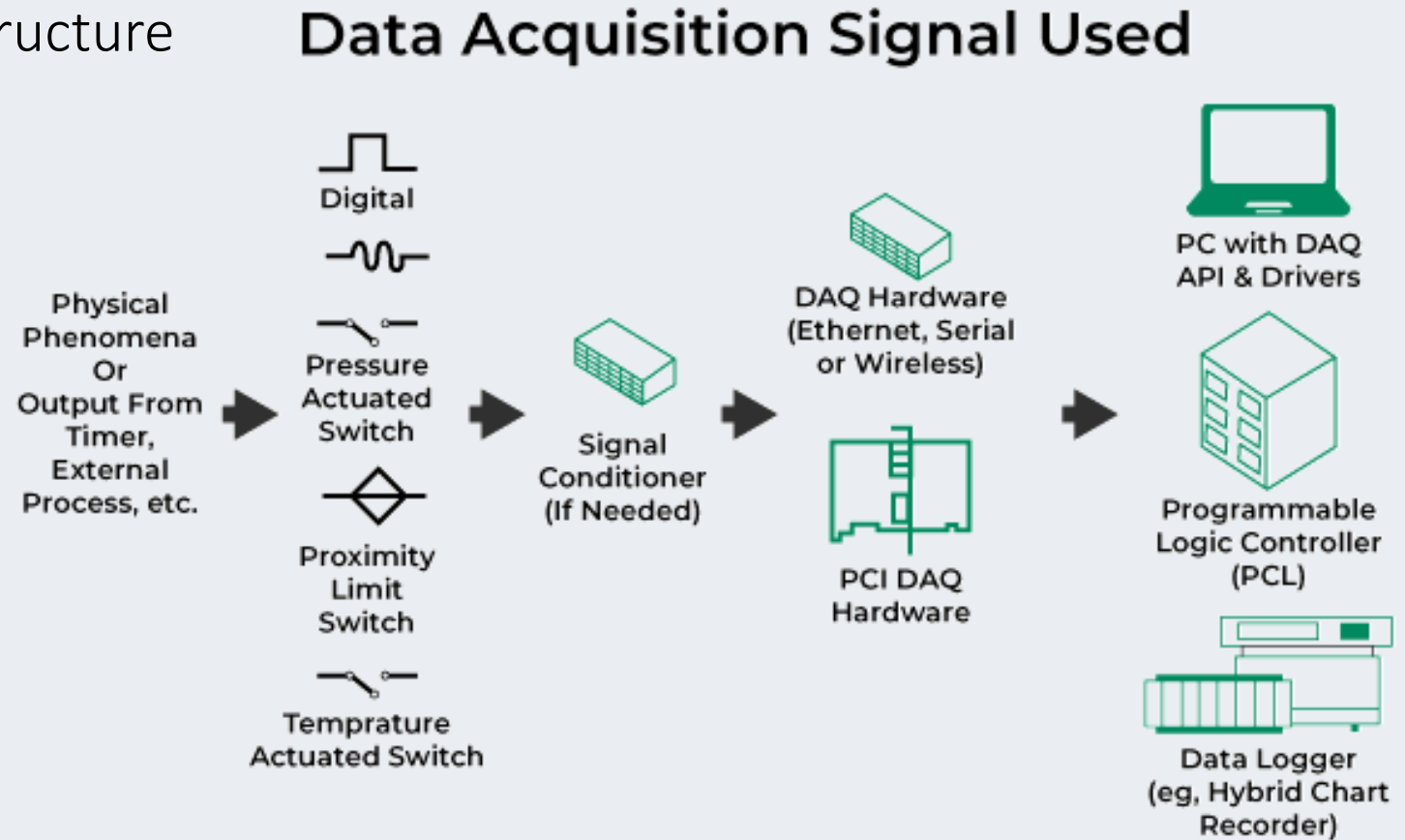
Common Experimental Problems

- 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?

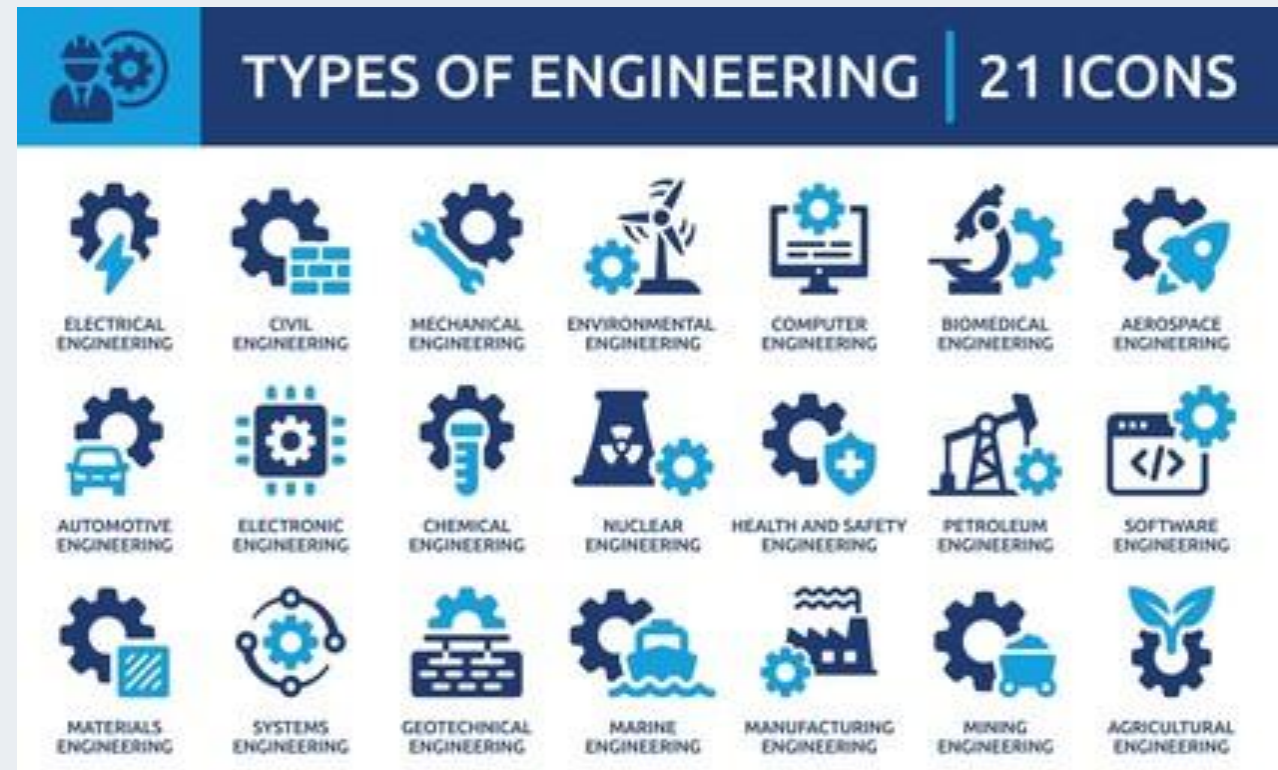
- Extracting meaning from data
- Detecting patterns
- Supporting conclusions
- Enabling prediction



