JOSEPH PAWSON AND RICKY TERRINGTON

What should be taught in a 3D geological modelling course?

British Geological Survey

Current approaches

Software based

Leapfrog

Aspen SKUA

Petrel

GeoScene 3D

Theory based

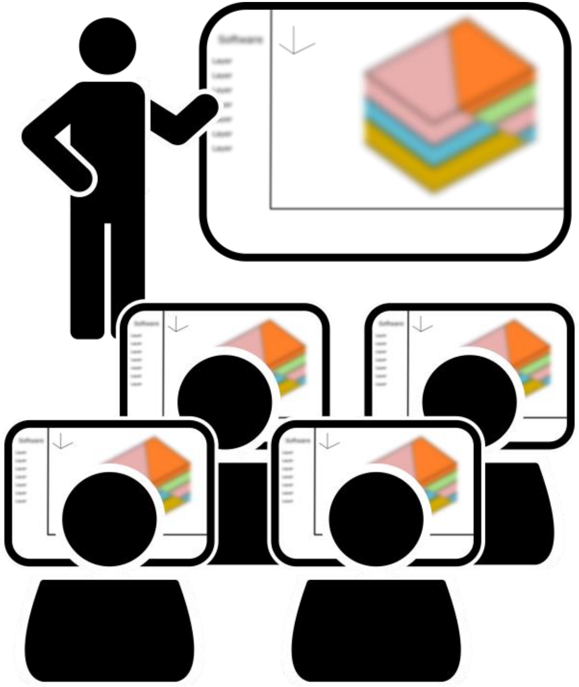
Implicit

Explicit

Probabilistic

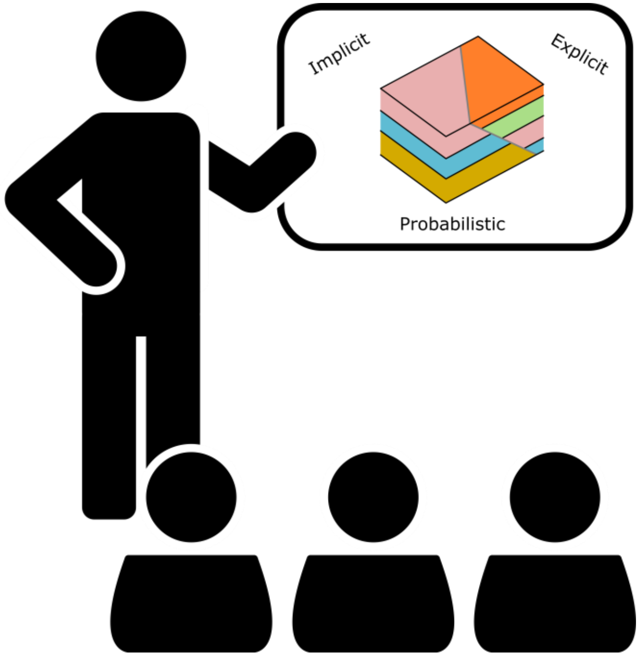
Software specific training course

- Software specific courses redundant after 2 or 3 years
  - Software development, licencing restrictions
- Modeller typically required to have skills in more than one software – as not one package can do everything
- Can quickly become a click button exercise with already prepared and clean input data
- Hard to learn software in single session – best learned through application

