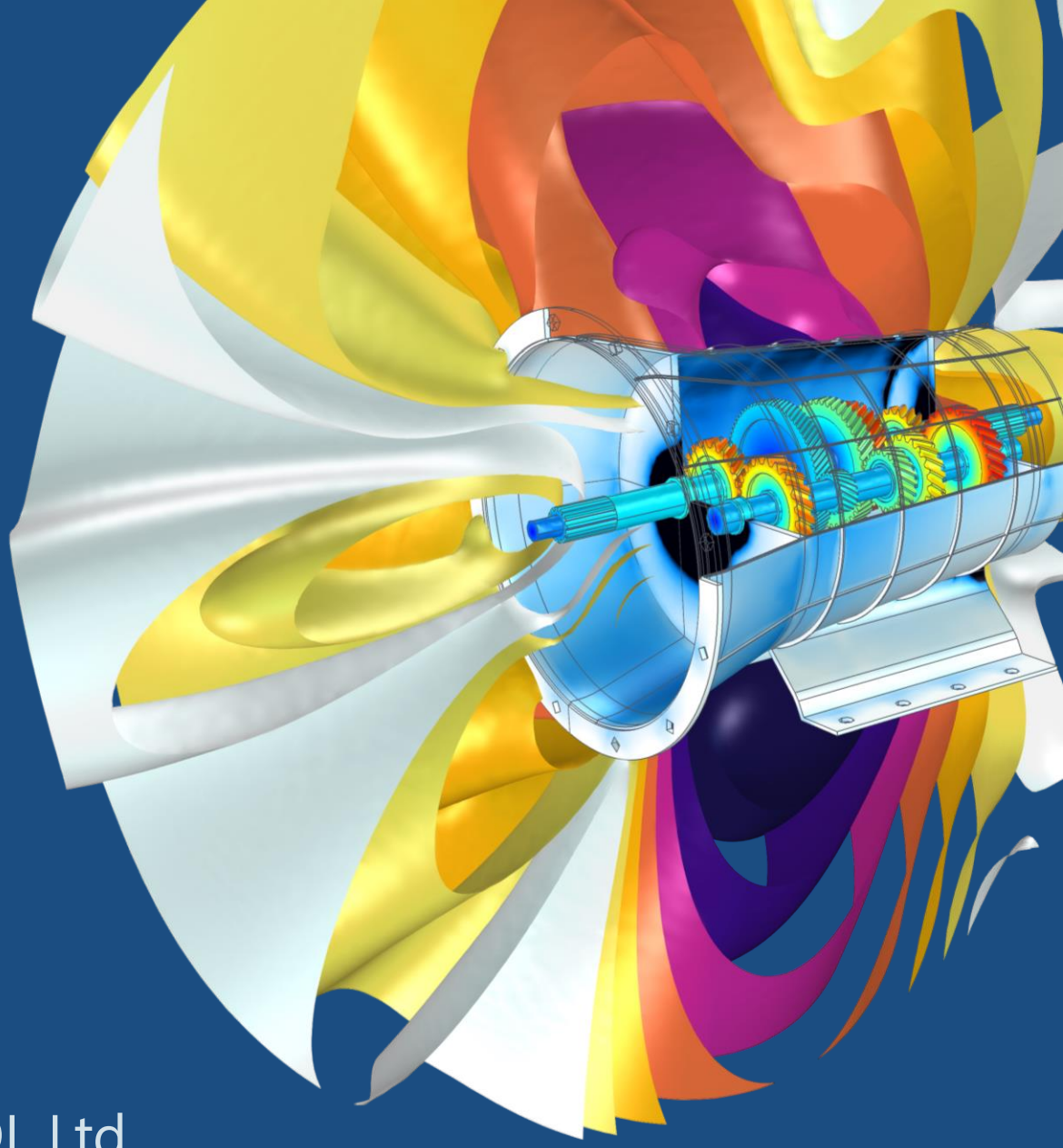


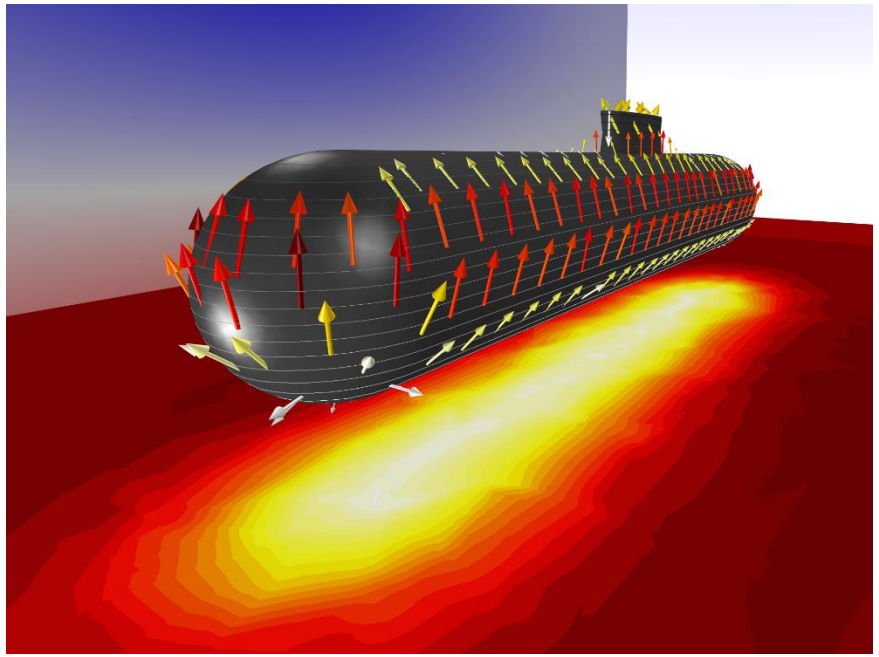
Careers in Simulation

2nd September 2019

Robbie Balcombe, Technical Director, COMSOL Ltd

Agenda

- Introduction to COMSOL®
- An overview of computational modelling
  - The history of computational modelling
  - Simulation case study
  - The future of computational modelling
- Why consider a career in computational modelling
- What we look for when recruiting
- Some important points to remember when applying



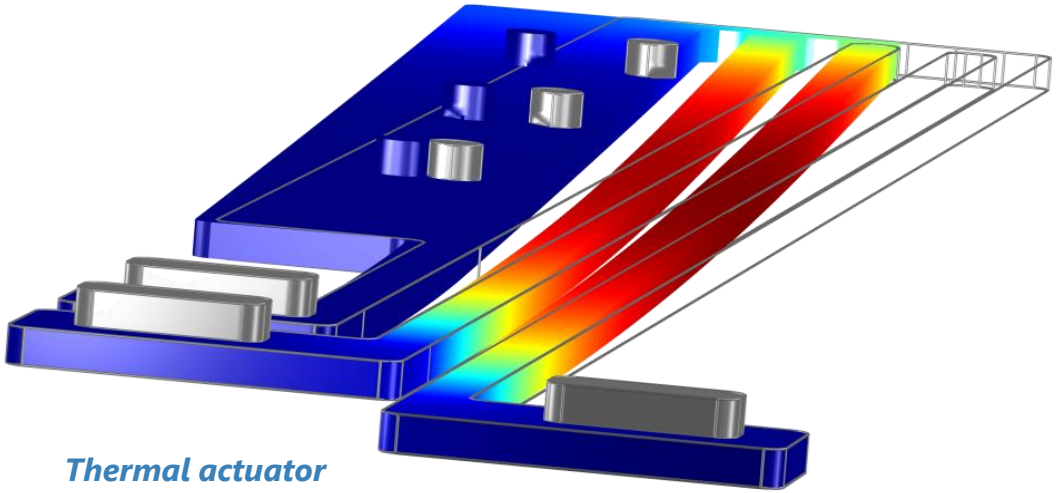
Magnetic signature of a submarine

COMSOL

- Modeling and Simulation
  - Ready made physics interfaces
  - General mathematics interfaces
  - Built-in CAD tools
  - Add-on modules with specialized physics interfaces
  - LiveLink™ products to connect with partner software
    - Most major CAD tools
    - MATLAB®
    - Excel®
- Development tools
  - Model Builder
  - Physics Builder
  - Application Builder
- Deploying Applications
  - COMSOL Multiphysics®
    - COMSOL Compiler™
  - COMSOL Server™
    - Browser and Windows® clients