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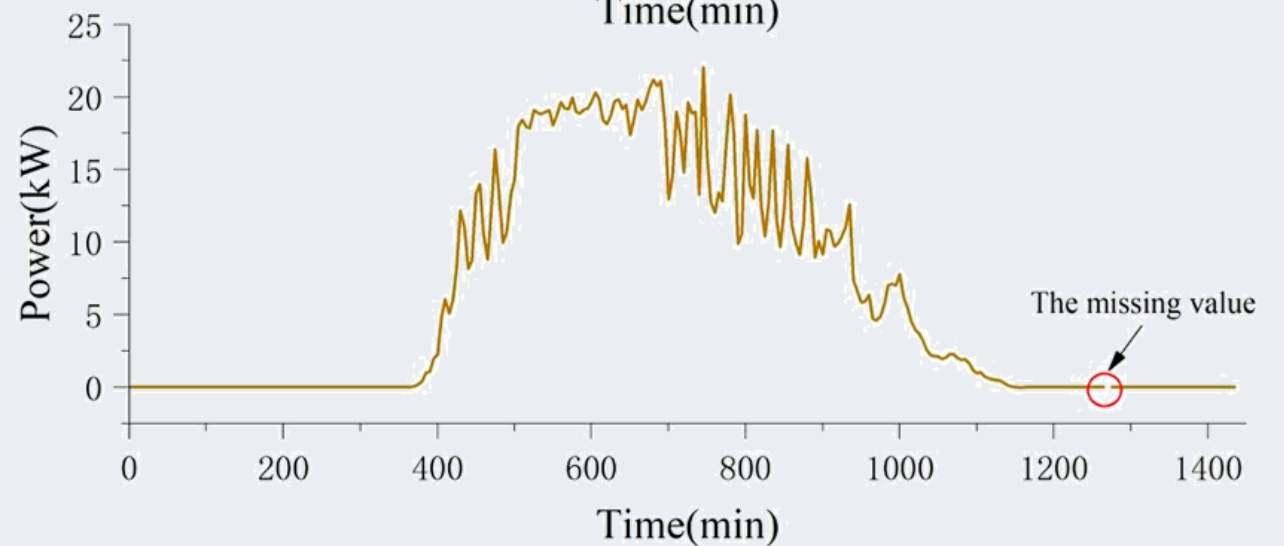
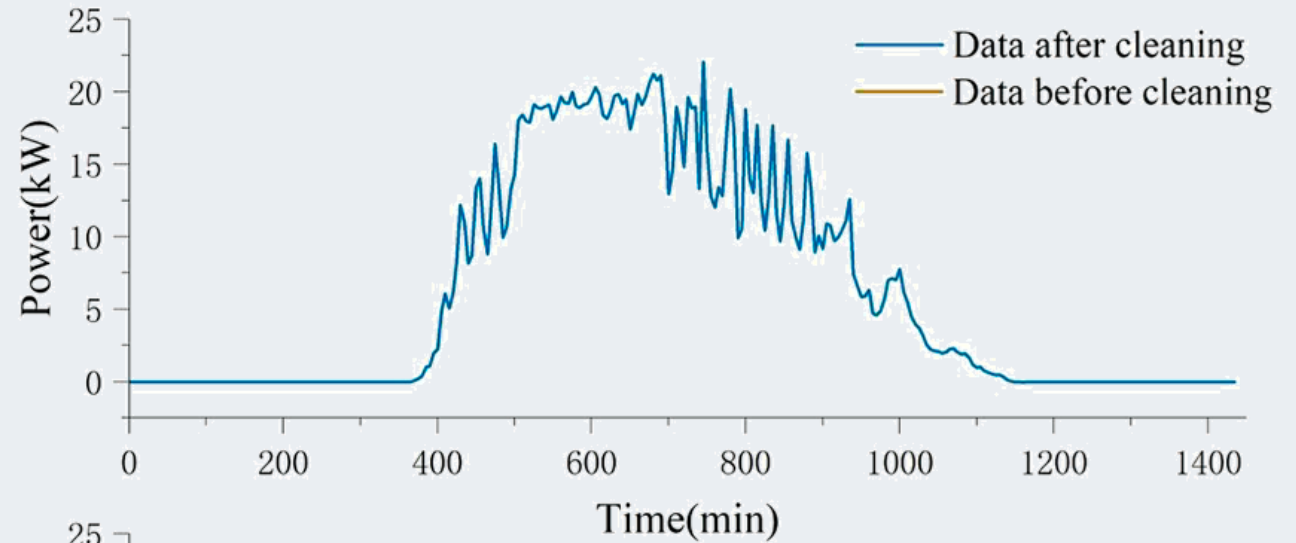
Types of Data