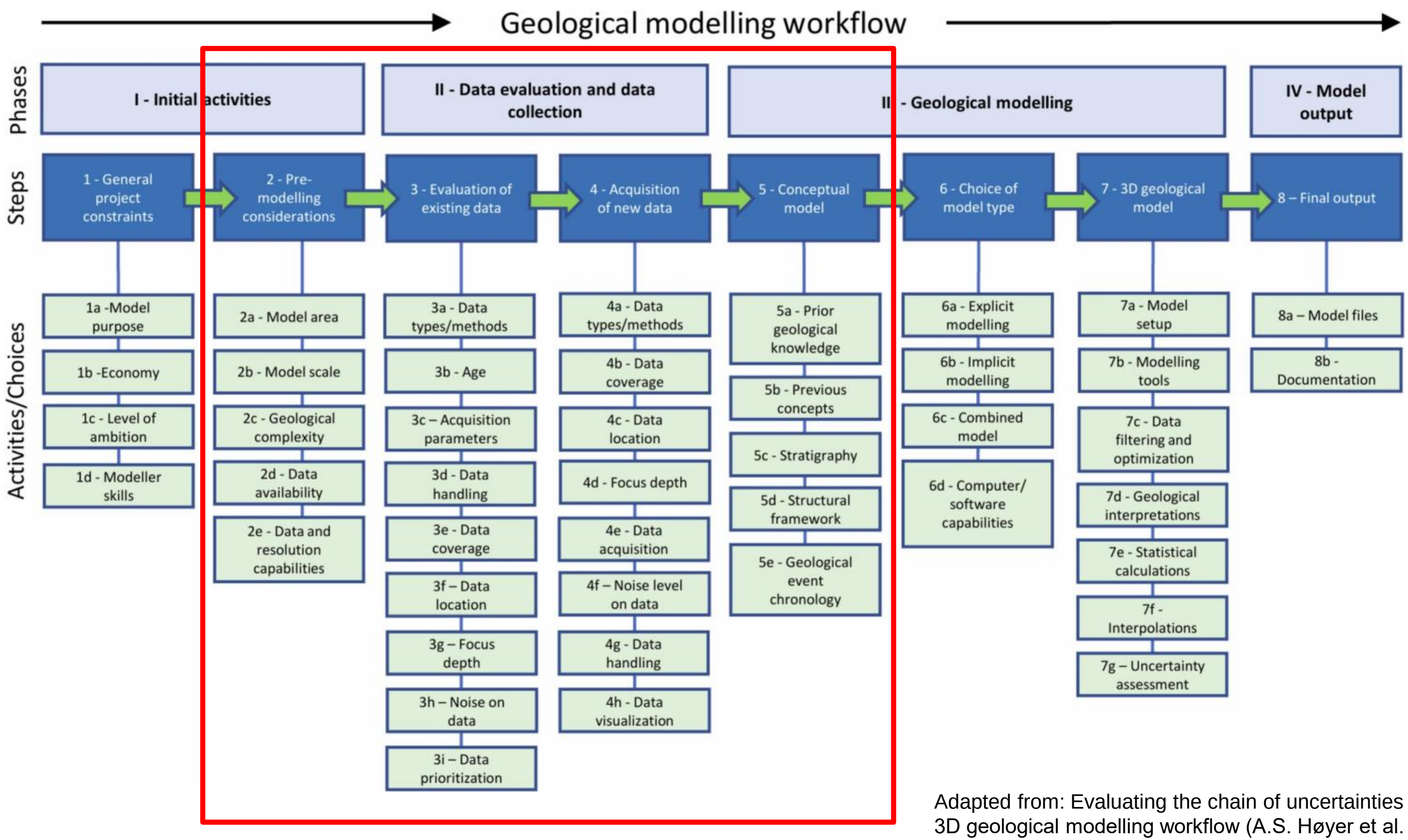


Theory based training course

- Important to understand the concepts and reasons for different approaches
  - Implicit/explicit/probabilistic
- Usually beyond what is required for a beginner modeller
  - Most industry standard software use implicit modelling
- Teach theories of 3D geology, not just software
- Avoid "black box" approach



- Data preparation, interpretation, digitisation and processing often forms most of the model creation, compared with the model iteration process and reporting

