Planning a Petrel Project

Doing a Petrel project is like digging a hole in your backyard. You start knowing how big the hole is to be, how deep you will go, and that you have two hours left before it gets dark. Having dug holes before, you know there is plenty of time to dig this hole so you get your tool, a shovel, and start digging. Unfortunately, things don't go as planned. Had you taken a few minutes to analyze the situation before digging you would have realized:

- A large tree is growing about 5 feet from the hole
- The hole is on a line between the gas pipe leading into the house and the gas meter at the property line
- Others who have dug holes in your neighborhood have always found a 4 inch caliche layer about two feet down.

It is clear that a little planning would have told you that you must:

1. Reposition your hole to avoid the gas line
2. Have a saw or ax to handle the roots
3. Have a pick or jack hammer to break up the caliche layer
4. Refine your estimate to be four hours instead of the two you thought would work
5. Make adjustments because you will not finish before dark

This simple hold digging task had a few surprises and was underestimated by a factor of two.

Sooner or later, if you use Petrel you will have to estimate how long your project is going to take and be reasonably accurate in that estimation. Like digging a hole, you must know what you are going to create, the obstacles you will encounter, and the tools you will use to do the work. As consultants the authors perform this analysis on each project. Unless you have done many tens of Petrel projects your "gut feeling" or "quick estimate" of what will be required is seldom correct and usually underestimates the time required by a factor of two or three. This Tips & Tricks article discusses the process of evaluating, planning, and estimating time for a Petrel Project.

The Interview

Your first task is to learn about the project for which a model is to be built. You must determine what they (those requesting the model) have, what they want, and how long you have to get it done. This is an interview process that usually last one or two hours. At the end of it you must have enough information to write the modeling proposal. Questions to ask and information to be learned include:

- General information
    - Who is in charge of the project (contact information)
    - Who are the primary contacts on the project (contact information)
    - When does the model have to be done
- Get the 15 minute history
    - Geologic history
        - Depositional environments
        - Structural setting

- Field history
    - Discovery
    - Types of hydrocarbon
    - Onset of drilling and production
    - Major changes in production
    - Current status
  - What literature is available on the field or basin
  - What company reports have been written about the field
  - What models have been built before
    - Who built them
    - What program was used
    - How were they used
    - Were there problems with those models
    - Why is the field being re-modeled
- What is the goal of the model?
  - Simulation
  - Volumes
  - Well planning
  - General understanding of the geology
  - Other
- How large an area is to be modeled?
- Structure
  - What is the regional setting
  - Number of horizons, names, and geological relationships
    - Which horizons are seismic based
      - Who did the interpretation
      - Is that person(s) available for questions
      - Is the interpretation in time or depth
        - Is there a velocity model
        - How many of the wells were used in the velocity work
        - If in depth are the events tied to all tops
      - Do the events correspond to the horizons that will be modeled
      - Is the areal extent of each event similar
      - Is the noise content similar for all events
    - Which horizons are well based
      - Who picked the tops and fault cuts
      - Is that person(s) available for questions
    - What are the general horizon trends
    - Any folding of significance or overturned structures
    - What is the total thickness and relief of the section to be modeled
  - What is the general character of each zone isochore
    - Always present or missing in some areas
    - Thick or thin in an area or following certain trends
    - Any minimum or maximum thickness expected
    - Which zones are well behaved and which have problems
  - Number of faults, types, timing, impact on production
    - Which are critical to the model's goal