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



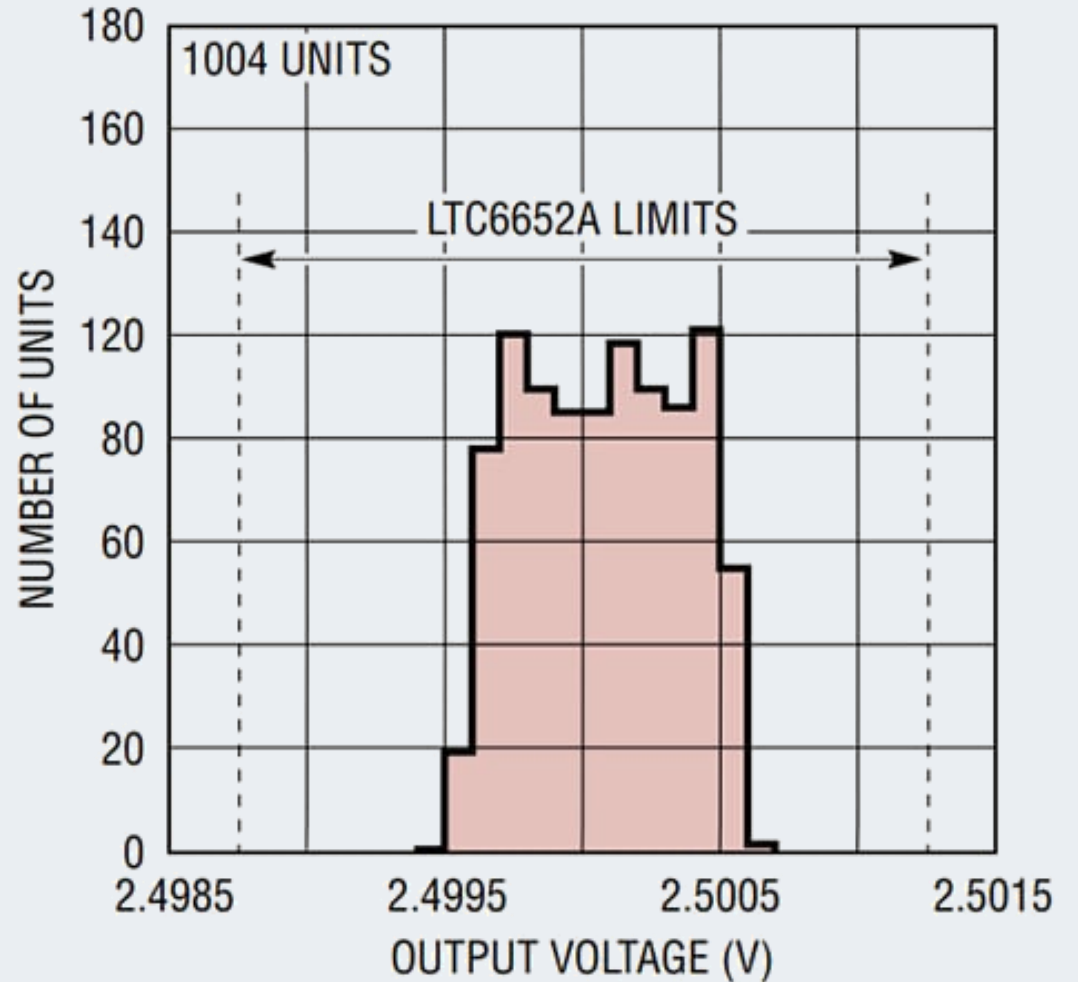
Data Cleaning

- Missing values
- Outlier detection
- Signal filtering
- Normalisation



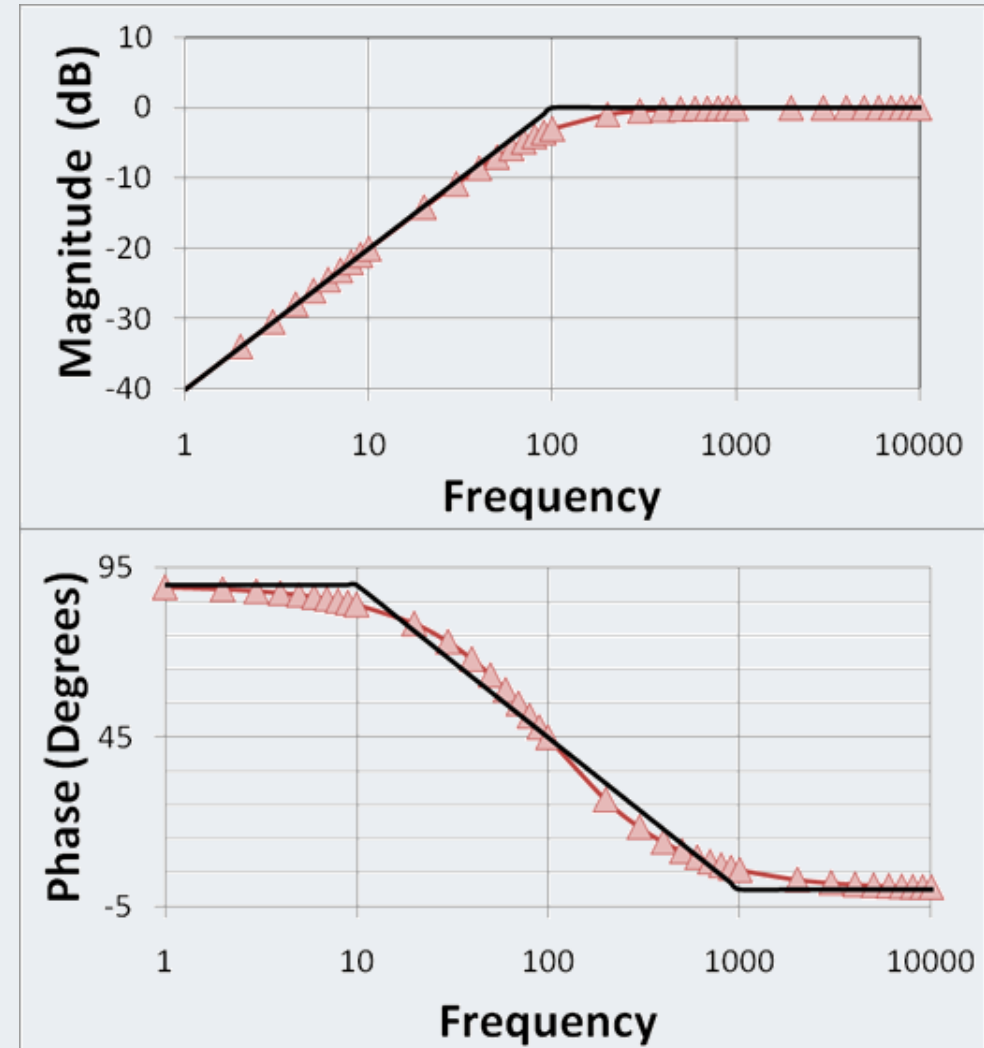
Statistical Foundations

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



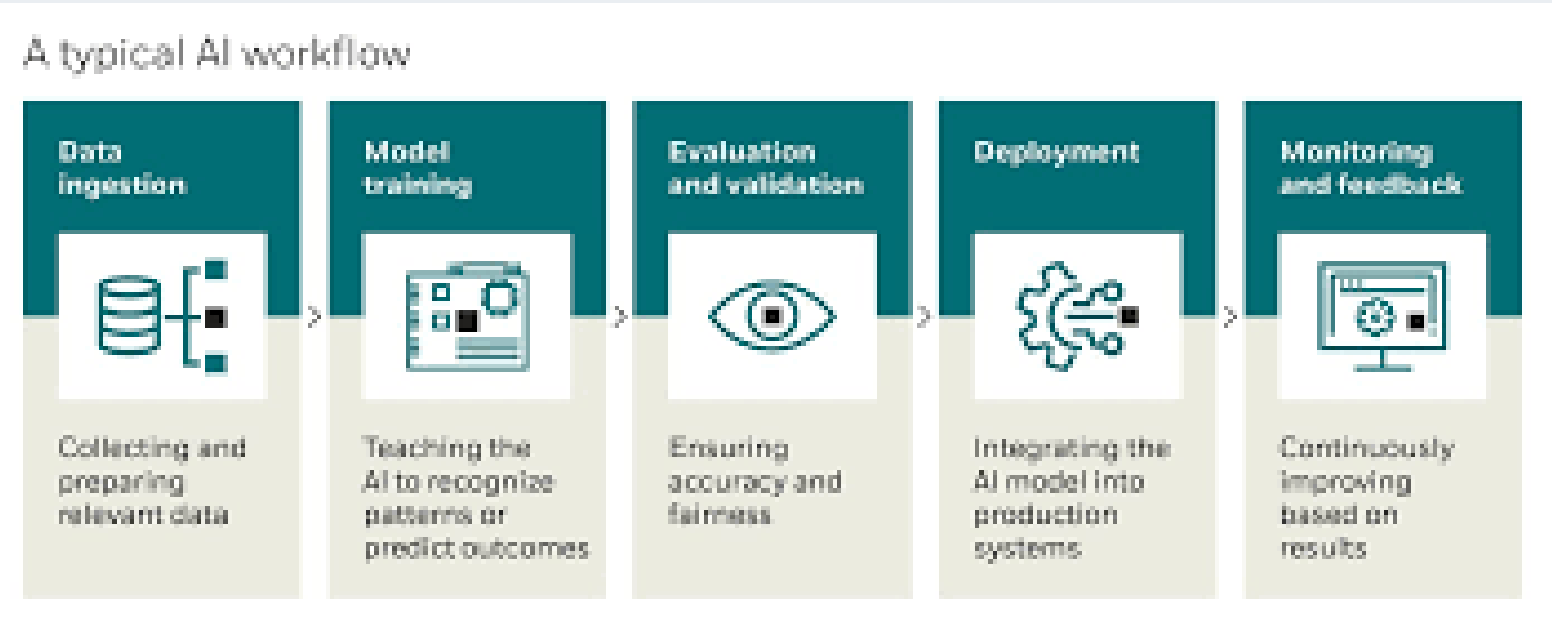
Visualisation Matters

- 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)