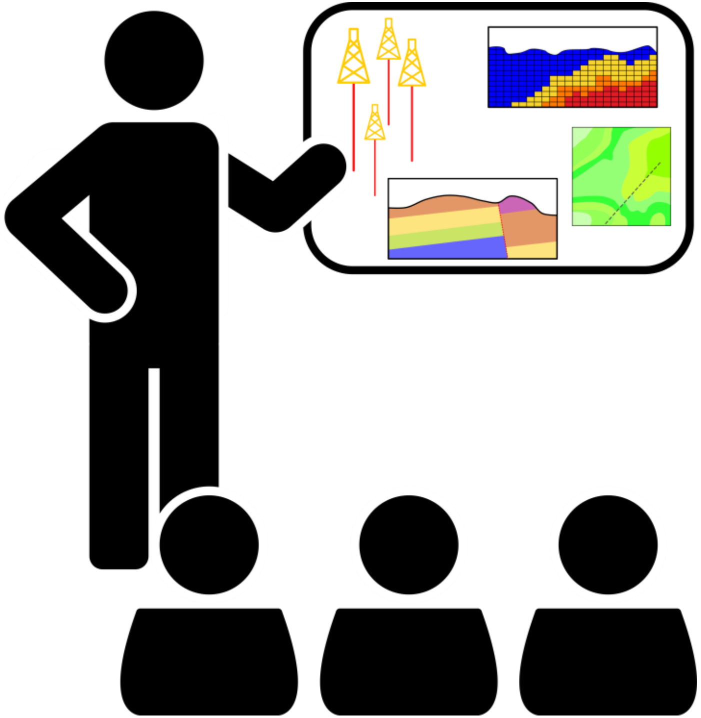


Adapted from: Evaluating the chain of uncertainties in the 3D geological modelling workflow (A.S. Høyer et al. 2024) https://doi.org/10.1016/j.enggeo.2024.107792

Data-driven training

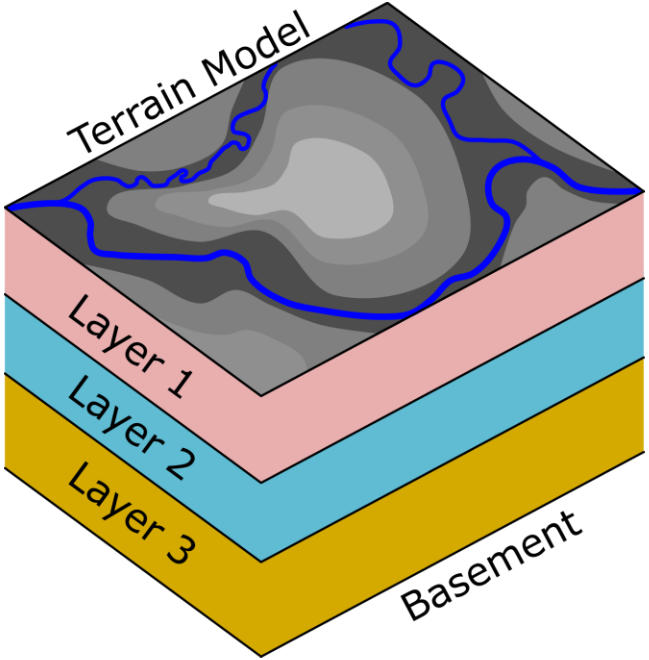
Data-driven training course

- While the software may change, the input data does not
- Model itself can be recreated in the future in any software, if the input data is prepared well
- Manipulation and cross-validation of 2D data for use in 3D geological modelling
- Communicate the importance of preserving trust-worthy data for future use, by feeding data back into corporate databases



Building a Conceptual Geological Model

- Data and Literature Review:
  - Identify/understand any potential bias
- Summarise current geological knowledge of the model area:
  - Working hypotheses and generalised layer sequence
- Possible modelling challenges
  - Is it going to be representative of the geology at the required scale
- Start simple, complexity can always be added later as understanding evolves