Why Simulations are Used in R&D

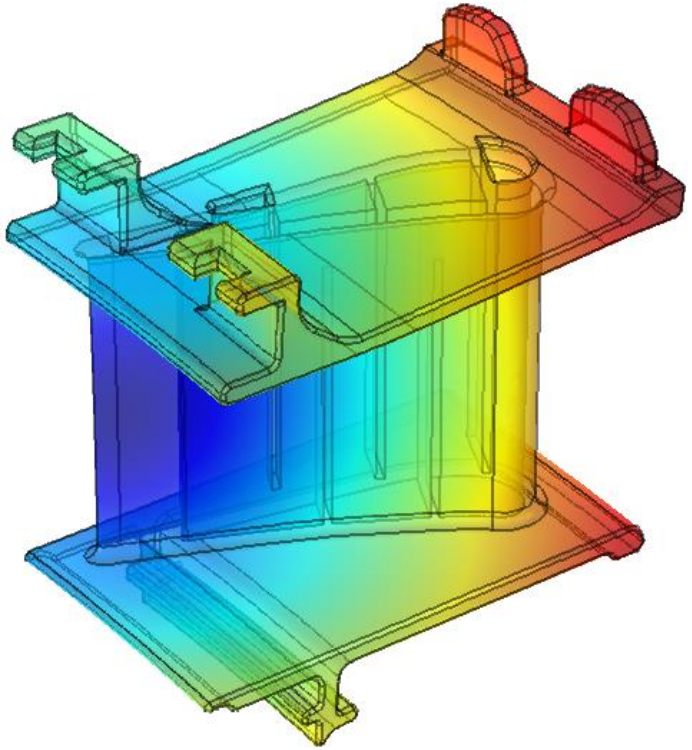
- Simulations can account for phenomena on a variety of length-scales
- Evaluate performance of designs
  - Reduced experimental costs
  - Non-invasive testing
  - Graphically represent ‘invisible’ phenomenon
- Analyse interactions between different physical phenomena
- Investigate a wide range of operating conditions
- Optimise product design
- With increasing environmental concerns companies want to minimize waste



Thermal actuator

Simulation and an Optimisation Work-flow

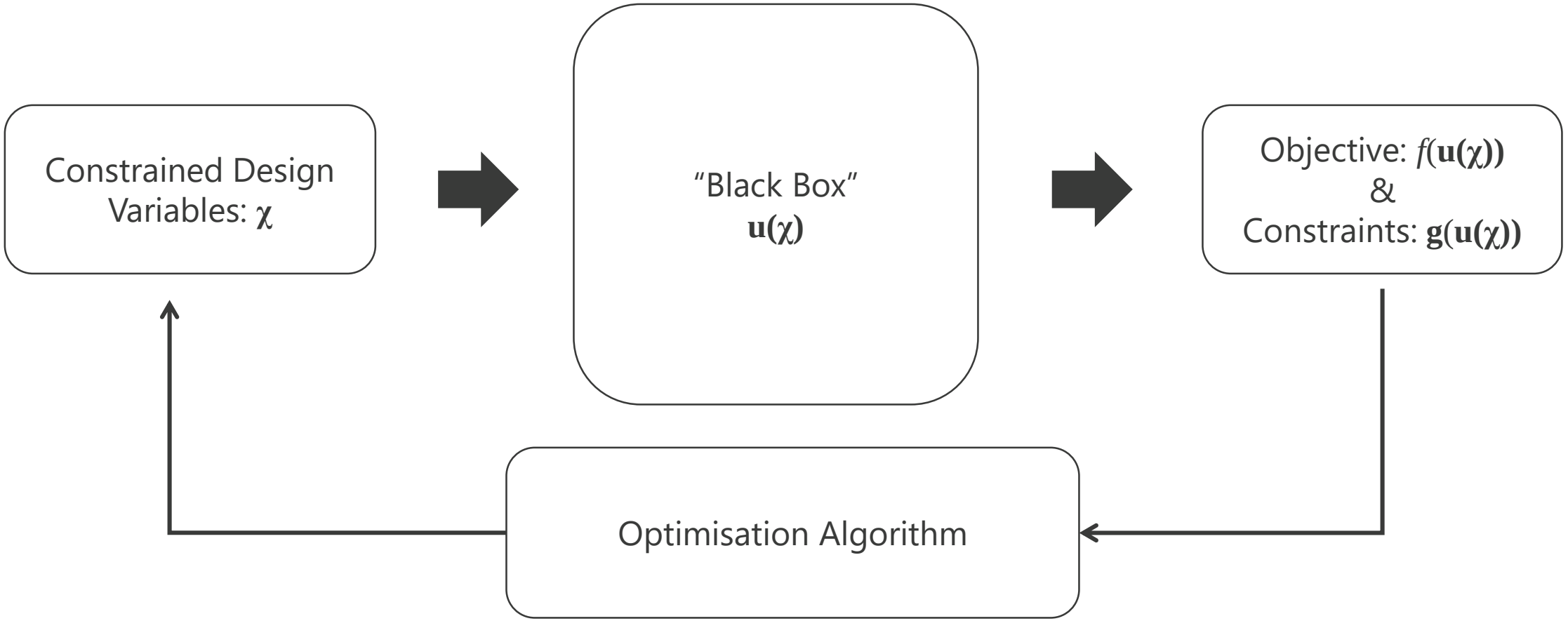
- Dimensions
- Material Properties
- Operating Conditions
- etc…



