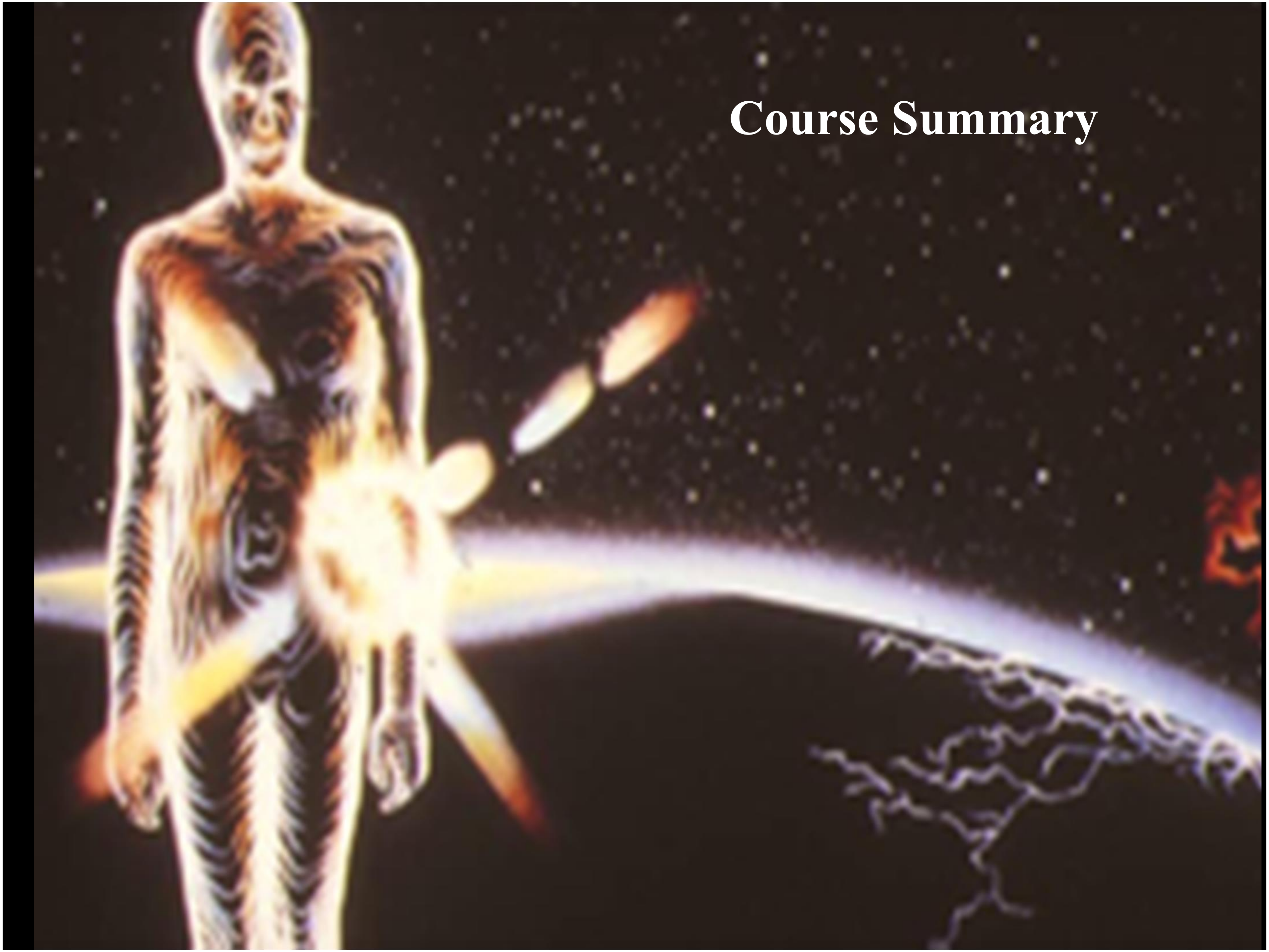
Course Summary

Educational aims

- To introduce students to the assumptions and limitations that underlie state-of-the-art modelling methods as used to appraise the performance of buildings, their environmental control plant, and associated renewable energy supply technologies.

- To impart an appreciation of the mathematical models for the underlying heat and mass transfer processes, and the numerical methods by which such process models may be conflated to form an integrated simulation program.

- To give insight into the range of possible applications of integrated energy simulation an procedures to orchestrate such applications.

- To identify the adjustments required to organisation work practices to incorporate state-of-the-art energy systems simulation as a best practice business approach.

Learning outcomes

Appreciation of the capabilities and limitations of the various methods for assessing the performance of buildings and their associated conventional and new energy supply systems, including energy efficiency, indoor air quality, human comfort and environmental emissions. You should also:

- appreciate that environments result from a complex interaction of many heat, power and mass transfer mechanisms;
- have a basic knowledge of how to apply modelling and simulation to address this complexity;
- understand the theoretical and operational principles underlying contemporary energy simulation programs; and
- appreciate the limitations of current design tools and the issues to be addressed to ensure their effective application in practice.

Energy-related issues and modelling methods

Climate change; air quality; fossil fuels; nuclear power, renewables; matching demand and supply; demand side control; embedded supply; sustainability; need for modelling; attributes of a simulation model.

Energy flow-paths and thermo-physical properties

Buildings and supply systems
Flow-paths: transient conduction; surface convection; long- and short-wave radiation; fluid flow; casual gains; control signals
Material properties (units, derived values)
Passive devices
Environmental impact

Weather boundary conditions

Parameters (units)
Collections and selection criteria
Influence on energy systems

Response function methods

- PDE solution method
  - Time domain
  - Frequency domain
    - Admittance method (response factors) + calculation

Numerical methods

- Representing buildings and energy supply systems
- Discretisation
- Conservation equation formulation (explicit and implicit approach)
- Equation organisation and whole equation-set solution
- Imposing control
- Application example (heat pump)

Short- and long-wave

- Solar geometry
- Spectral distribution
- Building interactions + calculation
- Long-wave radiation exchange(numerical approach)

Fluid flow

- Nodal network method:
  - Boundary conditions; nodal placement; component models; equation set solution + calculation
- Computational fluid dynamics:
  - Domain discretisation; conservation equations; boundary conditions; equation set solution
- Linking the building, plant and flow domains

Use in practice

- Components of an energy simulation program
- Behaviour follows description (or reward follows effort)
- Performance assessment method
  - Model calibration
  - Integrated performance views
- Adjustments to company work practices