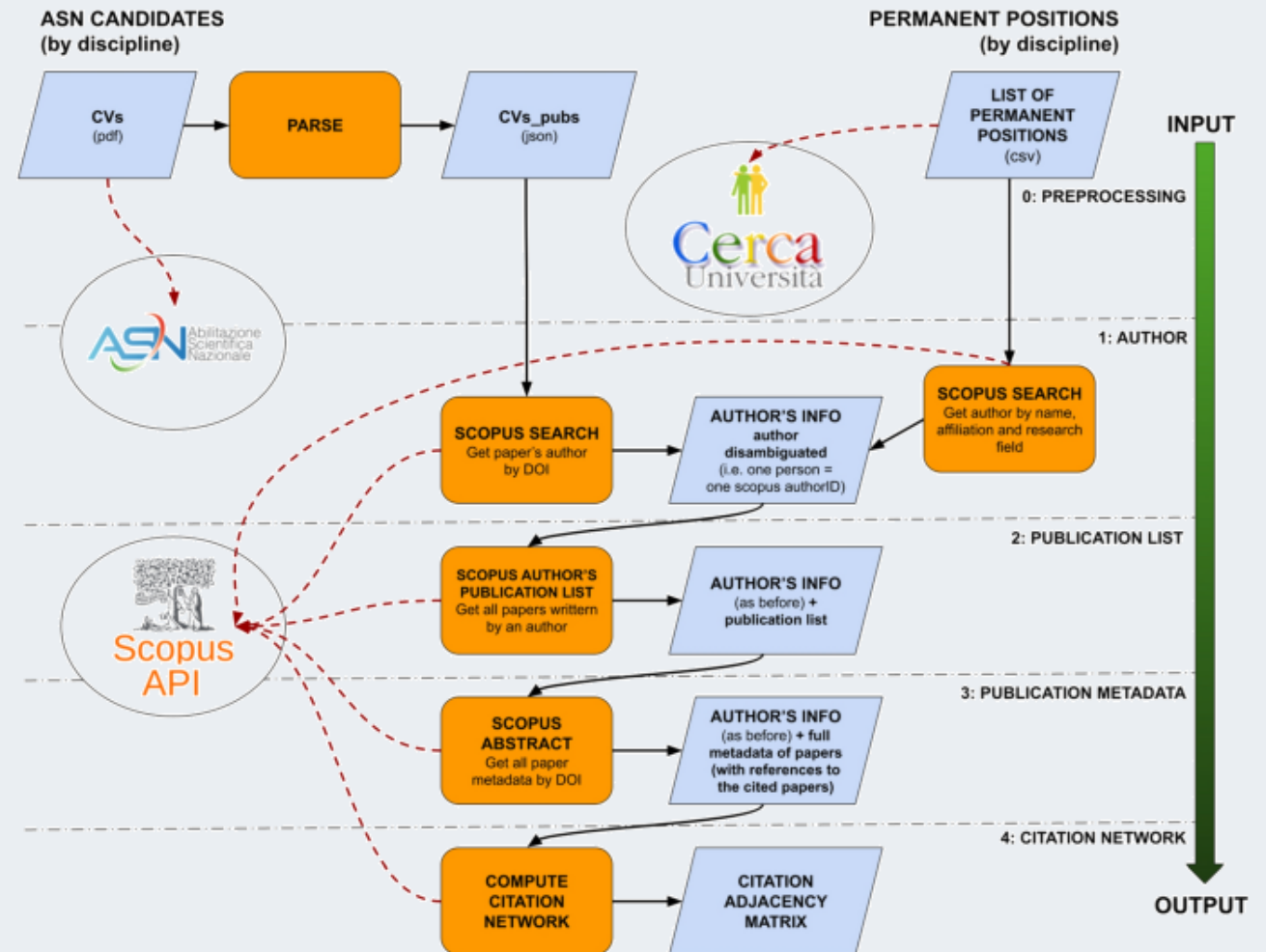
Research Integrity

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



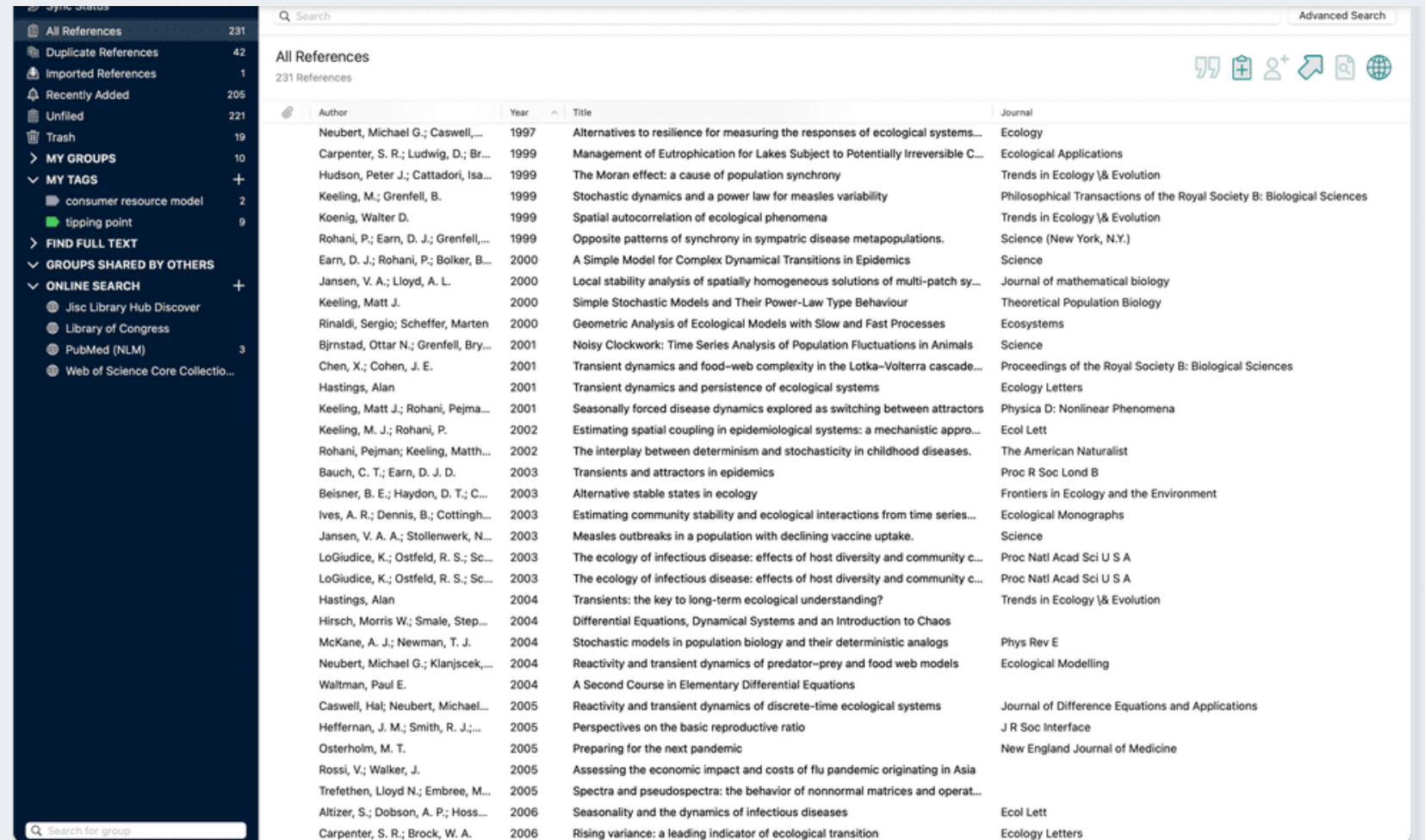
Literature Review as a Tool

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



Reference Management

- EndNote
- Zotero
- Mendeley
- Citation discipline

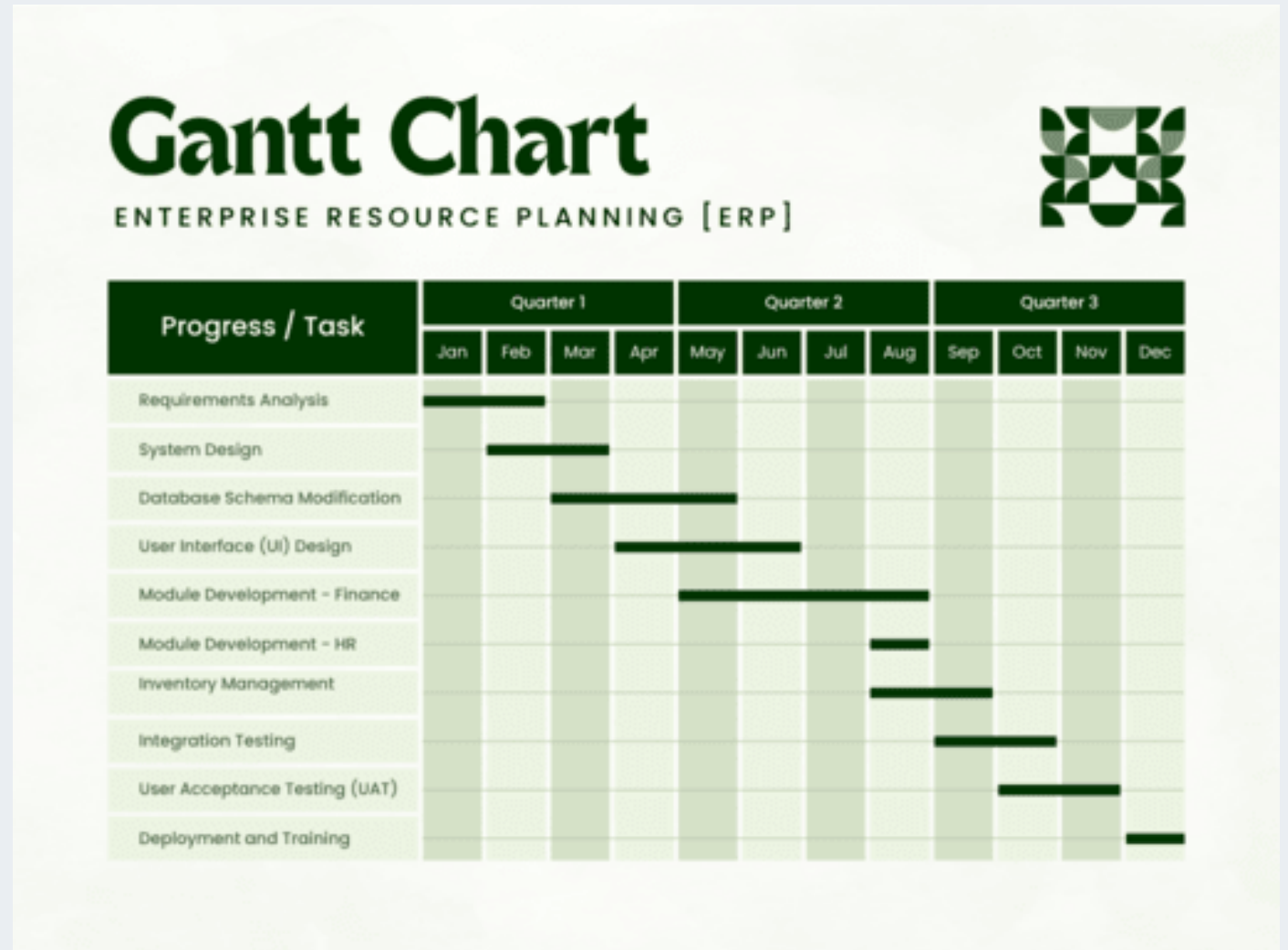


The screenshot displays a reference management application interface. On the left is a dark sidebar with navigation options: All References (231), Duplicate References (42), Imported References (1), Recently Added (205), Unfiled (221), Trash (19), MY GROUPS (10), MY TAGS (consumer resource model: 2, tipping point: 9), FIND FULL TEXT, GROUPS SHARED BY OTHERS, and ONLINE SEARCH (Jisc Library Hub Discover, Library of Congress, PubMed (NLM): 3, Web of Science Core Collectio...). The main area shows a search bar and a list of 231 references. The table below represents the visible data in the screenshot.

