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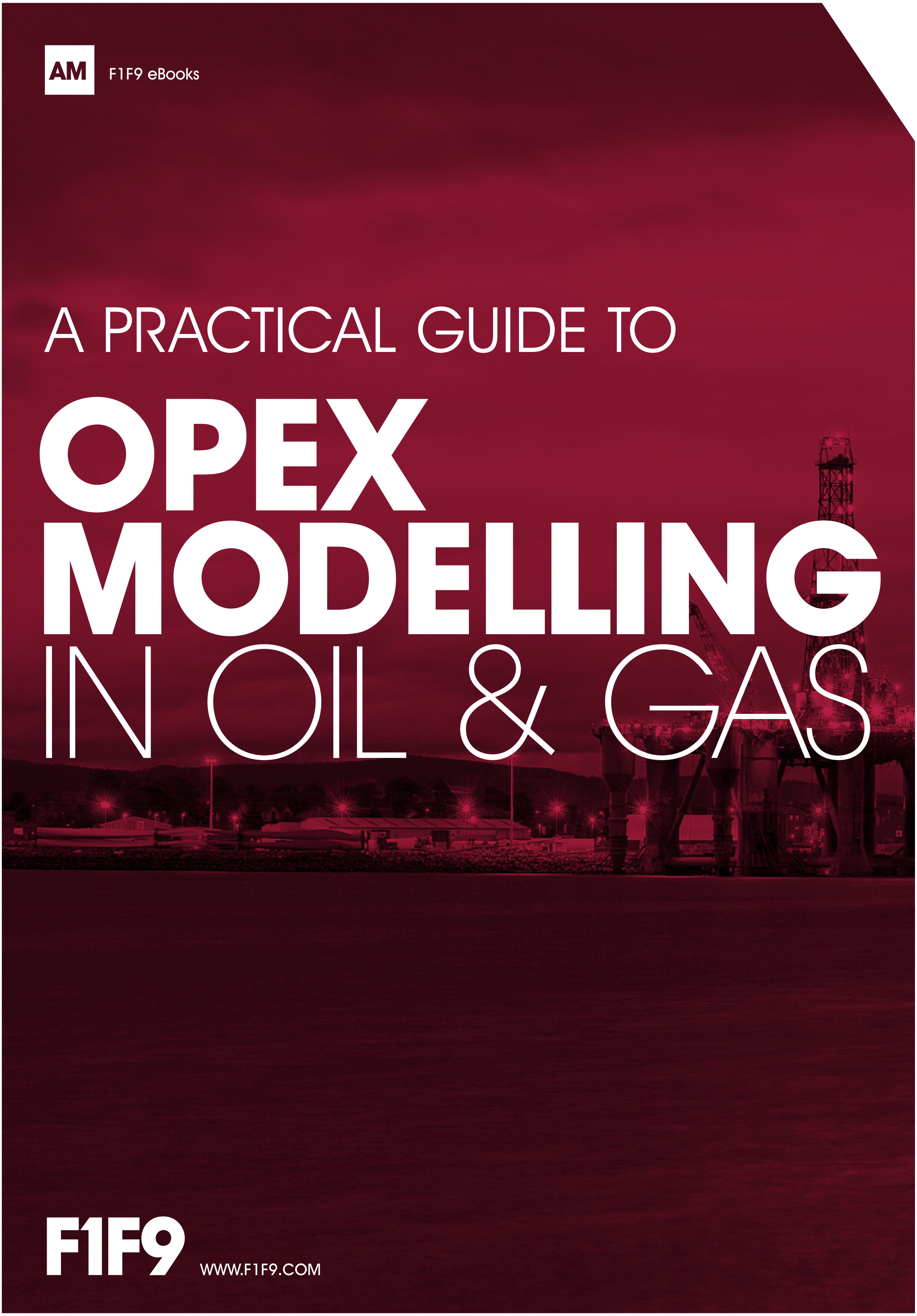

A PRACTICAL GUIDE TO

OPEX MODELLING IN OIL & GAS

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FMH

FINANCIAL MODELLING HANDBOOK

We occasionally publish materials from the Financial Modelling Handbook. These typically contain step by step instructions on topics that are common to all financial models, tending to focus more on "construction techniques" which can be used in all modelling situations.

THIS GUIDE → AM

ADVANCED GUIDES FOR MODELLERS

These guides are often related to specific code modules that are useful for sector specific models.

MM

GUIDES FOR MANAGING MODELLING ASSIGNMENTS

Managing modelling assignments requires a separate skill set from building a model, especially where a team of modellers is involved. These books provide guidance on the process and risk of model build assignments, as well as recommendations on managing modelling teams.