$$K(\chi)u=b(\chi)$$

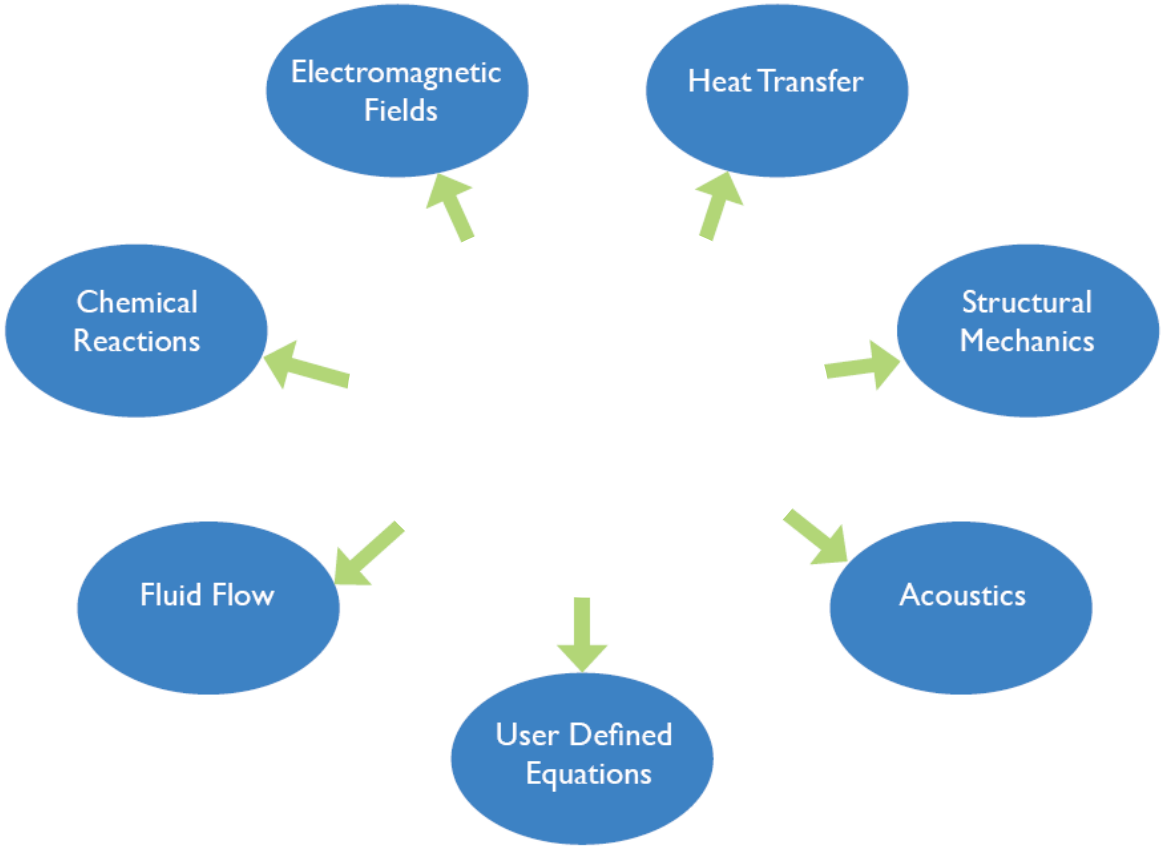
- Performance
- Failure criteria
- etc…

Simulation and an Optimisation Work-flow



Early Days of Computational Modelling – Single Physics

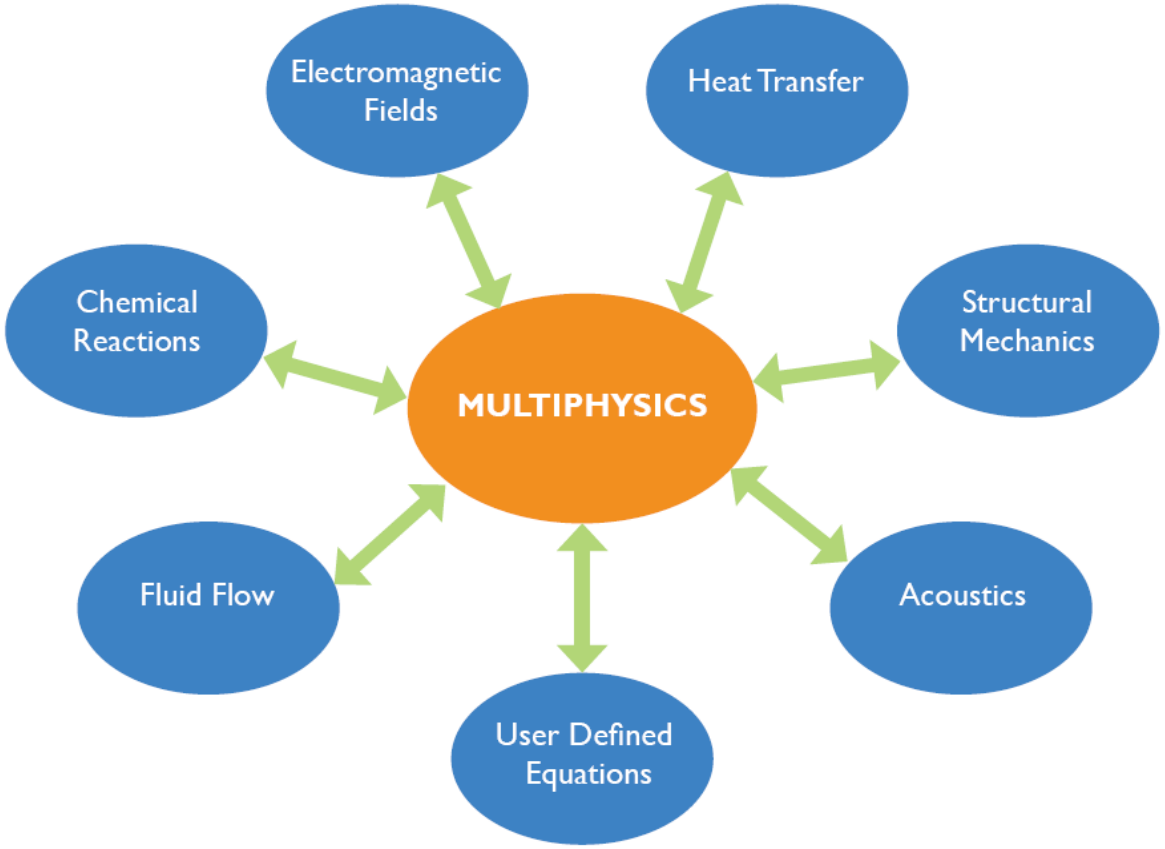
- Using computers to understand thermodynamics, fluid flow, structural mechanics, was one of the first practical uses of computers.
- Resources were scarce while theoretical, continuum, mathematical models were being formed.
- Pioneering researchers simplified through a “divide-and-conquer” approach.



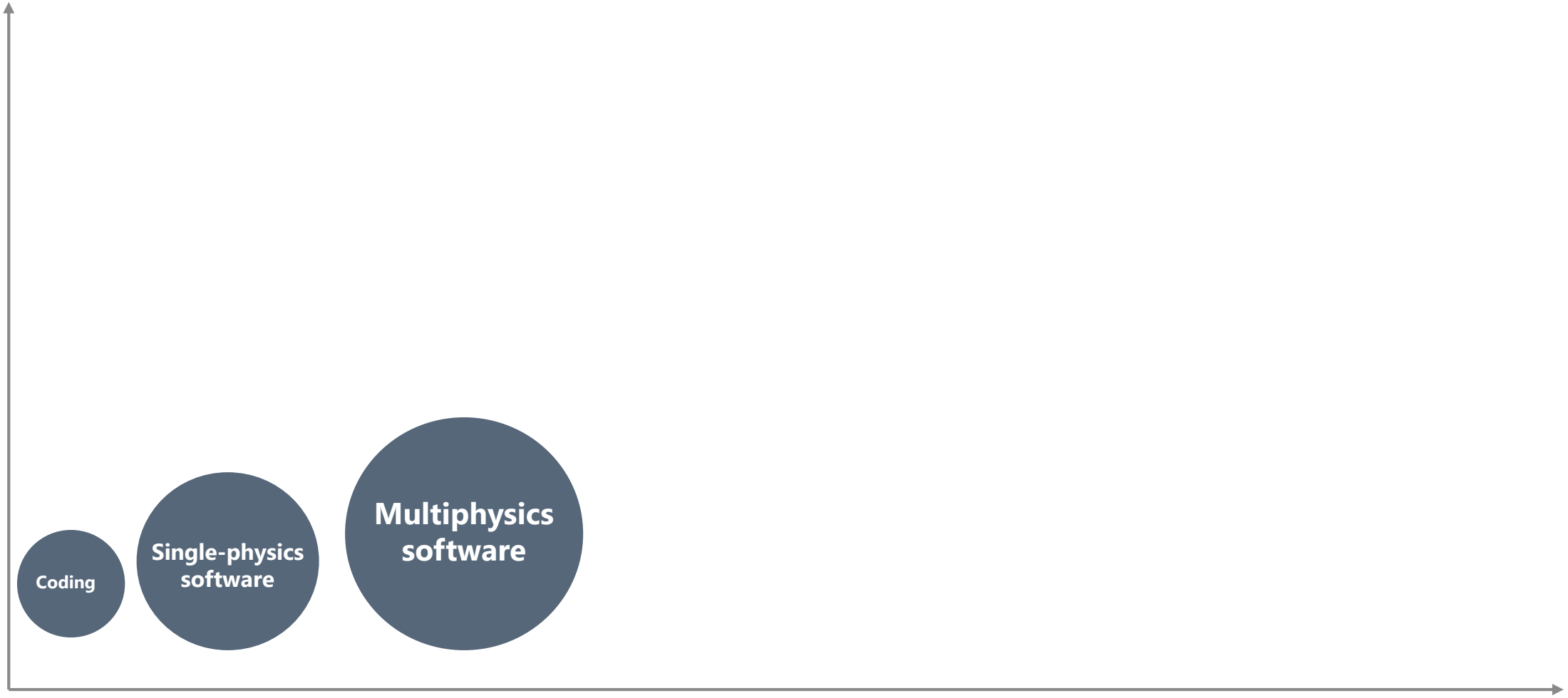
- Computational scientists focused on a small section of the full physical spectrum, fields like computational fluid dynamics (CFD) and finite element analysis (FEA) for structural mechanics.

Computational Modelling Today – Multiphysics

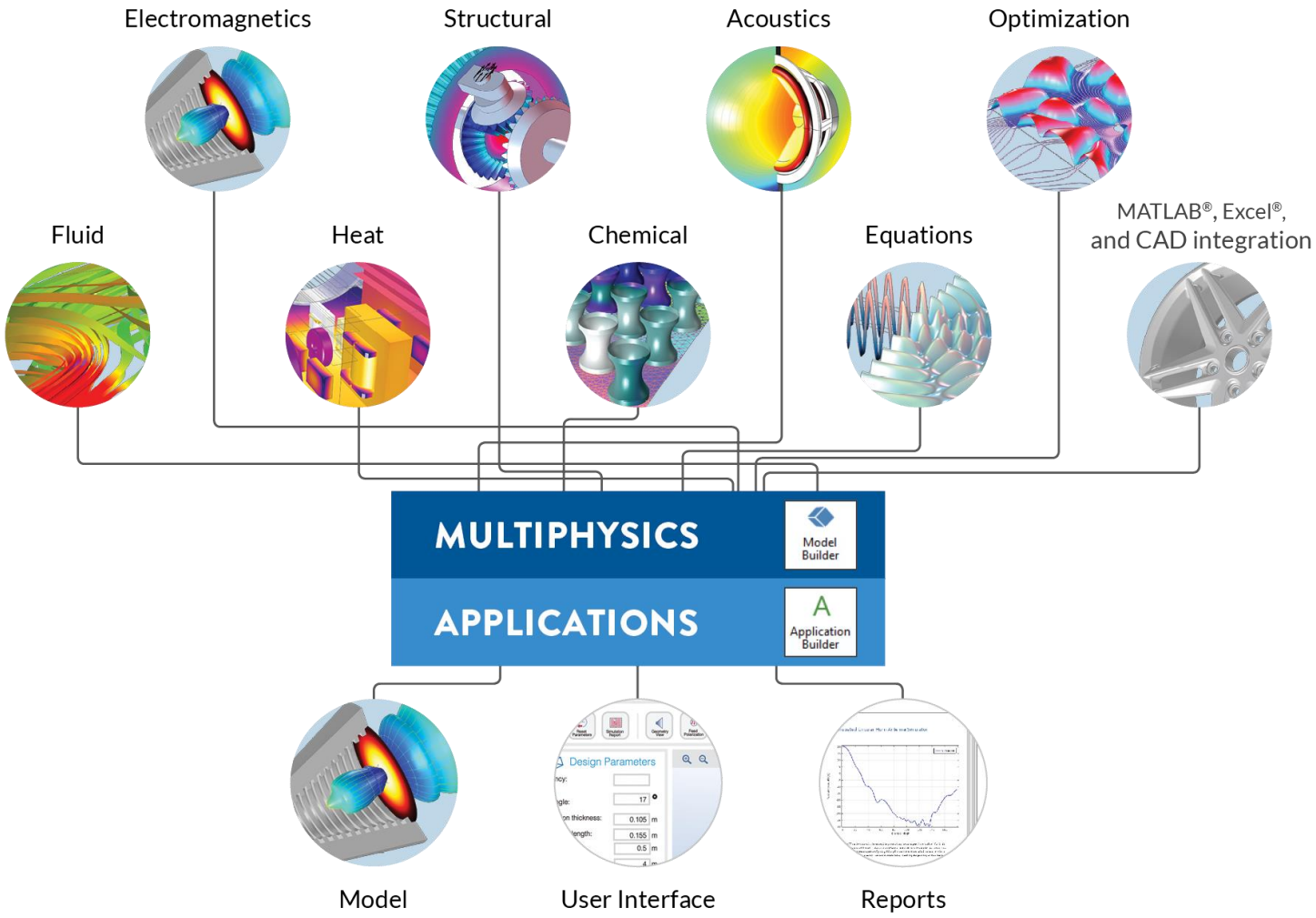
- Solvers have improved and theory has solidified, while in parallel hardware has gained speed and capacity at an exponential rate.
- Today we have at our fingertips very powerful machines matched with powerful algorithms, which means that multiphysics simulations are no longer computationally unrealizable.
- **"Multiphysics"** describes a simulation that combines multiple physical phenomena.