        - Which are not important
        - Any Y-faults, how many, and where do they occur in the section
        - Any fault planes oriented the same or within 20 degrees of a structure surface
        - Any reverse faults of significant displacement
        - When does faulting occur, before, during, or after deposition
    - Any sub-zone structures such as stream channels and what data supports them
- Geophysics
    - Are the seismic data (2D or 3D) available for import to Petrel
    - Is there a reason to import the seismic data
    - Is it in depth
        - If not is the velocity model available?
        - If no velocity, are the interpretations available in both time and depth
        - If no depth then what is the plan to get to depth
    - How good is the 3D data
        - Can the depositional features (channels, sand, pay, …) be seen in the amplitudes
        - Are there particular zones or areas that are better than others
- Stratigraphy
    - What is the depositional environment
        - In general
        - Does it vary for each zone
    - What are the key rock types
        - What are the reservoir rocks
        - What are the non-reservoir rocks
        - How do they vary in character (thickness, grain size, …)
            - Laterally
            - Vertically
        - How persistent are they
    - What are the dominant facies and facies associations
        - List the facies
        - General character of each facies
            - Shape and size laterally and vertically
            - How persistent are they
            - Rock types and distribution in each facies
            - Reservoir or engineering properties of significance
        - Which facies occur together (association)
            - Typical proportions
            - Facies position in association - random or specific order (juxtaposed)
            - Association's occurrence relative to other associations or zones.
- Petrophysics
    - Which logs are used
        - For general interpretation
        - For picking tops
        - For calculating net (list cutoffs for each log)
        - For calculating pay (list cutoffs for each log)
        - For defining facies (list cutoffs for each log)
    - Top picks

        - List them in top down order
        - What do they represent
        - Which are field wide
        - Which are localized
        - Which will be modeled (structure surfaces built)
        - Which can be ignored
        - Why would a top be missing
        - Did one or multiple interpreters pick the tops
        - Are there vintages of tops and which is to be used
    - Fluid contacts
        - What types of fluid contacts exist
        - Create a list of all contacts and where they occur
            - Do contacts vary from zone to zone
            - Do contacts vary from fault block to fault block
            - Are contacts flat or tilted
        - Are any contacts uncertain
            - Is there a range defining highest and lowest levels for a contact
            - How is the uncertainty to be modeled
        - Is any special processing or consideration needed for the water contact
    - Facies
        - Are there facies logs
        - Is there more than one log and which should be used
        - How was it built
            - Cutoffs from other logs
            - Hand painted from visual observations of other logs and data
            - Who defined the log and is he available for questions
    - Porosity
        - Are there porosity logs
            - What log was calculated (total or effective)
            - Is the same porosity log available in all wells
            - Are the porosity values all good or are there problem wells or zones that should be altered or ignored
        - Are there core porosities
            - How are they distributed in the field
            - How do core and log porosities relate
        - Is there any special consideration to be addressed when modeling porosity
    - Net-to-Gross (N:G)
        - How was N:G determined
            - Has the method always been used or are there other methods
            - Are there optimistic and pessimistic versions of N:G and how defined
            - If multiple versions when should each be used
        - Is there a N:G log for each well
        - Are the N:G values all good or are there problem wells or zones that should be altered or ignored
        - Is there any special consideration to be addressed when modeling net-to-gross
    - Water saturation (Sw)

        - How was Sw determined
            - Has the method always been used or are there other methods
            - Are there alternate methods for defining Sw
            - If multiple versions when should each be used
        - Is there an Sw log for each well
        - Are the Sw values all good or are there problem wells or zones that should be altered or ignored
        - Is there a transition zone
            - How is it defined
            - Is it of significance considering the goal of the model
            - Is it of significance considering the cell size (resolution) of the model
            - When can it be ignored
    - Permeability
        - Is there a perm log
            - How was it calculated
            - Does it exist for all wells
            - How is the correlation between the por and perm logs
        - Is there a por-perm relationship from cores or other source
            - Can this be considered to represent the entire field
            - Can a relationship be defined for each facies
            - Is there a transform(s) for converting from porosity to permeability
    - Are there other properties that need to be modeled
- Eengineering issues?
    - Does production indicate barriers between wells
    - Does production indicate a relationship between por and perm that differs from what the data indicates
    - Anything else
- Are there any uncertainties that must be addressed
    - Structure
        - Horizons
        - Velocity
        - Faults
        - Isochores
    - Facies
    - Petrophysical Properties
    - Fluid contacts
- Data (where will the data come from for each item)
    - Well data (how many wells)
        - Well headers (name, X, Y, KB)
        - Deviation surveys
        - Tops (how many horizons)
        - Logs (usually Las format)
        - Cores
    - Seismic data
        - Survey (3D or 2D)
        - Horizons (how many)