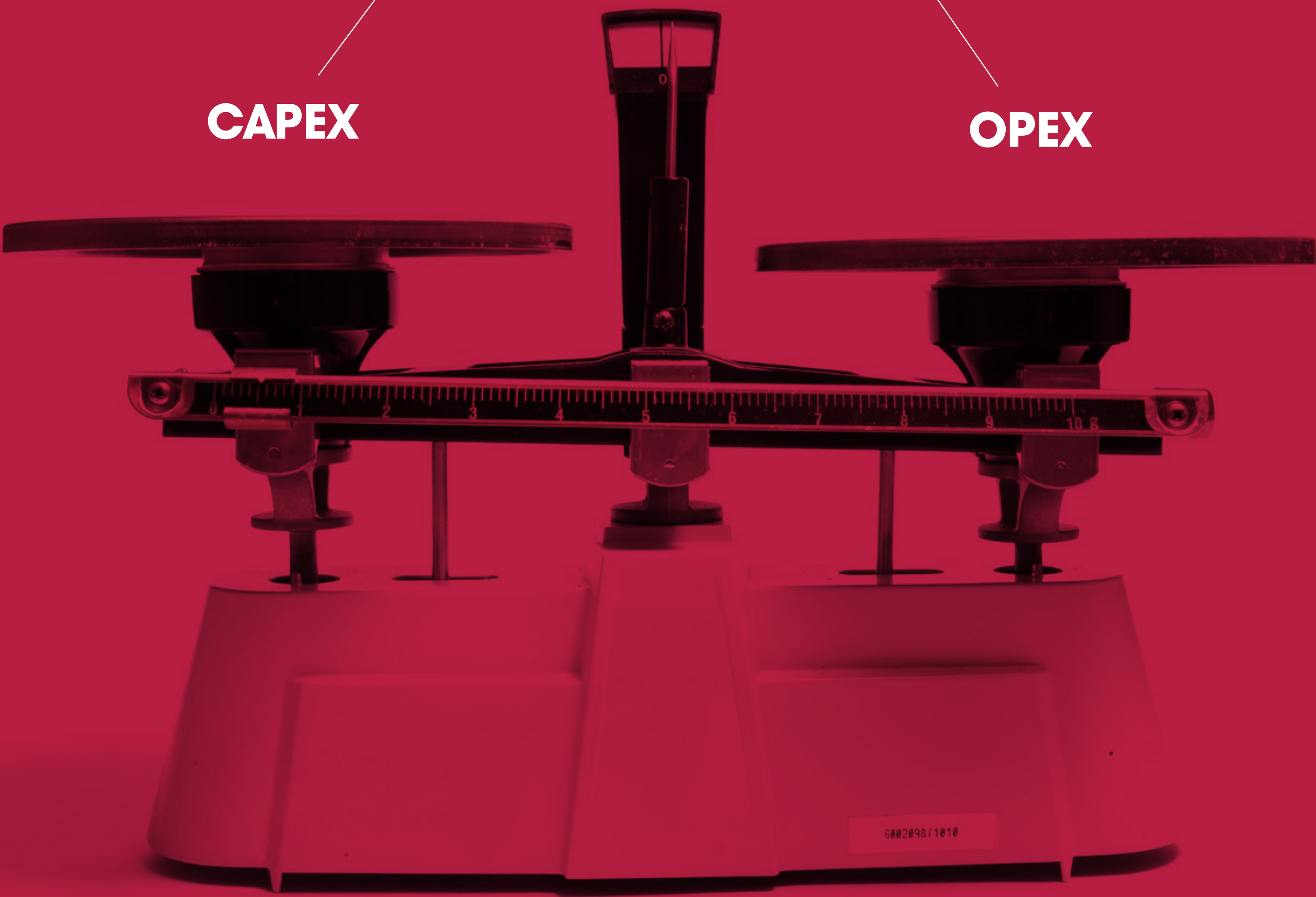
CG

COMMERCIAL GUIDES

These contain sector specific commercial guidance that is useful for modelling and modelling managers. As we know, spreadsheet modelling begins with a conceptual understanding of the business situation. (If you didn't know that – check out our ebook "An introduction to the business analysis lifecycle.") These guides aim to increase your conceptual understanding of a specific topic.

CONTENTS

WHICH IS MORE IMPORTANT ?



ABOUT F1F9

F1F9 provides financial modelling and business forecasting support to blue chip clients and medium-sized corporates. We also teach financial modelling skills to companies around the world. Our clients have access to high quality, low-cost modelling support delivered by over 40 professional modellers.

F1F9 co-developed the FAST Standard that allows modellers and non-modellers to work together and understand financial models. Transparency is the core value that drives our modelling and our business activities.

F1F9 OIL & GAS TEAM

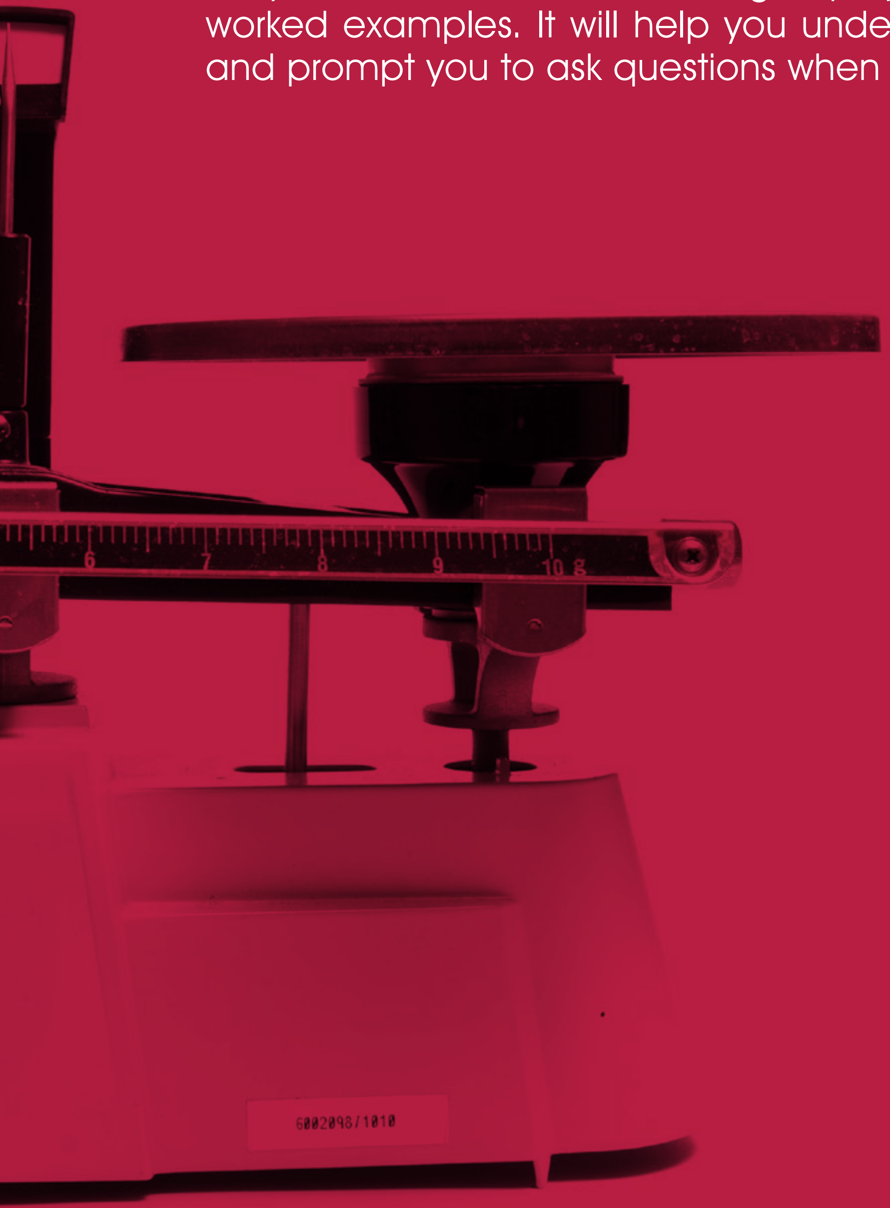
F1F9's dedicated Oil and Gas modelling team is led by Danie Prinsloo. Danie has more than 18 years of oil and gas experience. With a strong technical background in chemical and process engineering and a further qualification in computer science, Danie has worked in a number of major commercial functions and gained extensive experience in strategy development, project evaluation, business development and commercial agreements.

