# Summary

This rapport describes the development of the *Logistic Concept modelling tool* for the Shell Exploration and Production division, and more specifically, for the Logistics and Infrastructure group within the Operation Readiness and Assurance (OR&A) department.

**The ORP Process**

When developing new opportunities Shell Exploration and Production (EP) uses the *Opportunity Realization Process* (ORP), which is an over-arching framework for maturing all business opportunities from initial idea to value realization. The use of this framework is mandatory for all capital projects in EP with a total gross cost over $20 million. The ORP provides guidelines and rules for developing and executing new business opportunities.  The ORP has the five defined phases of figure 0-1. Each ORP phase has a clearly defined set of tasks, decisions and deliverable for all disciplines involved. Each phase has to be concluded with a Value Assurance Review (VAR) by a Decision Review Board to confirm that all disciplines have met requirements and project value is still assured, before a project can move into a next phase. The first phases of a new development cover the maturing of an 'opportunity' into an oil or gas producing 'Asset'. The subsequent 'Operate' phase covers the producing life of an Asset; the final 'Abandon' phase covers the decommissioning, removing and recycling process of the asset and its infrastructure.


*Figure 0-1*

**The OR&A team**

Any project that exceeds a total cost of 100 million dollar is to be supported by the OR&A team. The main task of the OR&A team is to assure that at the commission and start-up, at the end of the execute phase, the plant is ready for a quick and flawless ramp up of production to target operation levels. Among the Deliverables for Logistics & Infrastructure Engineers during the ORP *Select* phase, is the creation of high level L&I philosophies and *concepts*, for both the E*xecute* ant the O*perate* phase of the project.

**Logistics concepts**

A logistic concept defines how logistic support, for both material and personnel, will be provided over land, sea and/or air; a concept is defined by the locations of bases of operation, e.g. supply- marine- and airbases, and includes the number, type and deployment of transport equipment. For most new developments, a considerable number of alternative logistic concepts is available: a region can have more than one suitable location for an operational base, contain one or multiple (offshore) assets which can be supplied with various combinations and sharing possibilities of logistics resources, e.g. different vessels types and sizes for offshore transport, different truck and rail options for onshore transport. Due to the vast amount of combinations of parameters and the stochastic nature of most of them, the clear distinct set of requirement between the Project and Operate Phase and the potentially changing business environment over time, finding an optimum integrated logistics solution is a difficult task without any system(atic) and/ or software support.

The quality of a logistic concept can be measured in term of performance indicators and the 'optimum' integrated logistic concept, comprising of marine logistics, aviation, land transport and subsequent required infrastructure, will make the best use of synergies between existing and future developments.

Due to the fact that the development of the opportunity is still in ORP *Select* Phase, which implies that parts of the project will not be accurately and completely defined at this stage, the concept modelling tool will focus in optimizing concepts will lie on comparing performance of the different alternatives.

Also, in optimizing logistic concepts, Shell's standards require the impact or exposure to HSSE related matters to be 'as low as reasonably practical' (ALARP). In practice this means that if, for a certain operation, multiple alternatives exist, the safest alternative should be chosen, even if this option is a more costly option. However, the inclusion of 'reasonably practical' implicitly limits the investment to a level where *additional* increase in HSSE performance would require an unrealistic *extra* investment

**Performance indicators for logistic concepts**

- Cost is an obvious driver in selecting the optimum logistic concept. However, it is important to strive for minimum cost while keeping sharp eye for HSSE exposure. In practice, optimum balance between Cost and HSSE exposure, in line with Shell standard practices and guideline, should be found.

- HSSE plays an importance role in decision-making, as around 50% of all incidents and fatalities in the Oil & Gas industry are logistics related. Reducing transport movements or choosing the concept with the safest transport alternative will therefore have a direct and important effect on overall HSSE performance. A recently developed model for comparing the safety of transport modes in any region of the world provides the method and the data for calculation transport safety.

- Shell has set high targets in the reduction of the emission of greenhouse gasses from operations worldwide. Therefore it is decided to include emission of transport movements in this model. During the simulation all vehicle, vessel and aircraft movements are monitored for $CO_2$ (kg) emission.