The Evolution of Computational Modelling



COMSOL Multiphysics®



All Industries Benefit from Multiphysics Simulation

Multiphysics Simulation Story: MRI Tumor-Tracked Cancer Treatment

University of Alberta, CANADA

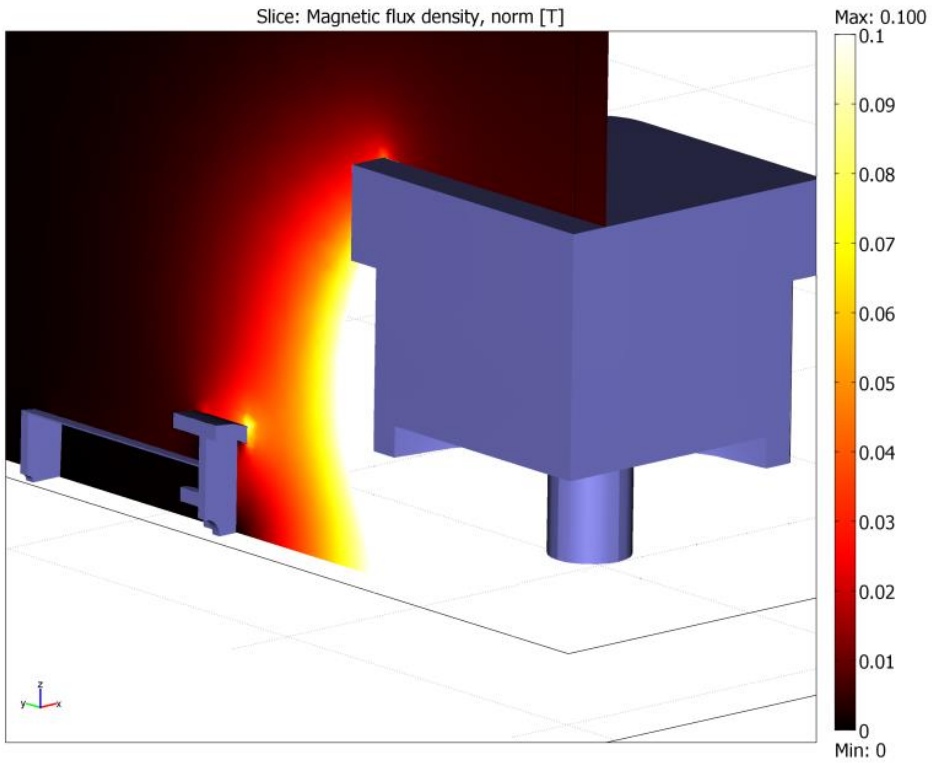
Gino Fallone

Cross Cancer Institute, CANADA

Stephen Steciw and Joel St. Aubin

The Challenge

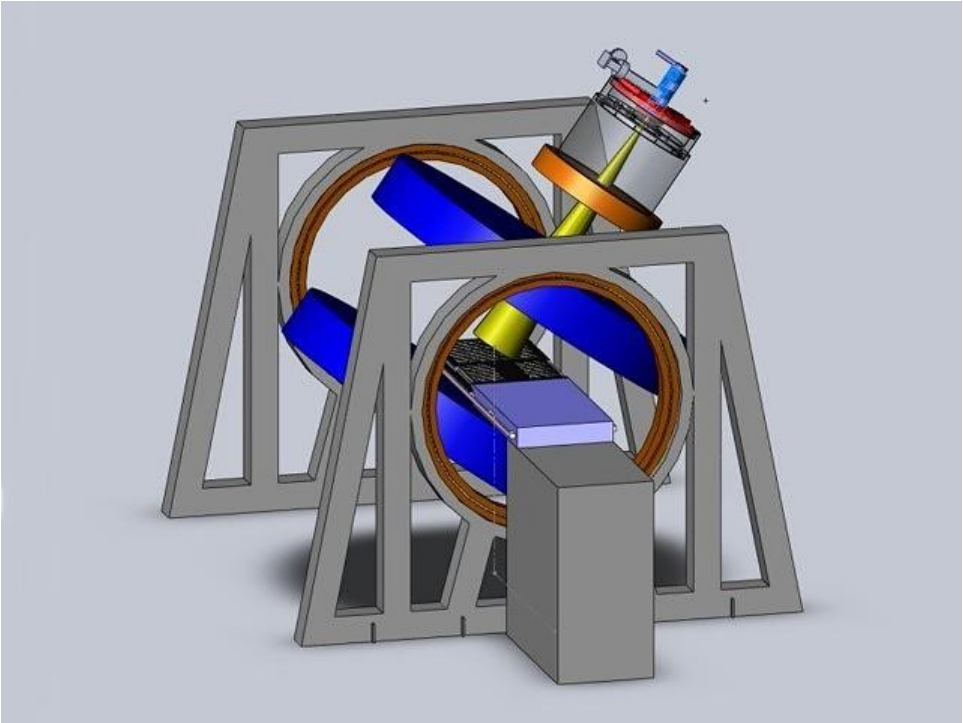
- The targeting of radiation therapy for cancer involves significant uncertainty in accurately targeting tumors
- MRI may be used to help by accurately identifying the location of a tumor in soft tissue
- But it has to be carried out independently of radiation treatment delivered by a linear particle accelerator (Linac) as the two techniques' physical phenomena conflict
    - The magnetic field from MRI deviate the particles
    - The particle acceleration creates magnetic fields



Passive shielding for a perpendicular Linac MR system orientation (magnetic field lines perpendicular to electron trajectories)

The Solution

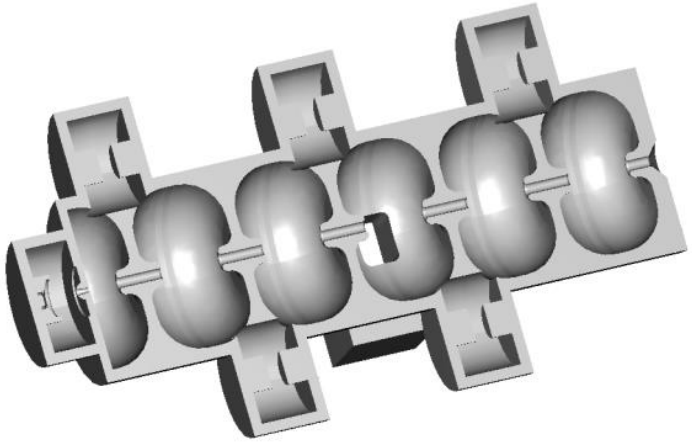
- Combine MRI and Linac in order to form an ideal treatment system that could pinpoint any tumor at all times during treatment
  - The optimal combination of MRI and Linac and the room in which the new installation would be housed was evaluated with COMSOL Multiphysics
- Simulation played a vital role in the progression towards clinical use of such a combination
  - The design verified through simulation that designing the Linac and the MRI scanner to move together as one whole system provided the best results

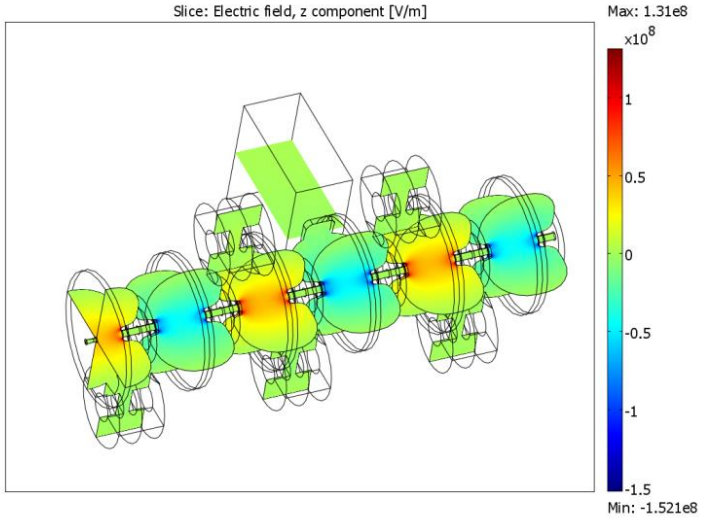


Linac MR system. The integration of the two technologies, with careful control as given by simulation, allows both to work without influencing each other.