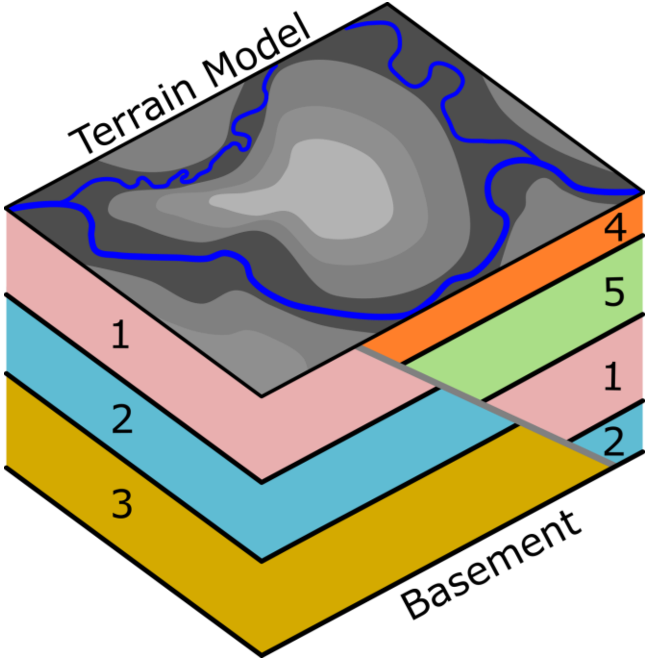


Define model standards – tolerances and model restrictions

- Levels of precision and accuracy
- Borehole standards
  - Tops/bases of units? Coding scheme to use?
- Criteria for including/excluding faults
- Many more…

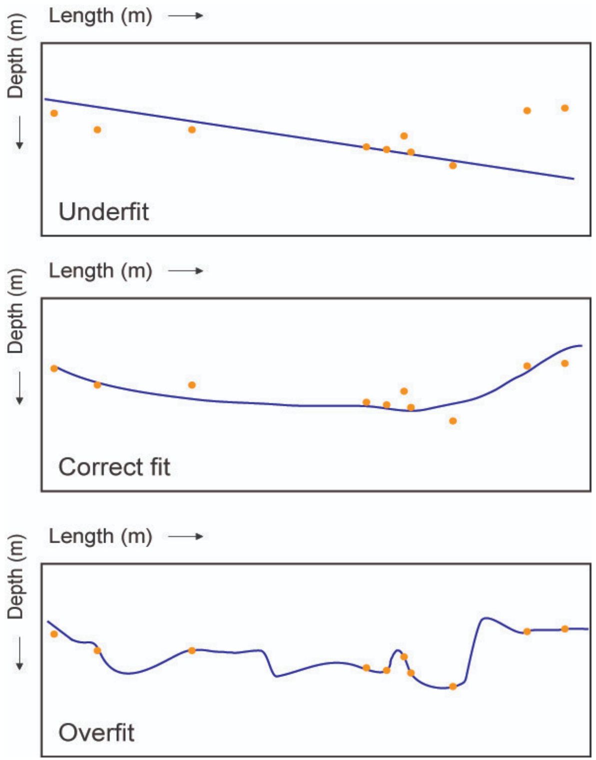
- Are you going to get the result you need? – scale/limitations

- Record all of this in a modelling standards metadata document
  - Use it during digitisation, modelling iteration and reporting
  - Important for the QA stage



Uncertainties in geological modelling

- Relative to each model and data availability/reliability
- Identify data uncertainties early in the data collection process
- Help to identify problems where the model does not match the conceptual geological model
  - Which data source to 'trust' if a contradiction occurs
- Avoid problems associated with overfitting and underfitting
- Communicating these effectively – liability and mitigation



Uncertainties from input data

Terrain models
- Surface resolution
- Age of data – more recent landscaping/artificial ground