Danie's commercial negotiation and valuation experience covers Algeria, Australia, China, Iran, Latvia, Lithuania, Malaysia, Netherlands, Nigeria, Qatar, Russia, South Africa, Tanzania and the United Kingdom. He has a proven ability in the development of multibillion dollar energy investment opportunities and providing the financial models used to support these investments while ensuring high standards of quality control are maintained.

INTRODUCTION

Ask a modeller in the oil and gas industry about costs and chances are they will think that capital expenditure ("capex") is way more important than operating expenditure ("opex"). Yet over the life of the project, opex is often a much larger number than capex. In addition, it can be difficult to model.

This guide will help you understand the types of opex that you are likely to encounter in oil and gas projects. It will provide you with worked examples. It will help you understand why opex is important and prompt you to ask questions when you are modelling.

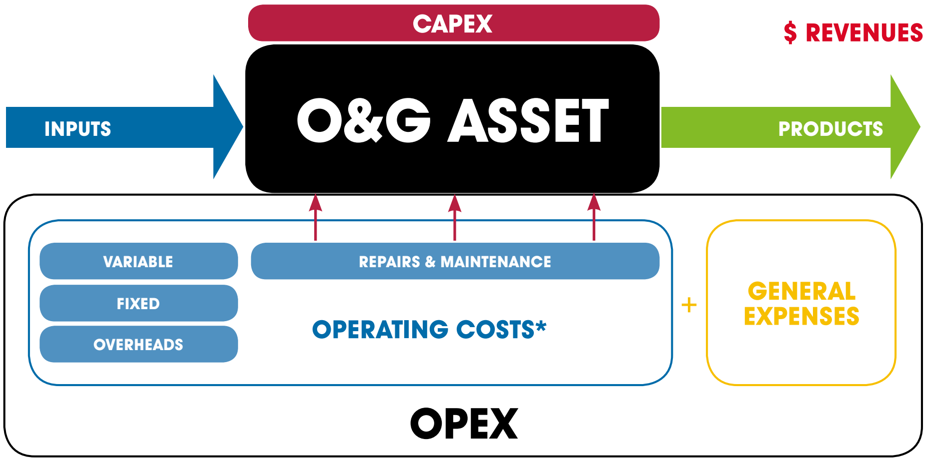


UNDERSTANDING HOW TO MODEL OPEX

Oil and gas assets take inputs and turn them into products that earn revenue. Opex is incurred throughout the life of the asset and is significant. Opex is not always charged or paid for on a uniform basis. This can lead to complexity in modelling.

Figure 1 is a picture of the revenue generation process arising from the capex and opex investment in an oil and gas asset.

Note: Engineers may not all use the same definitions and can use different definitions to mean the same thing. E.g. Direct Production Cost is commonly referred to as Variable Production Cost.



* Sometimes referred to as *manufacturing costs.*

Figure 1: Simplified schematic of revenue generation

Operating Costs = Direct Production Costs + Fixed Charges + Asset Overhead Costs
Total Opex (or Total Production Cost) = Operating Costs + General Expenses

Applications of opex modelling

Opex will have a material impact on the potential profitability of a project – and therefore its dividend policy. So opex modelling is key to identifying an optimal solution from a number of possibilities.

Sensitivity analysis on opex will be required to support decision making. Opex modelling will be required to assess the parameters over which the project can operate and still be sustainable.

How and when is opex estimated?

As economic and financial modelling is crucial at each phase of project development (Figure 2), a key objective of the modeller is to represent the timing of expenditure as the project develops and data changes.

The level of detail in forecast opex increases as the development phase matures. Models will need to accommodate increasing granularity of data. The advantage of a model built to the FAST Standard is that it is simple to add extra levels of detail whilst maintaining the model's robust structure.