The Simulation

- A magnetostatic simulation was needed to establish a means of shielding the EM fields emanating from Linac, from MRI's magnetic fields
  - The new shield is more than three times lighter than the original design and dramatically reduced the MRI's field inhomogeneity by more than three times
- COMSOL Multiphysics has also been used to design a 30 cm long Linac particle accelerator, generating a 10 MeV electron beam
  - This reduction in length is of major importance because it means that the room needed to house the Linac MR system can be
    significantly smaller

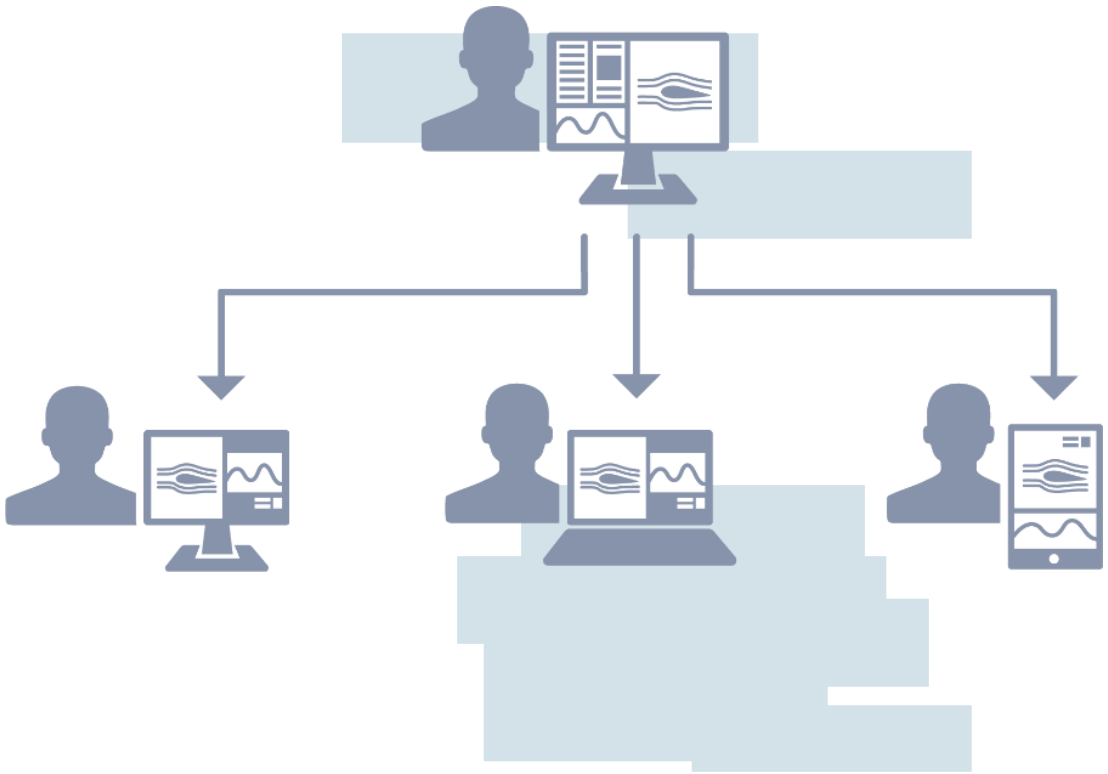




Cutaway view (top) and electric field distribution of the short 10-MeV waveguide (bottom)

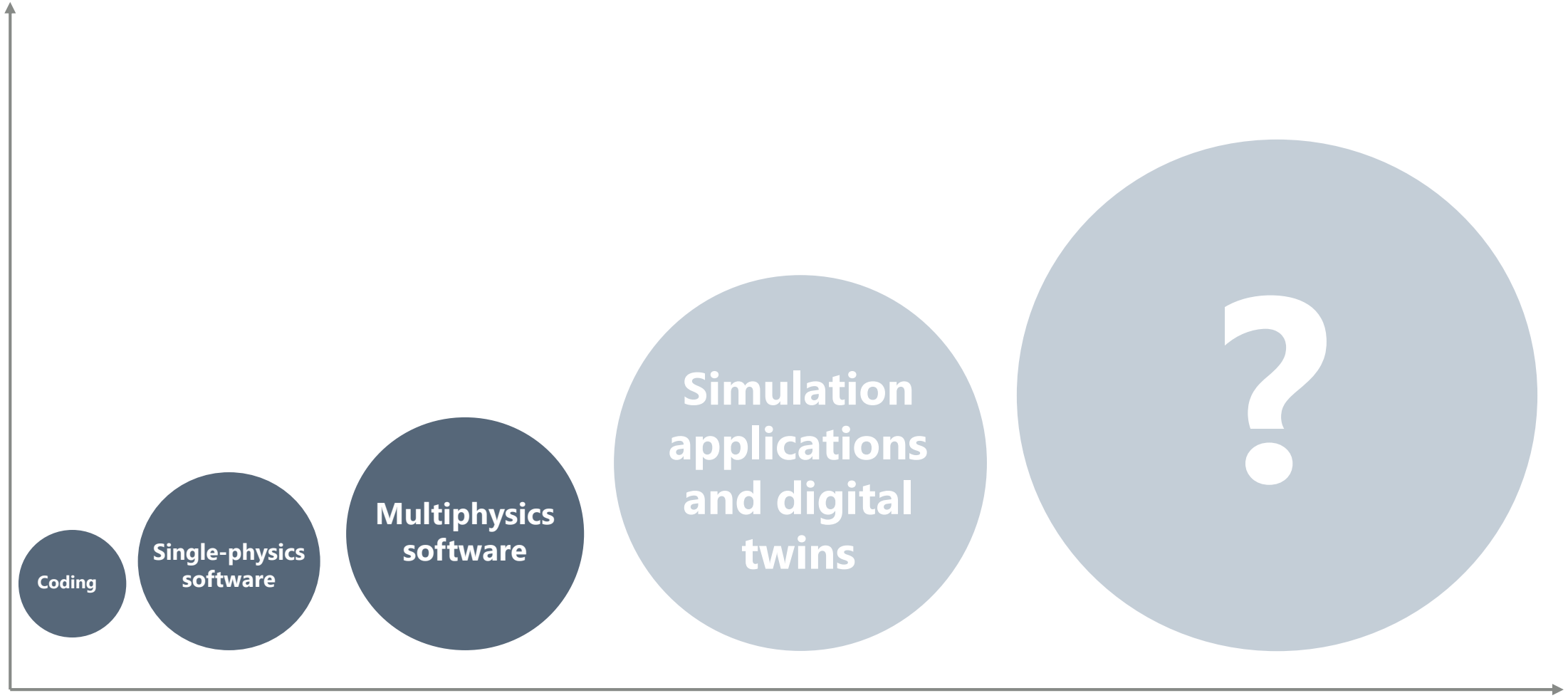
The Future of Computational Modelling

- Democratization of Simulation
  - Transfer the power of simulation from the expert to the person actually using the results
  - Simplify models and design them to a specific audience
  - Efficiently deploy these models to this audience