Author	Year	Title	Journal
Neubert, Michael G.; Caswell,...	1997	Alternatives to resilience for measuring the responses of ecological systems...	Ecology
Carpenter, S. R.; Ludwig, D.; Br...	1999	Management of Eutrophication for Lakes Subject to Potentially Irreversible C...	Ecological Applications
Hudson, Peter J.; Cattadori, Isa...	1999	The Moran effect: a cause of population synchrony	Trends in Ecology & Evolution
Keeling, M.; Grenfell, B.	1999	Stochastic dynamics and a power law for measles variability	Philosophical Transactions of the Royal Society B: Biological Sciences
Koenig, Walter D.	1999	Spatial autocorrelation of ecological phenomena	Trends in Ecology & Evolution
Rohani, P.; Earn, D. J.; Grenfell,...	1999	Opposite patterns of synchrony in sympatric disease metapopulations.	Science (New York, N.Y.)
Earn, D. J.; Rohani, P.; Bolker, B...	2000	A Simple Model for Complex Dynamical Transitions in Epidemics	Science
Jansen, V. A.; Lloyd, A. L.	2000	Local stability analysis of spatially homogeneous solutions of multi-patch sy...	Journal of mathematical biology
Keeling, Matt J.	2000	Simple Stochastic Models and Their Power-Law Type Behaviour	Theoretical Population Biology
Rinaldi, Sergio; Scheffer, Marten	2000	Geometric Analysis of Ecological Models with Slow and Fast Processes	Ecosystems
Bjrnstad, Ottar N.; Grenfell, Bry...	2001	Noisy Clockwork: Time Series Analysis of Population Fluctuations in Animals	Science
Chen, X.; Cohen, J. E.	2001	Transient dynamics and food-web complexity in the Lotka-Volterra cascade...	Proceedings of the Royal Society B: Biological Sciences
Hastings, Alan	2001	Transient dynamics and persistence of ecological systems	Ecology Letters
Keeling, Matt J.; Rohani, Pejma...	2001	Seasonally forced disease dynamics explored as switching between attractors	Physica D: Nonlinear Phenomena
Keeling, M. J.; Rohani, P.	2002	Estimating spatial coupling in epidemiological systems: a mechanistic appro...	Ecol Lett
Rohani, Pejman; Keeling, Matth...	2002	The interplay between determinism and stochasticity in childhood diseases.	The American Naturalist
Bauch, C. T.; Earn, D. J. D.	2003	Transients and attractors in epidemics	Proc R Soc Lond B
Beisner, B. E.; Haydon, D. T.; C...	2003	Alternative stable states in ecology	Frontiers in Ecology and the Environment
Ives, A. R.; Dennis, B.; Cottingh...	2003	Estimating community stability and ecological interactions from time series...	Ecological Monographs
Jansen, V. A. A.; Stollenwerk, N...	2003	Measles outbreaks in a population with declining vaccine uptake.	Science
LoGiudice, K.; Ostfeld, R. S.; Sc...	2003	The ecology of infectious disease: effects of host diversity and community c...	Proc Natl Acad Sci U S A
LoGiudice, K.; Ostfeld, R. S.; Sc...	2003	The ecology of infectious disease: effects of host diversity and community c...	Proc Natl Acad Sci U S A
Hastings, Alan	2004	Transients: the key to long-term ecological understanding?	Trends in Ecology & Evolution
Hirsch, Morris W.; Smale, Step...	2004	Differential Equations, Dynamical Systems and an Introduction to Chaos	
McKane, A. J.; Newman, T. J.	2004	Stochastic models in population biology and their deterministic analogs	Phys Rev E
Neubert, Michael G.; Klanjscek,...	2004	Reactivity and transient dynamics of predator-prey and food web models	Ecological Modelling
Waltman, Paul E.	2004	A Second Course in Elementary Differential Equations	
Caswell, Hal; Neubert, Michael...	2005	Reactivity and transient dynamics of discrete-time ecological systems	Journal of Difference Equations and Applications
Heffernan, J. M.; Smith, R. J.;...	2005	Perspectives on the basic reproductive ratio	J R Soc Interface
Osterholm, M. T.	2005	Preparing for the next pandemic	New England Journal of Medicine
Rossi, V.; Walker, J.	2005	Assessing the economic impact and costs of flu pandemic originating in Asia	
Trefethen, Lloyd N.; Embree, M...	2005	Spectra and pseudospectra: the behavior of nonnormal matrices and operat...	
Altizer, S.; Dobson, A. P.; Hoss...	2006	Seasonality and the dynamics of infectious diseases	Ecol Lett
Carpenter, S. R.; Brock, W. A.	2006	Rising variance: a leading indicator of ecological transition	Ecology Letters