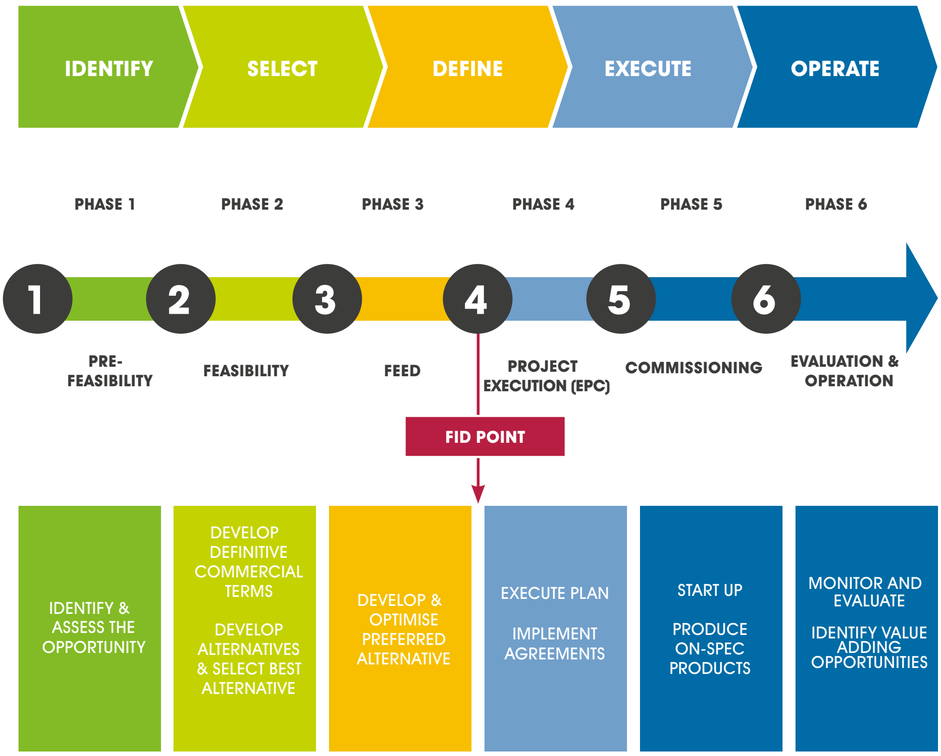


Figure 2: Phased development of an oil and gas industry project

'Top-down' opex estimates

During the pre-feasibility and feasibility stages, it is common for engineers to apply a top-down approach to appraising opex. Non-deterministic methods are usual at this stage and forecasts are often made on a real basis (i.e. excluding inflation).

The initial estimate may simply be a single value of total annual expenditure. This may, for example, have been derived from the capex estimate, or be based on similar projects or a 'rule of thumb'.

During the feasibility stage engineers will create process flow diagrams. This will allow a more detailed opex estimate by enabling estimates to be broken down by cost category.

A licensed commercial tool (such as QUE$TOR) will often be used to estimate costs.

‘Bottom-up’ opex estimate

As the preferred project becomes more clearly defined, greater detail emerges around the operation of the asset. Engineers and design teams:

- Produce heat and mass balances;
- Size and generate equipment lists;
- Optimise inputs and outputs, and
- Develop philosophy documents such as redundancy and sparing, operating and maintenance, etc.

Given the increased detail now available, it is possible to change the approach to opex estimation:

- We can start to use deterministic methods;
- Estimates can be created on a nominal basis;
- We can estimate individual items of variable and fixed costs with higher levels of confidence and accuracy.

This allows a detailed bottom-up estimate of opex to be generated. This will have a greater level of detail of the different types, breakdown and categories of expenditure.

The form in which data will be provided varies according to the type of costs. Examples of the different types of basis include annual, per unit of production, per day of operation, and per event or cycle.

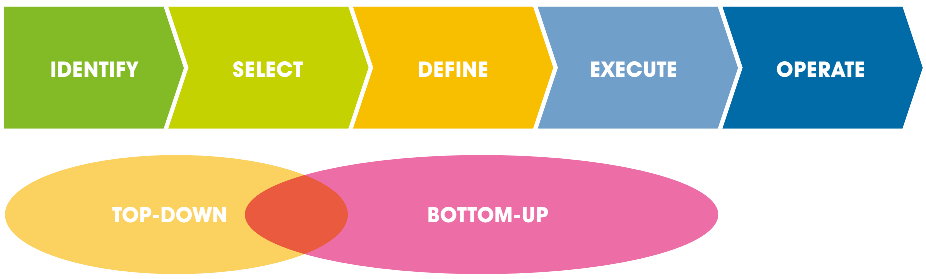
Annualisation of opex

Even during this more detailed ‘bottom-up’ stage, some costs may still be annualised. Annualisation of opex has advantages, chiefly in the early stages of project development. These include:

- Seasonal variations are evened out;
- Onstream factors are considered;
- Infrequently occurring large expenses are factored in (such as scheduled maintenance shutdowns);
- Annual basis can be readily converted to other bases;

However, annualisation does not represent the reality of cash flow. A typical mistake, post-feasibility, can be to try to continue to analyse groups of costs into a single annual figure.

Figure 3 shows, in general terms, the timing and the difference between top-down and bottom-up estimates.



- Initially single figure
- Later breakdown by category
- Split out of main items
- Non-deterministic
- Real basis

- Breakdown by category & item
- Different bases for different items
- Scenarios
- Deterministic
- Nominal basis

Figure 3: ‘Top-down’ versus ‘Bottom-up’

MODELLING OPEX IN OIL & GAS

In the pages that follow we set out a categorisation of opex. We have also provided two industry case study examples, with worked solutions in Excel, containing some of the different types and nature of opex that you will typically model in oil and gas projects.

The categorisation of costs presented is not hard and rigid, and the division between costs can be somewhat arbitrary and can be dependent upon the interpretation of variable, fixed and overhead costs. Certain items of expenditure can be classified without question, but the classification of other items can depend on further factors – even the accounting practice of an organisation.

It is important that modellers check and clarify assumptions. Make sure that you are clear on the assumptions and the basis for all items of opex, and the dependencies and timing of costs.

Direct costs are associated with running the asset. Indirect costs are associated with running the business.

DIRECT PRODUCTION COSTS

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DIRECT PRODUCTION COSTS

Overview

Direct production costs are associated with the level of production. Production volume is a key driver in calculating direct production costs.