        - Interpretations (time, depth, or both)
        - Grids (optional backup to interpretations)
      - Faults (how many)
        - Sticks
        - Polygons
        - Interpretation
        - Grids (optional backup to above data)
      - Velocity model
    - Culture polygons
      - Leases
      - Rivers, roads, etc.
- Volumetrics
  - What are volumes reported by
    - Fluid
    - Zone
    - Fault block
    - Lease
    - Facies
    - Distance from well
  - Units
  - Precision
  - Sensitivities that need to be run
- Displays
  - Maps to be generated
  - 3D views to be generated
  - Sections to be generated

Model Building Analysis

In this step you outline all the steps you expect to use to build the model. This is for your use and doesn't have to be fancy but should be fairly detailed. This is where you realize what is really required to do the project. It is often useful to have Petrel open while you do this and to look through the processes that will be used to remind you of what must be done. Use a spread sheet and have one column for the major process, one for the action to be performed, one for the Number of Hours it will take, and one for a Description of the action. More detail is usually good. Break the table into major areas such as Data Import, Well data Analysis and QC, 2D Gridding, Fault Modeling, Pillar Gridding, Make Horizons, Make Zones, etc. A small portion of this type of spread sheet might look like the table below.

You will find that this analysis table will quickly become your guide to the modeling process. By filling this out you will have mentally walked through the entire modeling process while considering all aspects of the project's data, geologic issues, and goals. When you are asked to justify your time estimates you can refer to this spreadsheet and demonstrate why you need the "extra" time to complete the work. The authors have found that this analysis also helps identify "time sinks" in the project, and have used this information to work with management and other team members to modify the modeling process to reduce or eliminate the "time sinks".

Table: Portion of a spreadsheet used to analyze the work and time required to do a project.

Major Step	Action	Hours Required	Discussion
…	…	…	…
Fault Modeling			**100 faults, 50 vertical joins, 2 Y-faults, 20 well cuts**
	Build Basic faults	17	100 faults at 10 minutes each = 1000 minutes = 16.7 hours
	Join faults (vertical)	3	50 joins at 3 minutes each = 150 minutes = 2.5 hours
	Join Y-faults	2	2 Y-faults at 1 hour each = 2 hours
	Tie to fault cuts	2	20 cuts at 5 minutes each = 100 minutes = 1.7 hours
	QC and Tuning	9	Tuning of initial fault data and continual adjustment of the faults throughout the modeling process at 5 minutes per fault = 500 minutes = 8.3 hours
	Total estimate	**33 hours (4.12 days)**	
Pillar Gridding			**100 faults, 12 fluid areas, WNW X-cell direction**
	Boundary Definition	1	Define boundary: part faults and part 3D seismic data edge = 1 hour
	Fault Direction	1	Direct the faults (2) associated with Y-faults and as needed to control the cells (10) = 5 minutes each = 60 minutes = 1 hour
	Trend Direction	1	Add trends as needed to control cell orientation and quality (10 trends) at 5 minutes each = 50 minutes = 0.8 hours
	Segment Refinement	2	Add trends and directed faults to fully define the fluid areas, 12 areas at 10 minutes each = 120 minutes = 2 hours
	QC and parameter tuning	5	Alter Pillar Gridding parameters, trends, etc. while checking the result in 3D until acceptable. Continue adjusting throughout modeling process. General QC and tuning = 2 minutes per fault plus 2 hours = 200 + 120 minutes = 5 hours
	Total estimate	**10 hours (1.25 days)**	

Make Horizons			**…**
	…	…	…

Proposal

The proposal contains several parts, each critical to convincing the client that you know what they want, understand the data and geology, have a plan, know how long it will take, and know what it will cost. Commonly included parts might be:

Introduction

The introduction is where you summarize the entire project in one or two paragraphs. You clearly define what the client wants done, the part of the work you plan to do, and how long it will take to do it. Keep this short and to the point. Management needs to be able to read this section and know the scope of the project and deliverables without having to read everything else. If you do not wish to mention costs in this section and they are important, then you should say where in the document they are discussed or that they will be covered at another time.