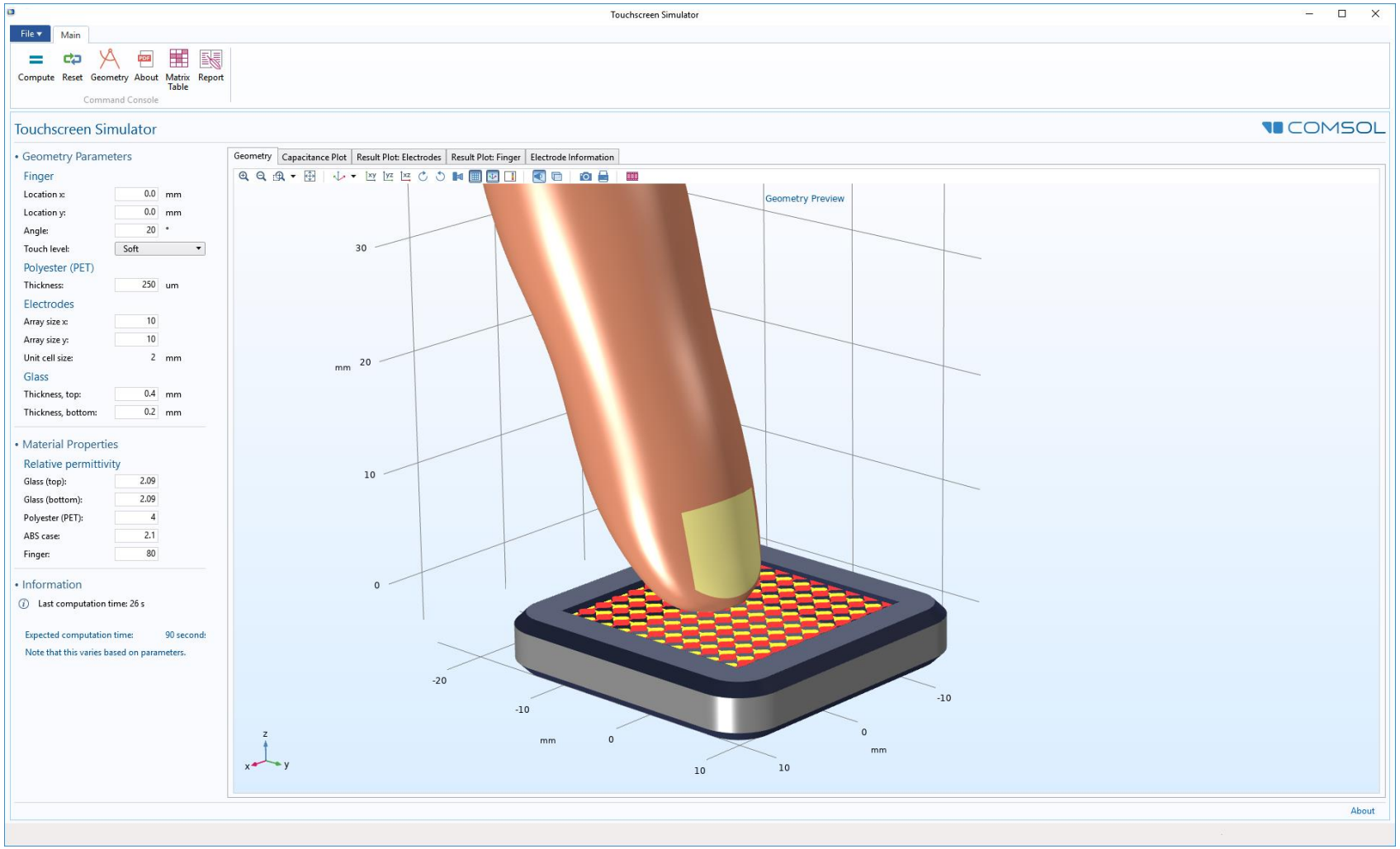


- Digital Twins/Industry 4.0
  - **Digital twin** is a computerized (or **digital**) version of a physical asset and/or process.
  - The **digital twin** contains one or more sensors that collects data to represent real-time information about the physical asset.

The Future of Computational Modelling

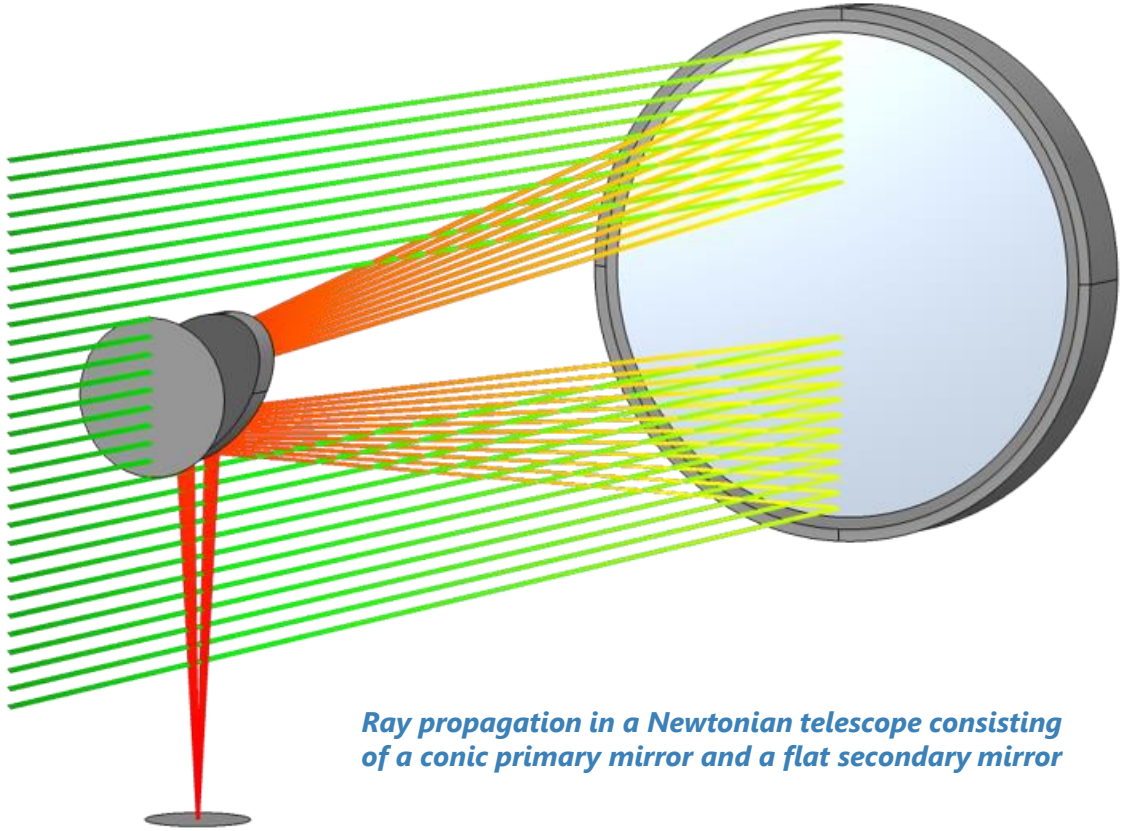


A Simulation “app”



Why Pursue a Career in Simulation?

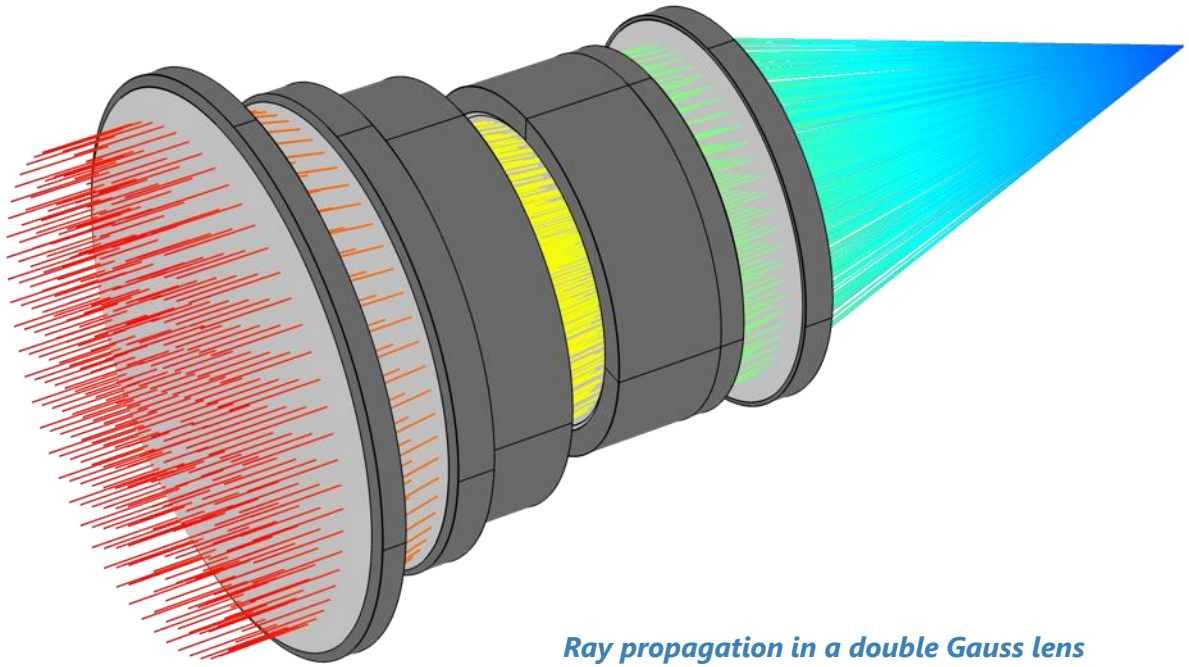
- Computational modelling is a growing sector of industry
- With the increasing sophistication of industry, computational modelling likely to become more widely used in R&D
- “Democratization” of simulation demand for simulation experts is likely to increase
- As industry moves towards automation and digital twins, “virtual-realities” based on computational models will become more widespread
- Utilise the skills and understanding that you have built up during your academic career, put them to use – “put theory into practice”



Ray propagation in a Newtonian telescope consisting of a conic primary mirror and a flat secondary mirror