Examples

- Feedstock / raw materials
- Operating labour
- Operating supervision
- Power / utilities / services
- Operating supplies
- Maintenance and repairs
- Laboratory charges
- Royalties / patents / licences
- Catalysts / chemicals / solvents

Issues to look out for

Commonly referred to as Variable Production Costs – it should be recognised that some items of direct costs will have elements of fixed costs in them (not to be confused with fixed charges): for instance, maintenance and repair costs decrease with reduced production level, but some maintenance and repair costs still occur when the plant is unavailable.

Cost may be directly proportional to production or may benefit from economies of scale.

Direct production costs are much less straightforward to model than fixed charges, asset overhead costs and general expenses: different items within one individual direct costs element can be dependent on multiple bases—this is demonstrated in Examples 1 and 2.

TIME DEPENDENT COSTS

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TIME DEPENDENT COSTS

Overview

There are items of operating costs that are triggered by a timing assumption rather than being driven directly by the level of throughput or production.

Examples

- Major shutdowns for maintenance and repair
- Catalyst change-out / replacement
- Operating supplies / spares replacement
- Equipment inspection / overhaul
- Routine maintenance (e.g. painting)

Issues to look out for

Is the cost cyclical with a set pattern (as may be the case with major shutdown)? Or is the item of cost driven by time elapsed or total number of hours of operation, etc. (as may be the case for maintenance of items of equipment)?

Do distinct periods or durations occur that have to be flagged and modelled separately?

Check whether engineers have used published values for mean time to equipment failure, for individual equipment costs.

Example 2 in this ebook demonstrates solutions for modelling time dependent costs.

FIXED CHARGES

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FIXED CHARGES

Overview

Fixed charges are incurred regardless of the level of production.

Examples

- Depreciation
- Local taxes (property)
- Asset insurance
- Rent
- Financing (interest)
- Lump sum royalties, etc.

Issues to look out for

Depreciation, property taxes and insurance are costs related to the capital investment in the project / asset.

Interest may be included as a fixed charge but because of its importance may be treated separately.

Engineers concentrate on direct production costs and may not provide any estimates of these charges. Where estimates have been made, they may have been made using arbitrary factors, taken from published sources or obtained from a commercial package.

ASSET OVERHEAD COSTS

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ASSET OVERHEAD COSTS

Overview

These are expenses incurred to allow the asset to function as an efficient unit. The nature of these costs is similar to fixed charges in that they do not vary widely with change in production.

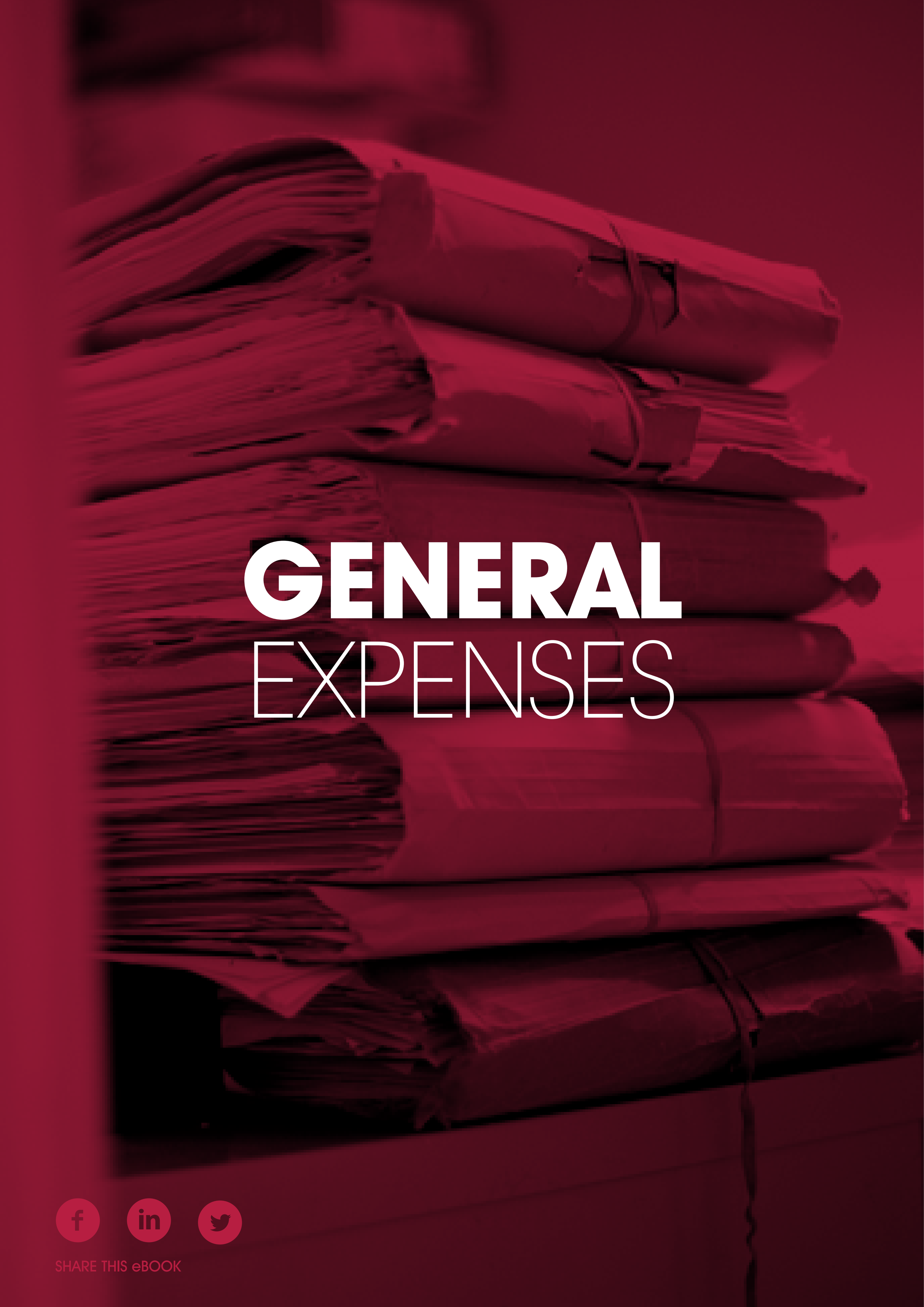
Examples

- HSE and protection
- Medical
- General plant overhead
- Payroll overhead
- Recreation
- Restaurant, etc
- Salvage
- Control laboratories
- Plant superintendence
- Storage facilities

Issues to look out for

May be categorised as indirect costs or indirect production costs. Initial estimates likely to be factored as a percentage of the direct production costs.