Data/Geology

In this section you describe the data you plan to use as input to the modeling process. While doing this you describe, aspects of the field's geology you consider critical to modeling. Data descriptions might include:

- The general description: thickness and areal extend of the model, number of horizons, zones, and their stratigraphic relationships, general rock types, depositional environment, facies that will be modeled and gross trends of the layers, faults, and rock bodies.
- Basic data: the number of wells, tops, fault cuts, and logs, the fluid contacts, the number of seismic horizons and faults as well as whether 3D cubes, 2D lines, velocity models, and amplitudes will be used.
- Special data: transition zones descriptions for water saturation, transforms that must be provided for por-perm modeling, and other statistical information from this field or neighboring fields critical to building the model.

Geologic high points to mention might include: baffles or conduits that impact production, geological trends both vertically and laterally that impact porosity, N:G, etc., boundary conditions that affect the model, and so on. You are listing these to ensure that 1) you consider them during the modeling and 2) to show that the modeling process has the ability to incorporate these geologic issues (or not). Geologic or engineering uncertainties should be mentioned and, if they are considered significant, you should describe how you will handle them.

Modeling

The modeling section describes the product the client will receive and some of the key components in the modeling process. A list of the deliverables goes here or possibly in a section by itself. Any reports that will be generated should be described (a report should always be generated, outlining all steps and assumptions made when modeling). If the client is new to modeling, you may want to provide a brief but informative outline of the modeling flow as it relates to this project (use the Petrel process list in the order they are executed as the outline for this). The Modeling Analysis you did in the previous step could be included as an appendix and referred to in this section.

Time Estimate

A table containing each modeling step followed by an estimate of time (hours) it will require is created. This would be a subset of the Modeling Analysis described in the previous section. The hours are summed. If the project could be done quickly by eliminating some deliverables or steps, then two tables or two columns might be used, one for the short version and one for the long. The times are recorded in the same units used for calculating the cost (hours if costs are in $/hour, days if cost are in $/day, etc.). The times are totaled. You may wish to include a "fudge" factor at the bottom to account for the unexpected. This is a multiplier applied to the final hours. We often use 1.25, which jumps the hours up by 25%. It is amazing how often that extra time is required to complete the project. The following table is an example of what this time estimate might look like.

Table: Example time estimate for project to be modeled using two approaches, both are to be done.

Activity	Estimate in hours
Build structural framework	24
1-Build average property grids	8
1-Convert property grids to model values	8
1-Generate displays and calculate volumes	8
1-Upscale for simulation	8
1-Total	56
2-Build facies model	24
2- Build other properties	24
2-Generate displays and calculate volumes	8
2-Upscale for simulation	8
2-Total	64
Sub Total	120
Unexpected Factor (25%)	30
Grand Total	150

Cost

In this section the rate you will charge for the work is listed. If several people are working the project at different rates then that is explained. The costs for expenses likely to be incurred are detailed. You then provide a listing of the hours to be performed by each individual and the expenses they will likely occur. Add to that any other costs. If a short and long version of the project was described then provide estimated costs for each.

Turn-key projects, which use a set rate for all work to be done, are liked by some clients because they lock in the cost to get a product. This approach can be risky unless you have really tied down the work to be done. It is risky to both the client and to you. To the client the risk is that you have underestimated the costs and might be tempted to push the project through quickly and do the work poorly to stay within budget. Risky to you because, if underestimated, you will receive less than your normal rate for the work. Whether charges are by turn-key or by the hour should be clearly stated in this section.