Map data
- Age of mapping
- Scale of map data compared to model scale

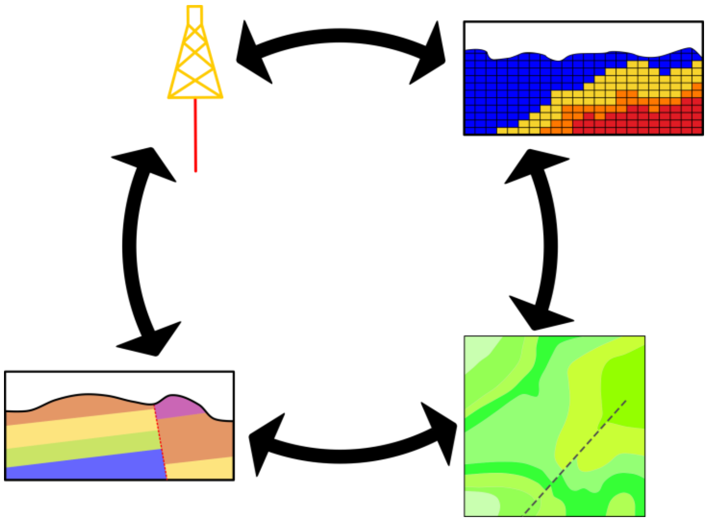
Legacy data and literature
- Previous interpretations of varying quality
- May no longer be valid interpretations – e.g. made before plate tectonics theory

Geophysical data
- Quality and resolution of data
- External factors influencing geophysical measurements
- Are the intended modelled units distinguishable using geophysics

Boreholes
- Quality of data – vertical resolution and drillers descriptions, method of drilling
- Purpose of drilling/drilling company – hydrocarbon prospecting wells may have low resolution in overburden and too high resolution in the target rocks
- Start height – if borehole was drilled before a quarry or in the base of a since infilled quarry

Cross-validation

- 3D geological modelling can be used as a cross-validation exercise for data
  - Check 3D validity of maps against the current understanding
  - Borehole conflicts may indicate poor data or faulting etc



- See the model itself as a by-product of the data validation process
  - The model will likely become redundant within 5 years

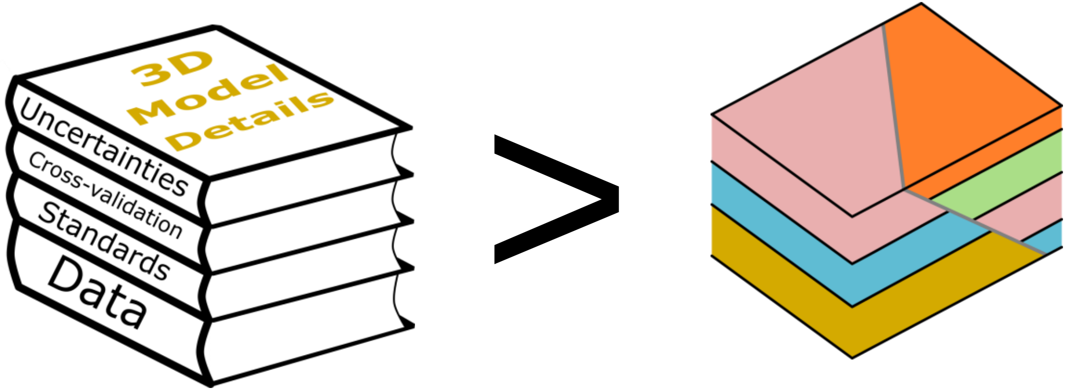
- The cross-validated data and developed geological understanding should be the focus of the documentation

Not exclusive…

- Obviously, some theory and perhaps basic skills in one or more software will have to be taught
- Knowing the theory behind a generated model surface/volume can help understand conflicts – important for the cross validation of data
- On-the-job training required to be confident in modelling

Summary

- A data focused, ‘software agnostic’, 3D modelling training course is more appropriate than a solely software-based or theory-based training course
- Producing robust datasets and documentation, is more important than the model building itself – the data and documentation form the legacy of the model
- Teaching skills that can be applied to a variety of software and techniques



THANK YOU

Any questions?