GENERAL EXPENSES



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GENERAL EXPENSES

Overview

General expenses relate to the operations of the company. There are three main categories of general expenses: administrative, sales and marketing, and research and development.

Examples

- Administrative expenses
  - Executive salaries
  - Clerical wages
  - Central engineering and technical
  - Legal costs
  - Office maintenance
  - Communications
- Sales and marketing
  - Sales office
  - Personnel expenses
  - Shipping
- Research and development

Issues to look out for

How have the elements been estimated? Be clear what the dependencies of different elements are.

Check which categories of general expenses should be included and which are not relevant – e.g. is an allowance required for R&D?

OPEX MODELLING CHECKLIST

Definitions and basis of assumptions

- **Check** the definitions used by the engineers – do you really understand them?
- **Clarify** anything that is not clear or has not been explicitly specified.

Helpful Modelling Guide: Using Placeholders

Timing and dates

- **Confirm** the timing of each item of opex.
- **Check** the base date and base index for to be used for each item.

Cost drivers

- **If a cost is variable, what drives it?** Does it vary with production, an input, time, or another metric?
- **If a cost is fixed, is it time dependent, cyclic, etc.?** Is it linked to another event such as a shutdown?

Overlooked or missing items

- The largest source of error in opex estimation can come from overlooking one or more elements of cost. **If you cannot identify an element of cost—check it,** as it might have been omitted or lumped with other items.
- **Have engineers used a proforma, checklists, or other aids?** If so, it can be useful to obtain copies as these might help to identify missing costs, and help in checking definitions, etc.

Annualisation

- **Have engineers annualised any major cyclic cost items?**
- If so, **obtain details and check** whether the timing of the actual cashflow will have an impact.

Feedstock / raw material costs

- Feedstock / materials costs are commonly the largest operating cost. **Do you know how feedstock prices have been obtained?** Prices may be projected, have a dependency on commodities, or have been obtained from suppliers or from published data.
- **Have you checked how the cost basis may change during the project?** For example, the price of a gas feedstock may be fixed, subject to normal escalation, for the first five years of operations, but thereafter switch to another basis such as a function of dated Brent crude oil price.
- **Do raw material costs vary depending on quality delivered or quality required?**
- **Are there any by-products or scrap costs to take into account? (Note these can also sometimes represent an income line item.)**
- **Are there any quantity discounts?**
- **What other supplies, catalysts or chemicals should be considered as raw materials?**
- **Have fuels been categorised as raw materials or utilities?**

Catalysts & chemicals

Catalysts and chemicals, unlike raw materials, usually refer to those materials that are not directly consumed in making the final product but which are necessary to carry out the process operations of the oil and gas asset.

- **Check the basis of catalysts and chemicals usage** – items may be consumed in proportion to feedstock throughput or production rate, but may be replaced on a cyclic basis such as catalyst beds.

Operating labour

- **Do you know the basis and breakdown of the estimate?** In preliminary cost analyses, the quantity of operating labour can often be estimated from company experience of similar projects or assets, or from published information.
- **Do you know what the relationship is between labour requirements and production rate?** It is unusual to be linear and a power factor is common.
- **Is operating labour divided into skilled and unskilled labour? Do sub-classes of labour apply?**
- As more detailed engineering takes place, **has account been taken of the types of worker required, geographic location of the asset, prevailing wage rates, and worker productivity factors?**

Operating supervision

How has this item been derived? Has it been factored from the Operating Labour, as typically is the case in the feasibility stages?

Supervision may remain fixed in the event of reduced capacity of the asset.

Utilities

The cost for utilities vary widely depending on the amount of each utility needed, asset location, and source.

- **Make sure you determine and understand how the estimate has been derived** by engineers (since this will change during the project).
- A utility may be purchased at a predetermined rate from an outside source, or may be a service with the company. **If the latter, is it a shared service?**

Maintenance & repairs

Annual costs for maintenance and repairs can vary from as low as 1-2% of capex for a simple process to up to around 20% as complexity, corrosive conditions etc. increase.

- **Does a split between labour and materials exist?** Initial estimates may assume a 50:50 split.
- Maintenance varies with rate of operation but not in a linear fashion. **Have costs as a percentage of 100% of capacity been estimated by engineers?**
- Maintenance costs tend to increase with equipment or asset age. **Check whether average values have been used or whether there is an element of time in costs.**

Capex vs routine expense?

Confirm what is being categorised as capex vs routine expense. (As a rule: if the expenditure increases the value of the asset, it is capex; while if it simply keeps the asset in working condition, it is a routine expense.)