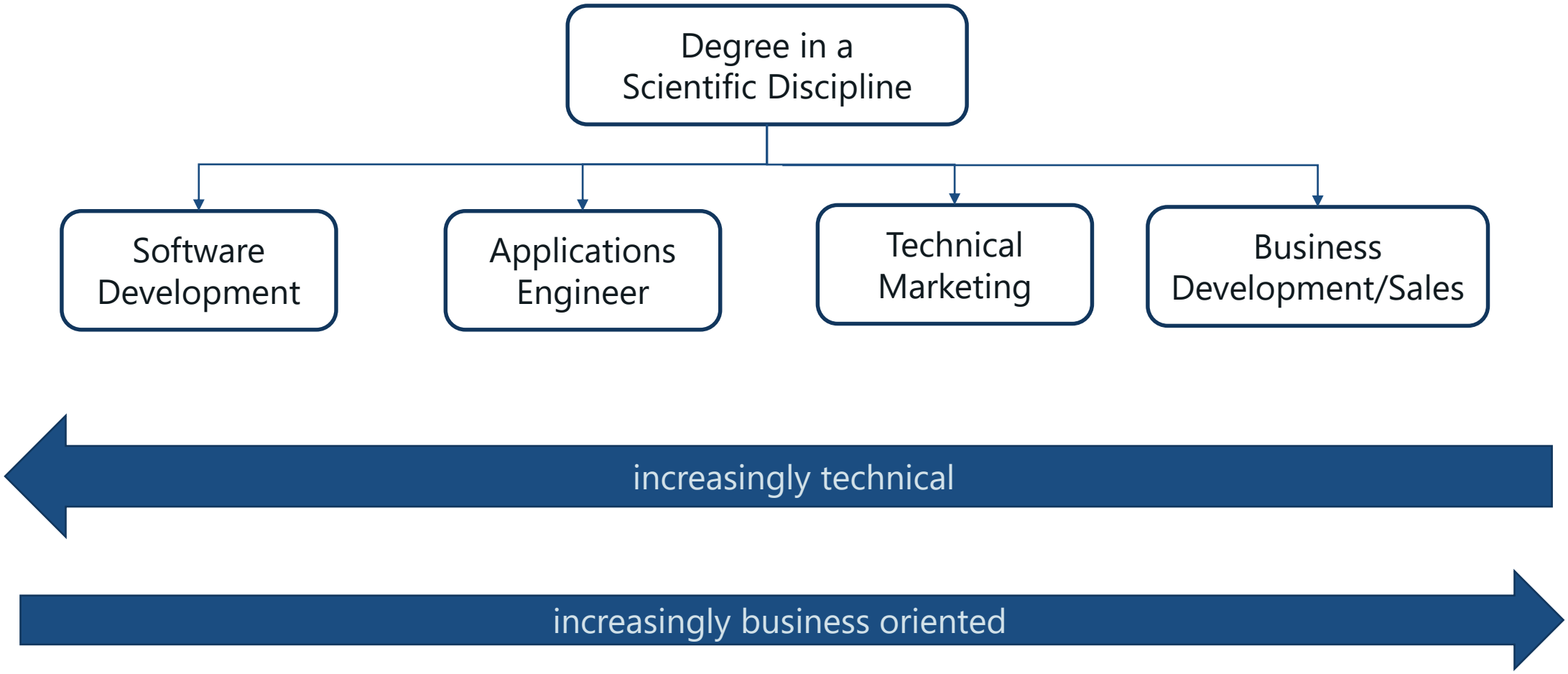
Why Work for a Software Company?

- Work at the cutting edge with the "state-of-the-art"
- Be exposed to a variety of different applications of science and engineering both in academia an industry
- Work as part of a team
- Software companies, tend to have a modern outlook, and provide a good working environment for staff
    - Modern offices
    - Staff perks
    - Flexible working hours/location



Ray propagation in a double Gauss lens

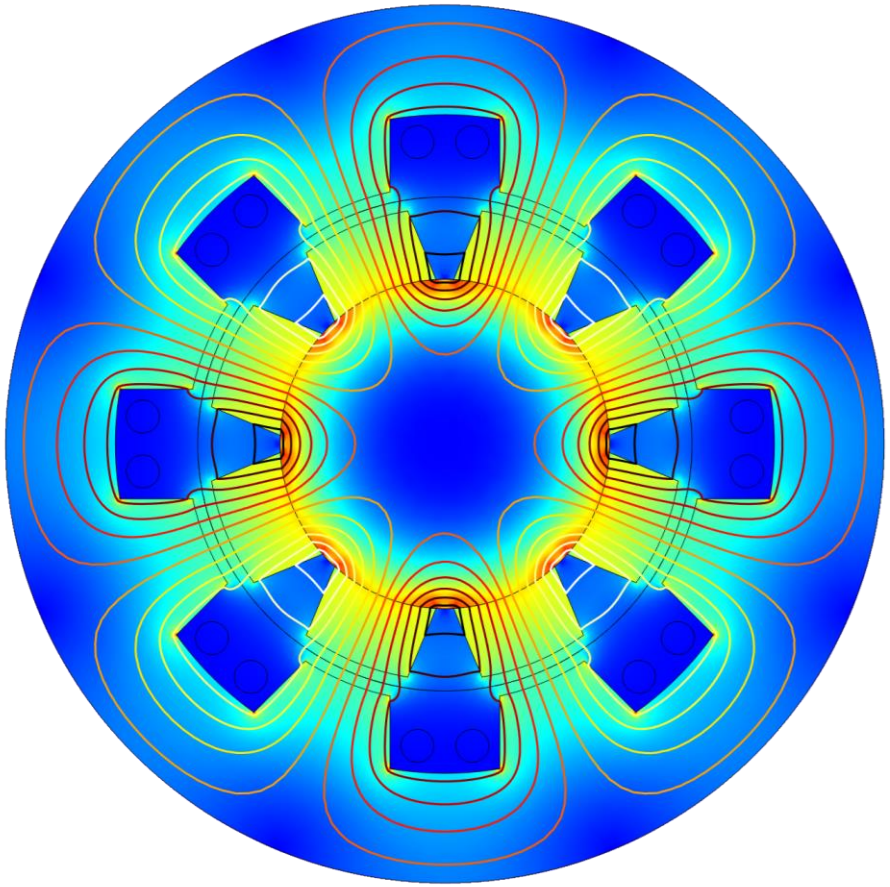
COMSOL/Software Company Career Paths



My Career Path

- Academic Career Path
  - M_{ENG} – Mechanical Engineering (2002 – 2007)
  - Ph.D – Computational Mechanics (2007 – 2011)

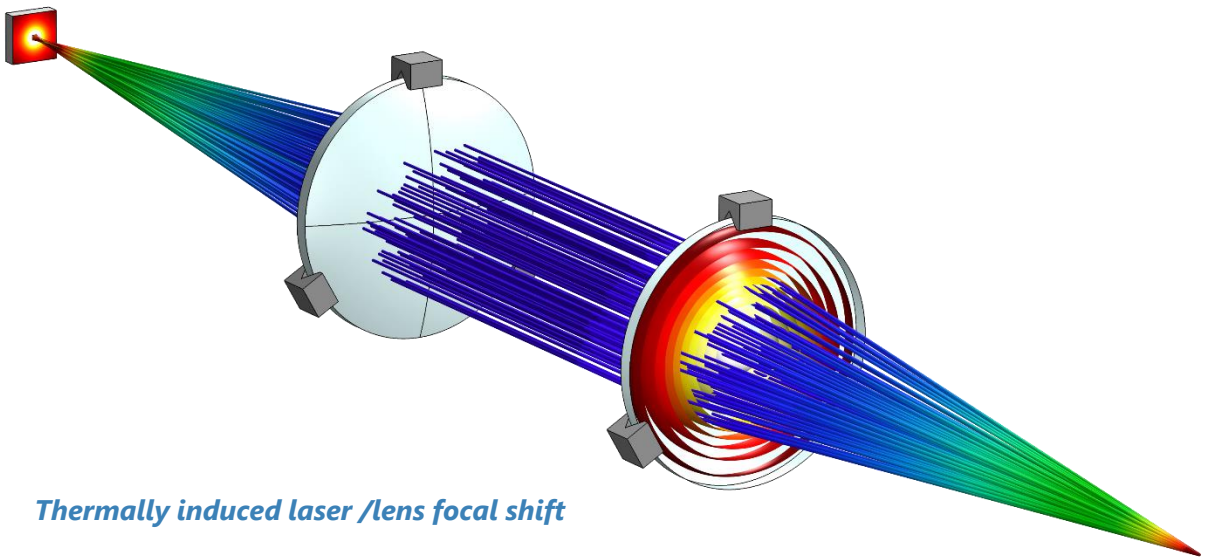
- Post-academia Career Path
  - COMSOL – Applications Engineer (2011 – 2013)
  - COMSOL – Technical Manager (2013 – 2016)
  - COMSOL – Technical Director (2016 – present)



Generator, Rotating Machinery

Why I followed this career path

- When I finished my Ph.D I wanted to remain in a technical role
- Was put-off pursuing a career in academic research because of competition for places and a lack of a clear career path
- I had spent a lot of my time as a student running simulations and writing code and this was the part that I enjoyed most
- I preferred being “hands-on” with software rather than developing software
- I wanted to work on shorter term projects that had a more direct application to industry
- Though I was uncertain whether this would be a good fit, I made a “leap of faith”
- I wanted to continue to make a contribution to the scientific community of some kind, and didn’t want to go into “the City”