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



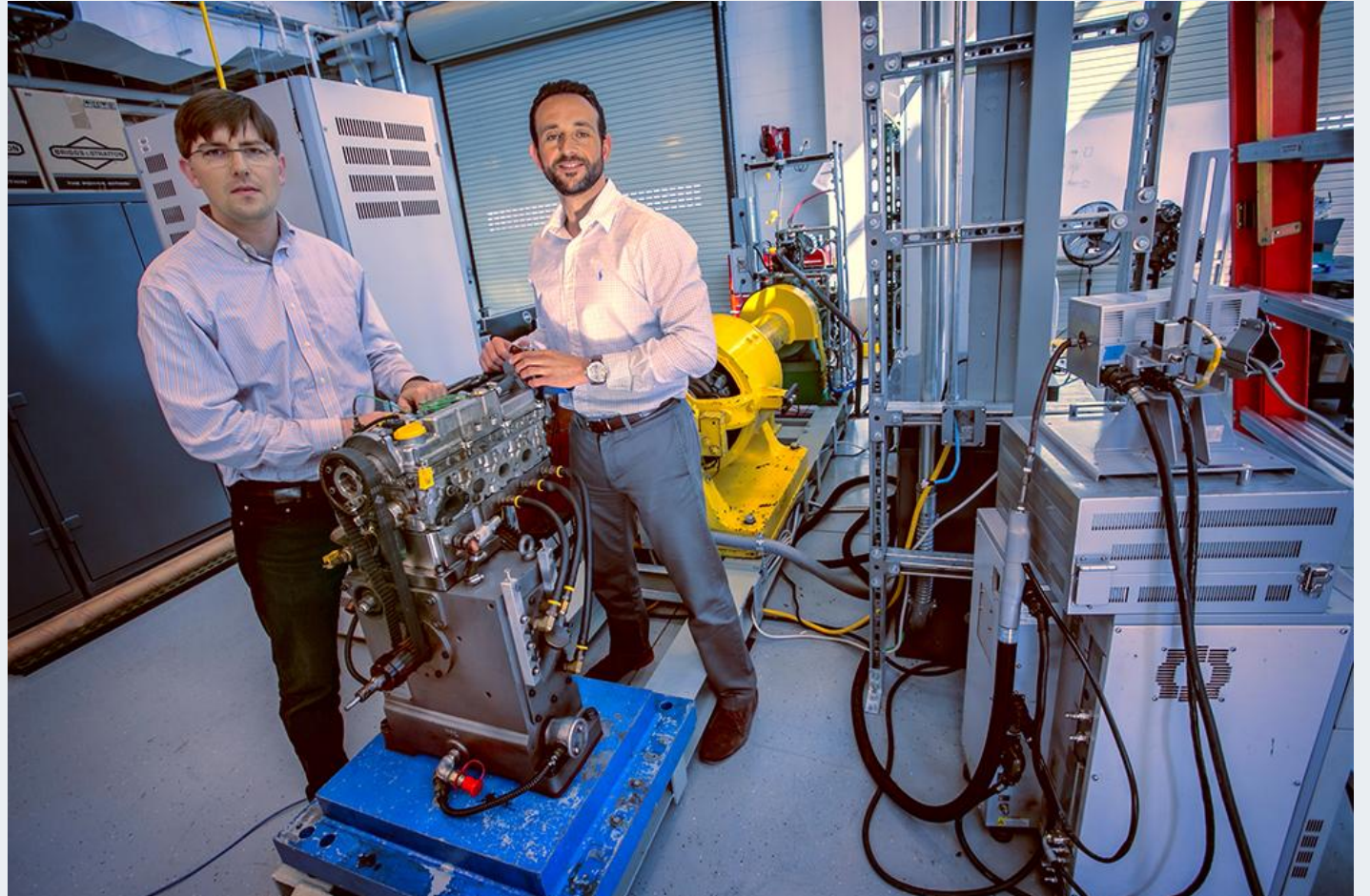
Conference Participation

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



Funding and Grants

- Scholarships
- Industry funding
- Government grants
- International collaboration



Industry Collaboration

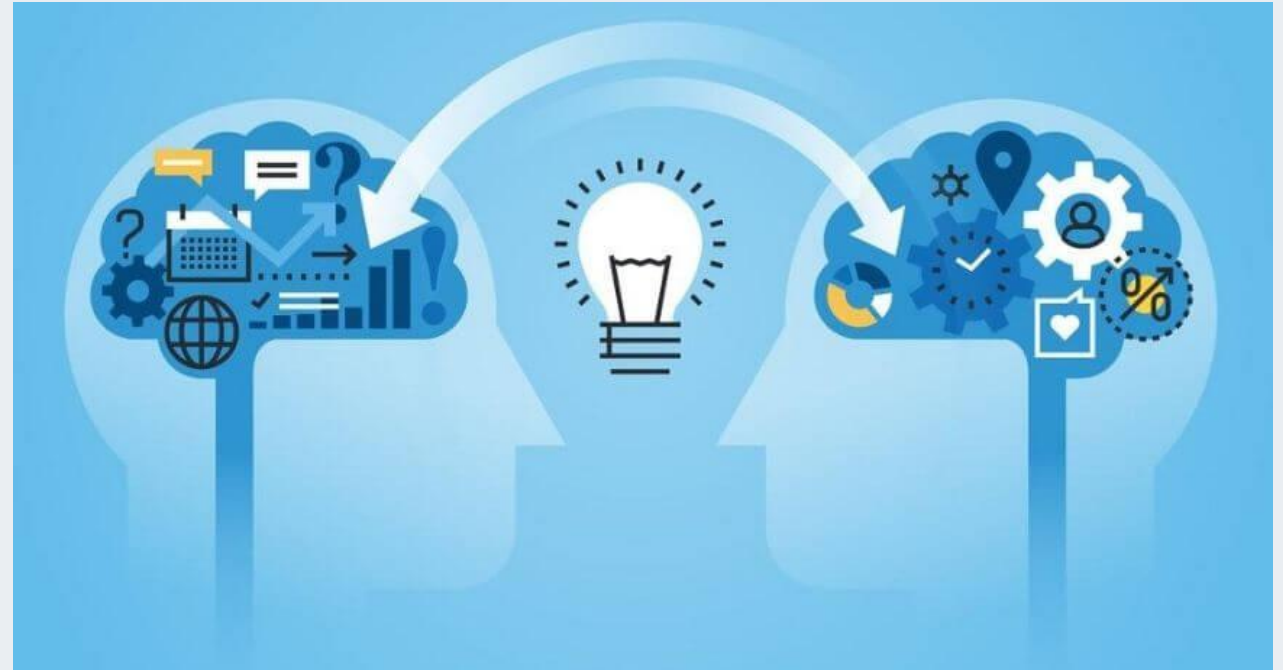
- Real-world problems
- Access to equipment
- Employment pathways
- Applied impact