OPEX
CASE STUDIES

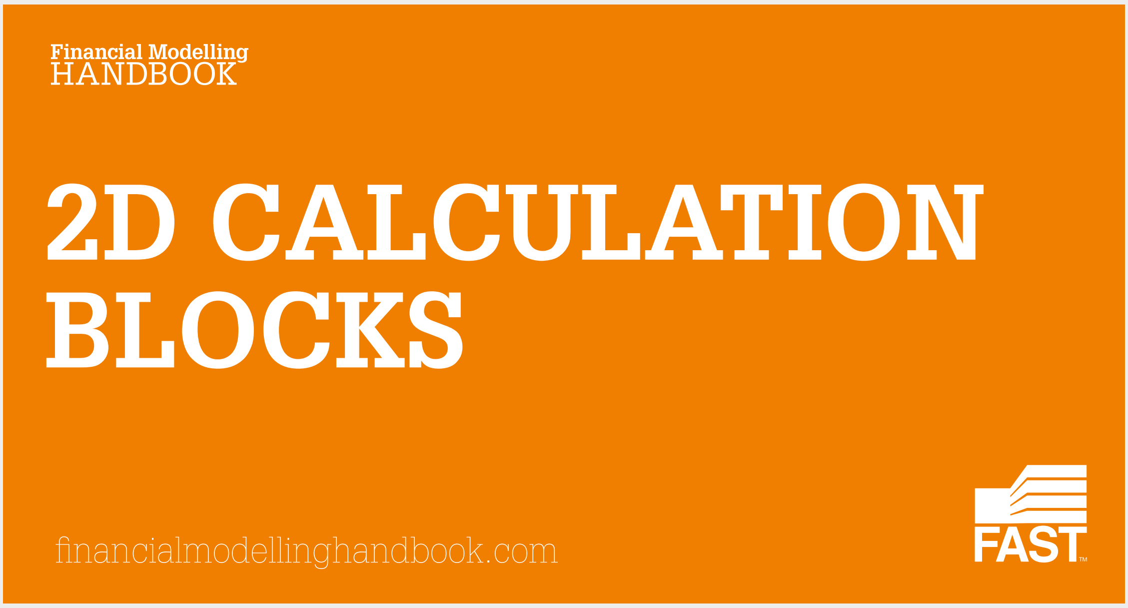
CASE STUDY
WORKING FILES

Download and review the worked example Excel files
The worked examples have been built to the FAST Modelling Standard.

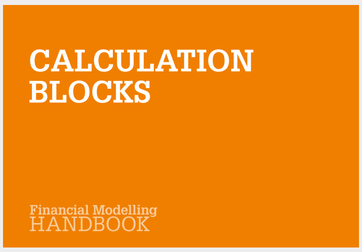
USEFUL INFORMATION
2D CALCULATION BLOCKS

The worked example files have been prepared according to the FAST Standard. In particular, a structure has been used that is known as a "2D calculation block".

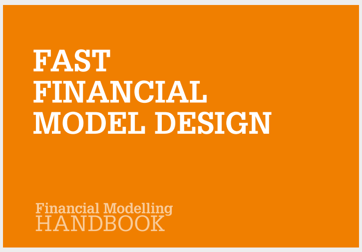
If you are not familiar with this structure you should check out this guide from the Financial Modelling Handbook.



The following might also be useful if you are new to FAST:



Calculation Blocks



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OPEX CASE STUDY EXAMPLES

In **Example 1**, you are faced with modelling a variable opex cost element, 'Catalysts and Chemicals', which also features two cyclical cost components, the period of each cyclical cost component being different.

Example 2 features the requirement to model maintenance costs that consist of a mix of direct production costs, having both a fixed and variable element, with individual components that vary with time period, vary with cycle, have a dependency on an event, are of different duration and / or change incrementally.

Example 1: FLOATING LIQUEFACTION PROJECT

Your company is assessing an opportunity to monetise a stranded offshore gas resource by investing in a Floating LNG ('FLNG') project to process well fluids and produce liquefied natural gas (LNG) for export plus by-product liquids (condensate and LPG). The project is at the stage of selecting the best alternative and a decision to commit to a front-end engineering design study is under contemplation.

Initially, you had been provided with a single, annualised opex value that you applied in your model, subject to the appropriate escalation.

Following further engineering, estimates have been made for the fixed and variable components of opex. One item of the variable costs is Catalysts and Chemicals which is currently estimated as a cost per unit of flowrate of well fluids into the FLNG vessel: the cost being 'guesstimated' by process engineers based on 'rules of thumb' for onshore plants. Consequently, the financial model has a single input for Catalysts and Chemicals.

The senior process engineer has been assessing different options for the design, for the topsides equipment of the FLNG, to process and treat well fluids (including acid gas removal, dehydration and mercury removal) prior to liquefaction. Annual quantities of consumable chemicals have been estimated for the base-case design scenario (at the current status of project development, quantities are not yet available as a function of production). Mol sieve and mercury removal beds are not consumables but are replaced at fixed cycles of 3 years and 7 years, respectively.

Example 1:

You have been asked to model the annual cost of Catalysts and Chemicals for a 25 year operational life of the base-case FLNG project based on the information provided in Table 1 and, for simplicity, assuming a start date of 1st January 2014. Mol sieve and Hg removal bed costs are not to be modelled as averaged annualised values, and the cost of the first cycle of each is to be included in Year 1 of operations. There is no need, at the present level of detail, to structure the model to deal with partial periods. Costs are assumed to escalate at 2.5% per annum.

	Quantity	Duration	Cost
Amine	1,000m^3	Per annum	$10.0/litre
Mono-ethylene glycol	3,800m^3	Per annum	$1.4/litre
Inhibitors:			
Corrosion	40m^3	Per annum	$4.0/litre
Scale	20m^3	Per annum	$4.2/litre
Wax	600m^3	Per annum	$3.8/litre
Misc. chemicals & lubricants, etc	-	Per annum	$60,000
Mol sieve	320m^3	Replaced on a 3 year cycle	$4.4/litre
Hg removal bed	50m^3	Replaced on a 7 year cycle	$24.0/litre

Table 1: Catalysts & Chemicals

Model

The key to modelling the cyclical costs is to generate flags to represent the year in which each item of cost is incurred. In the Excel file, Rows 116-122 of the opex sheet of Example 1 demonstrates a solution for setting up the required frequency flags for each of the different items constituting Catalysts and Chemicals.