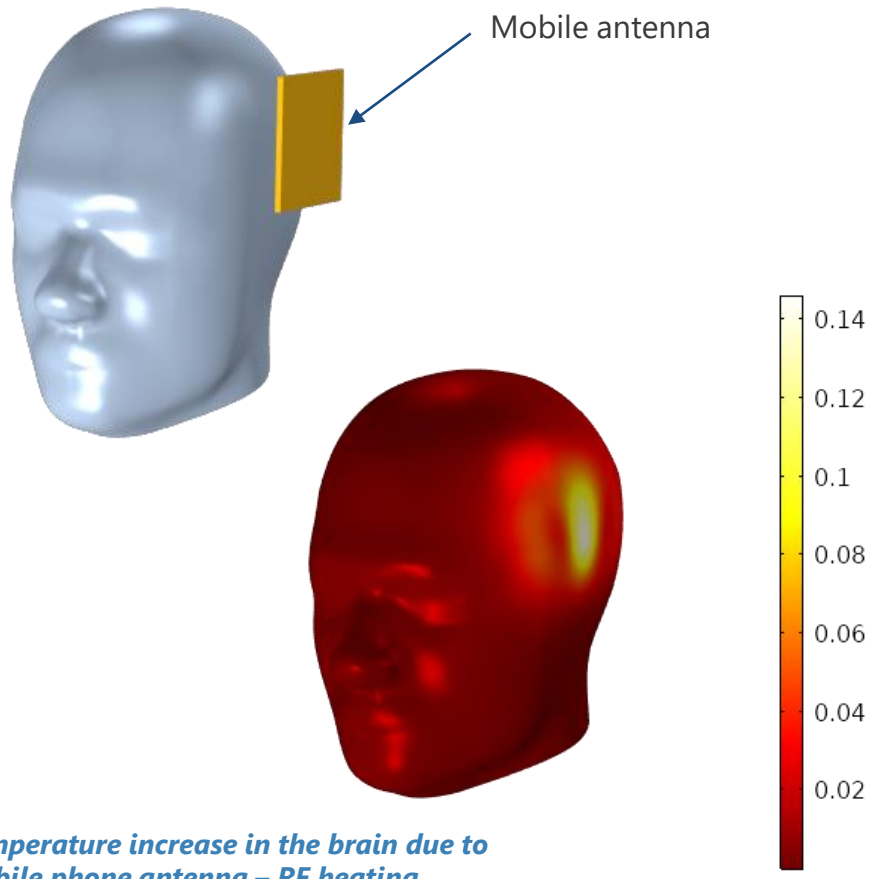


Thermally induced laser /lens focal shift

When Recruiting What Are We Looking for?

- Enthusiasm about science and engineering
- Strong understanding of the fundamentals of science
- Strong analytical and mathematical skills
- Very good problem solving skills
- Ability to communicate well to different audiences
- Ability to present well
- Motivation to want to develop and expand knowledge
- A candidate that is as versatile as possible

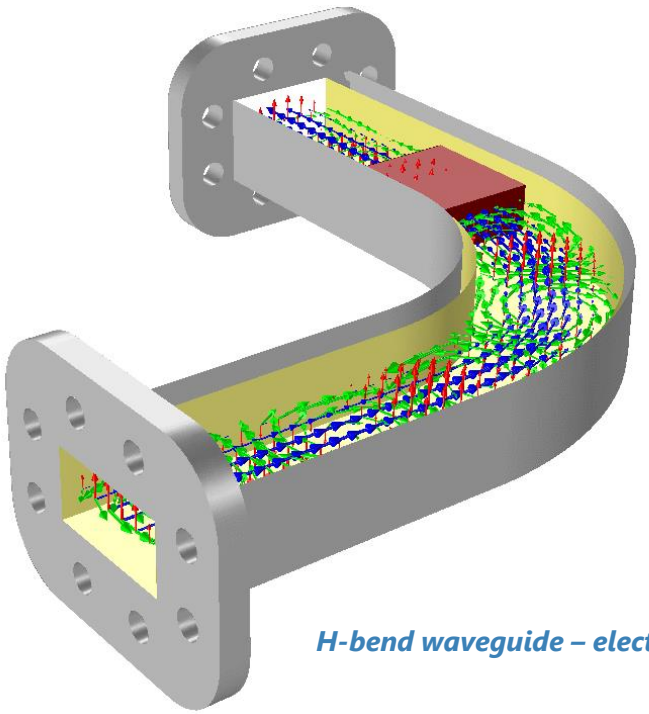
- We are not looking for simulation experts
  - It is easier to learn how to setup and run simulations than it is to learn the underlying scientific theory



Temperature increase in the brain due to mobile phone antenna – RF heating

Some Important Things to Remember

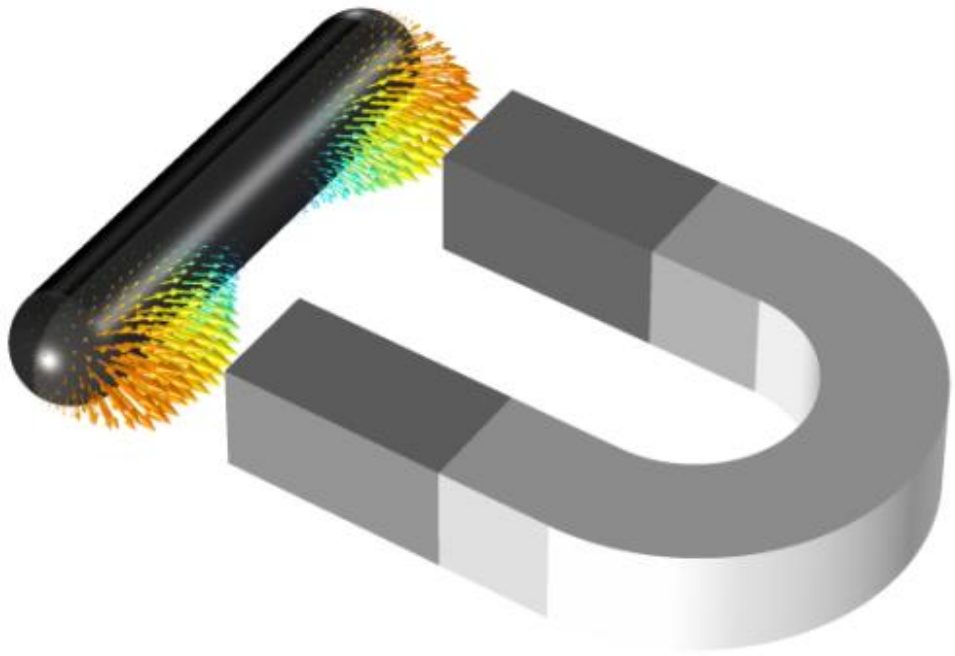
- Technical competencies are only one element that an employer is looking for “soft-skills” are also important
- When writing a CV make sure:
  - That your CV is clearly legible
    - The most important thing when writing a CV is formatting
  - That your CV is concise
    - Try to keep your CV down to 2 pages
    - When applying to industry there is no need to include all your conference contributions
- Don’t forget the fundamentals
  - When being interviewed be ready to be asked questions from your undergraduate studies or even A levels
    - If you have been told to expect technical questions, then if you are rusty then do some revision
    - “What is a partial differential equation?”



H-bend waveguide – electromagnetic waves

Some Important Things to Remember

- When asked to describe you Ph.D research be aware of your audience
  - In an interview you are likely to be asked to explain your Ph.D research
    - This can be aimed at testing how well you can explain this to an audience of non-experts, so avoid using language that is not generic
- Personalize the application to the role
  - If asked to include a cover letter then do so and include some details specific to that role
- Make sure you have done your research and know exactly who and what you're applying for
  - Demonstrate that you are familiar with the company and what they do, and also that you have an understanding of the role you are applying for.
- Remember that the interviewer also wants the interview to go well, so they are not trying to "find you out"!



Permanent Magnet, Magnetostatics

COMSOL Careers

- www.comsol.com/company/careers/

Cambridge, United Kingdom
Applications Engineer: Electromagnetics
Applications Engineer: High Frequency Electromagnetics/Optics
Inside Sales Associate - Academic Sales
Inside Sales Associate - Commercial Sales
Kgs. Lyngby, Denmark
Applikationsingeniør – strukturel mekanik
Helsinki, Finland
Sovellusinsinööri: Virtauslaskenta
Grenoble, France
Business Development Manager (H/F)
Ingénieur(e) Développement Simulations Thermiques (H/F) - Grenoble
Göttingen, Germany
Vertriebsmitarbeiter Innen- und Außendienst (m/w/d) für Simulationssoftware
Bengaluru, India
Academic Sales Engineer
Applications Engineer: Acoustics
Applications Engineer: CFD
Applications Engineer: Multiphysics
Applications Engineer: Structural
Senior Sales Account Manager
Technical Sales Engineer

Zoetermeer, Netherlands
Account Manager
Moscow, Russia
Менеджер по продажам (Sales Engineer - Technical Account Manager)
Stockholm, Sweden
Developer numerical algorithms
Developer Postprocessing and Visualization
Developer Structural Mechanics
Electromagnetic Applications Interface Developer
High Performance Computing (HPC) specialist
Master thesis students
Vassa utvecklare i C++ med intresse för matematik och algoritmer
Burlington, MA, USA
Applications Engineer
Applications Engineer (Multiple Openings)
Computational Physicist
Computational Physicist: Optics
Computational Physicist: Particle-Based Methods
Developer
Developer Numerical Algorithms
RF Applications Specialist
Sales Engineer (Multiple Openings)
Senior Applications Engineer
Los Altos, CA, USA
Applications Engineer (Multiple Openings)
Applications Engineer: Electromagnetics
Applications Engineer: Multiphysics
Sales Engineer
Los Angeles, CA, USA
Applications Engineer: Electromagnetics
Applications Engineer: Structural Mechanics
Sales Engineer/Technical Account Manager

Questions?