INDUSTRY-ACADEMIA COLLABORATION: BRIDGING THE SKILLS GAP IN ENGINEERING



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



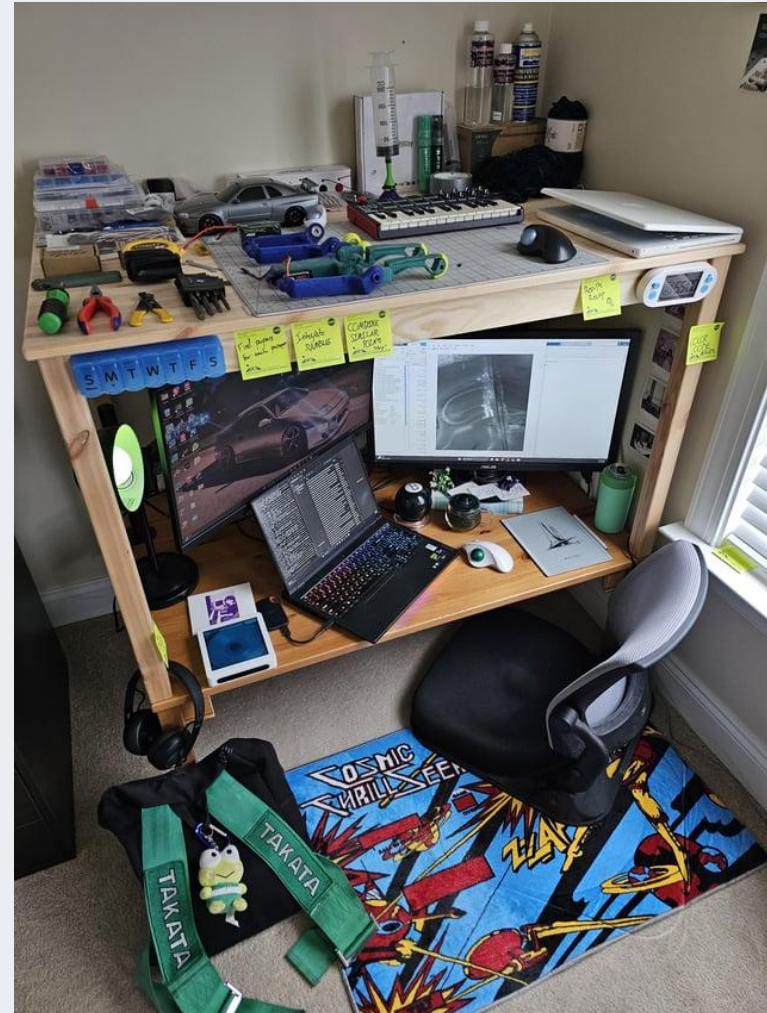
Time Management

- 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

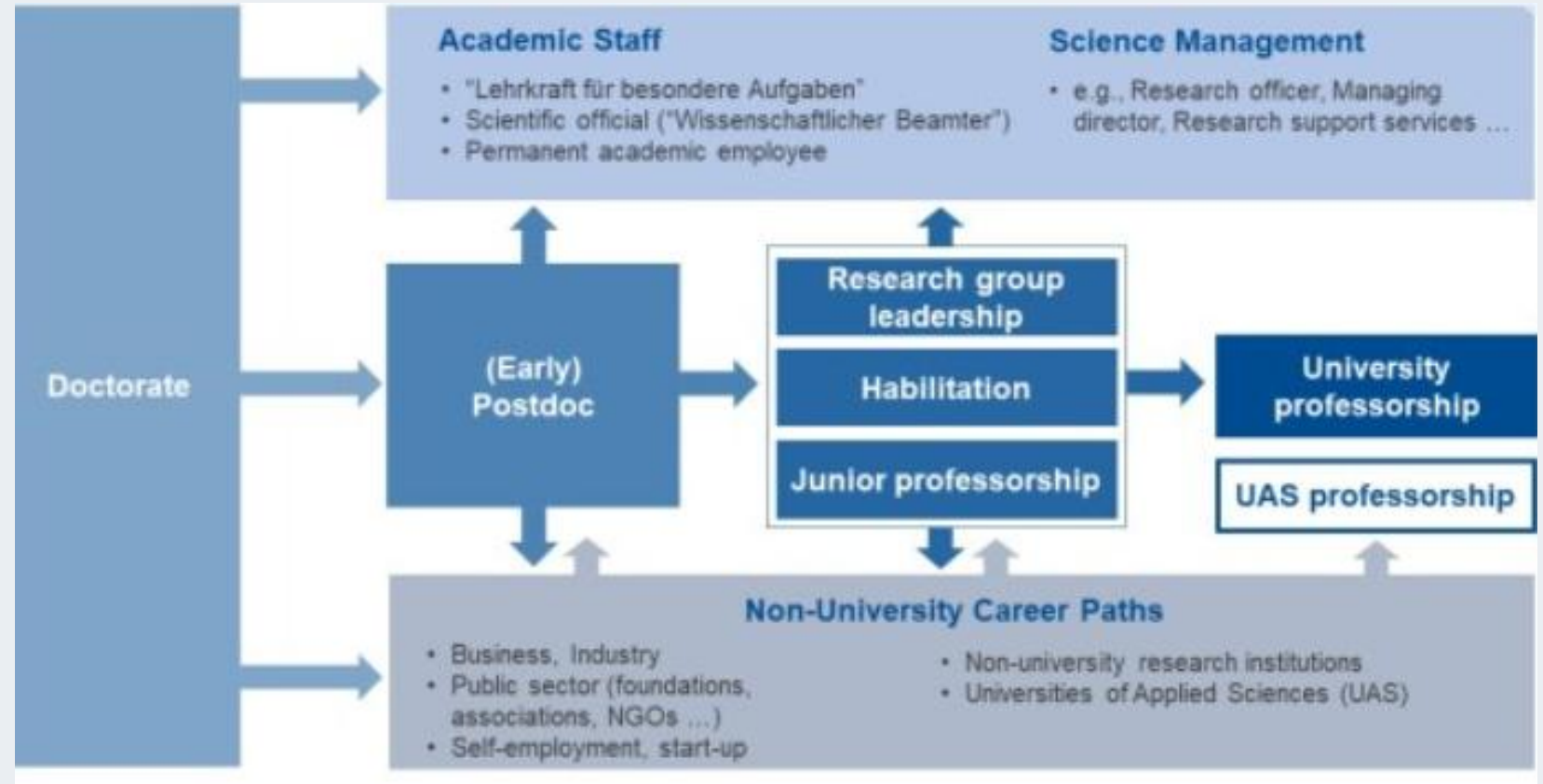
Engineering Thesis

Here is where your
presentation begins



Career Pathways After PhD

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



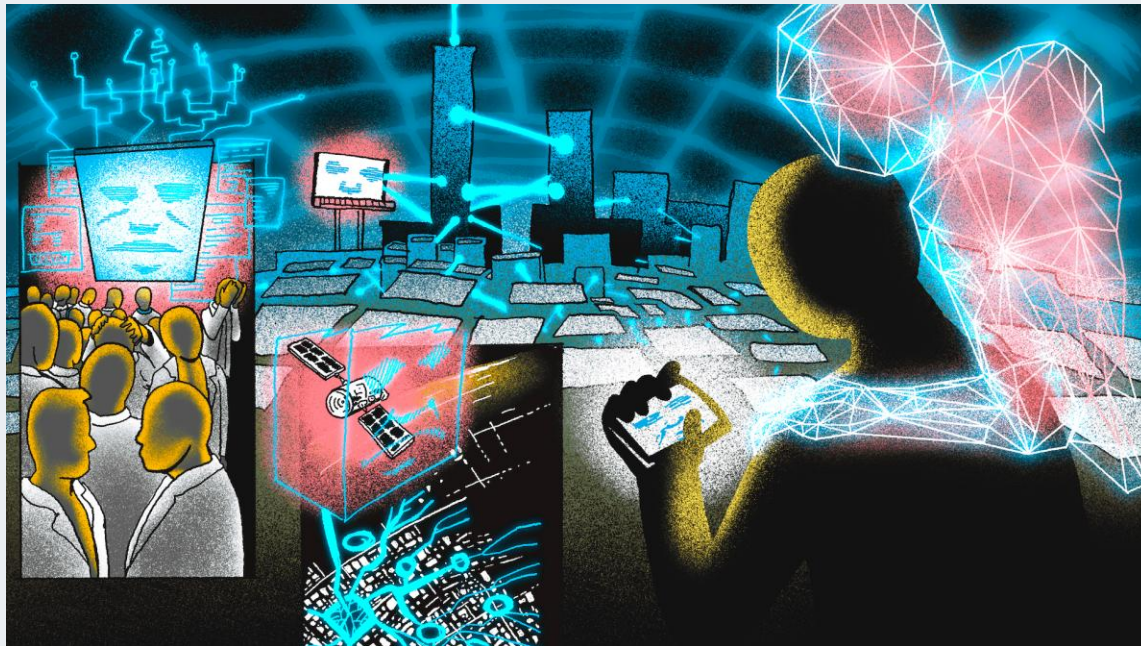
Key Success Formula

- 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

Find MORE courses here: <https://www.eit.edu.au/schedule/>

Upcoming Doctoral Webinars

All upcoming Doctoral Webinars:

www.eit.edu.au/news-events/events/

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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