Example 2:

ONSHORE OIL & GAS PROCESSING FACILITY

Your company is looking at a new prospect for an onshore facility. At the pre-FEED stage, the current version of the financial model has been based on the overall capex being $3.6 billion with annual opex for the onshore facility (excluding offshore) having been factored at 5% of overall capex, i.e. $180 million per year. Of the opex figure, engineers have to date, assumed maintenance costs to be 20% of the total annual operating costs based on previous experience, i.e. $36 million. Cost of maintenance, consequently, is currently modelled as the all-inclusive annual figure of $36 million including maintenance staff, outside contractors and materials, and includes allowance for the costs of maintenance shutdowns.

The Operating and Maintenance Philosophy is under development and includes the requirement to '… use a minimum manpower and achieve an as low as practical life cycle cost ...'. Maintenance requirements are divided into three areas: scheduled maintenance, routine maintenance and corrective maintenance. There is planned to be a dedicated Maintenance Team.

However, it is the philosophy that the project Shift Operators will be required to undertake many of the maintenance tasks including routine maintenance (and this cost is to be allocated under Operations rather than Maintenance). Specialist contractors and contractor services are utilised for major overhauls within the annual scheduled maintenance and during major maintenance shutdowns.

The engineering department is assessing the lifecycle costs of maintenance covering the project's permanent Maintenance Team and buying in of specialist contractor and contractor services to cover scheduled maintenance.

You have been asked to provide additional granularity in the financial model for Maintenance costs, and to ensure that your model is flexible enough to cope with additional cost breakdown as it becomes available, based on the information below. Instructions are to model maintenance costs for 25 years of continuous operations, on an annual basis, from a start date of 1st January 2020 (all costs are provided on a 2014 basis and the escalation factor to be used is 3.5%).

- **Maintenance Team:**
  - 1 x Maintenance Manager, annual salary $200,000.
  - 1 x Maintenance Planner, annual salary $80,000.
  - 8 x Maintenance Engineers (all disciplines inc. supervisory), annual salary $130,000 per Engineer.
  - 12 x Maintenance Technicians (all disciplines), annual salary $90,000 per Technician.

- **Major Maintenance Shutdown Costs:**
  - Cyclical – every 5 years.
  - $60 million 1st major shutdown.
  - $55 million 2nd major shutdown (building on lessons learnt from 1st shutdown).
  - $50 million 3rd and subsequent major shutdown.

Example 2:

- **Maintenance Materials and Spares:**
  - Includes items such as consumable materials, spares, specialist contractors and contractor services, outside maintenance service and vendor services.
  - 0-2 years: Equipment new and spares available from Owners cost. $4 million per year.
  - 3-5 years: Some equipment needs to be replaced / overhauled. $10 million per year.
  - Year 6 onwards: All equipment needs maintenance. $14 million per year, increasing by $1 million year-on-year except for years when a major maintenance shutdown is scheduled to occur (in which case no increase on the previous year).

Model

The Opex sheet consists of:

- Inputs (Rows 7-47)
- Timing (Rows 50-171)
- Escalation (Rows 174-179)
- Operating Cost (Rows 182-262)

A key part of the solution is the setting up of the timing flags for the different element of the Maintenance costs:

- Operational period flags and period of operations.
  Row 84 sets up the first operations flag.
  Row 88 sets up the last operations flag (for a 25 year period of operations).

- Maintenance shutdown period flag.
  Three flags are required to represent (i) the 1st, (ii) the 2nd and (iii) the 3rd and subsequent shutdowns.
  Rows 98-135 set up the relevant maintenance shutdown period flags.

- Maintenance equipment replacement flags.
  Flags are required to identify the three distinct durations so that the different opex cost rules can be applied for each duration.
  Rows 137-171 set up the relevant maintenance equipment replacement flags covering each duration.

It is necessary to apply an annual increase in the cost of maintenance materials and spares for duration 3 (i.e. Year 6+), provided a major maintenance shutdown is not scheduled for that year. Rows 236-245 show how the relevant duration 3 and major maintenance shutdown flags have been used to apply the required increase in maintenance material and spares costs.

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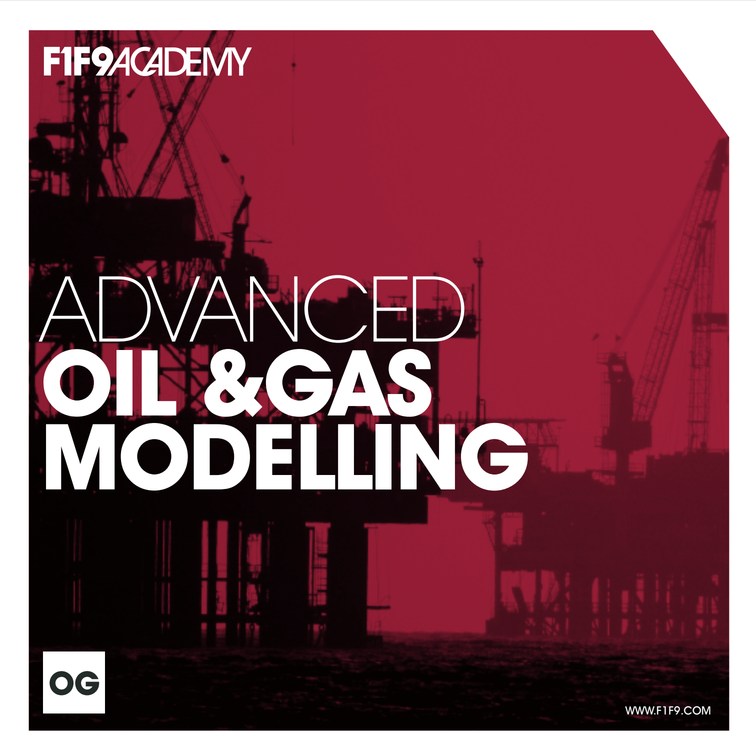

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