**The objectives of the concept modelling tool**

A logistic concept can be regarded as a general supply chain solution, with goods and personnel that need to be transported from a certain origin, though a number of intermediate destinations to a final destination. This type of problem has in general the following parameters that need to be determined:

- The number, location capacity and type of plants and warehouses to use;
- The suppliers to select;
- The transportation channels and resources to use;
- The amount of materials to ship among suppliers, warehouses and Assets; and
- The amount of materials to hold at various locations in inventory.

A Concept modelling tool must deliver an optimized concept that defines the above parameters as far as applicable to a specific case. The process of delivering an optimizing concept, should consist of the following three steps, providing the user a system to *control* decision variables, *evaluate* concept performance and to *compare* evaluation results:

1. The tool must be able to assist the user in generating a number of logistic concepts, given the regional information gathered in the Identify and Assess phases. During this stage, the tool should give the user a performance preview based on static calculation.

2. Having generated the logistic concept, the tool must evaluate the performance of each individual concept based on a number of key performance indicators that can be found in 3.2 In this evaluation stochastic effects as commonly encountered in the actual supplychain such a weather influences and delays in the systems, must be included.

3. Finally, the tool must provide the user with detailed records of the performance of the evaluated concepts, using a graphical interface to allow non-logistics people to understand the process. The records must give insight in the behaviour of the concept, the robustness for disturbances, the average utilisation rate of resources and infrastructure and the overall performance on the three established Key Performance Indicators.

**Comparing concept performance though simulation**

For the design of the concept modelling tool, the object-oriented simulation approach appears to be the best match to the tool's objectives. Simulation approaches excel in handling complicated model structures, and can provide an accurate and detailed insight in the actual behaviour of a supply system. Furthermore, the flexible Process interaction method enables the model to be easily tailored to specific needs *and* suitable for any future extensions. The drawback of simulation models is a limited ability to *self-optimize* logistic concepts.

**Structure of the concept modelling tool**

Based on the objectives the modular tool structure of figure 0-2 is suggested. This modular set up is chosen for two reasons: First, to allow the user to store data or retrieve during a case evaluation and second, to allow the user to perform the *Concept generation – Concept evaluation* cycled repeatedly without having to go trough *the defining the region step* again.

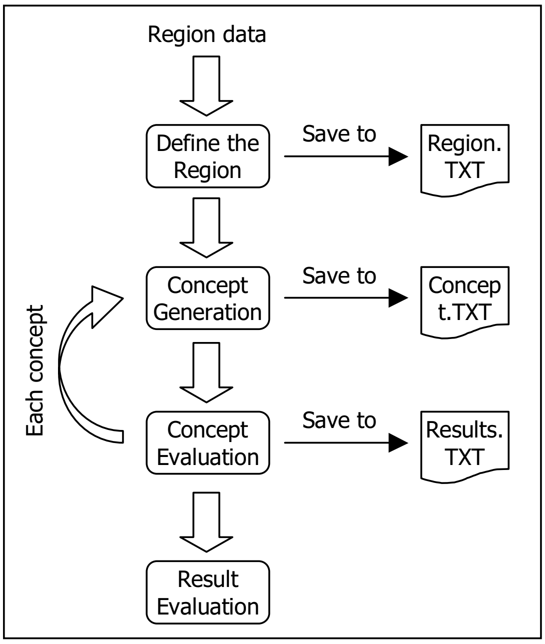


*Figure 0-2, the hierarchical structure of tool layers*

Each tool module has a specific goal:

- Region defining: The goal of this data entry step is to build a data structure with will be used throughout the following steps in modelling a case.
- Concept generation: The goal of this layer is to assist the user with the procedure of building and lining-up of logistic concepts. In this process, the tool will give the user an evaluation of the performance of the concept, based on static calculations. This way, the tool provides the user a quick understanding of the performance of the concepts and enables to filter the most promising concepts from *all* feasible concepts. The generated concepts will then be offered, one by one, to the next layer for a detailed evaluation of their performance.
- Concept evaluation and result evaluation: The goal of this module is to assess the performance of a logistic concept and to bring behaviour and relations to the surface that cannot be assessed in a static calculation. Additionally, the robustness of a concept can be evaluated through a control on stochastic influences.

**The processes in the Concept modelling tool during Concept Selection**

The concept generation module requires the user to define the supply chains to transport personnel and material from origins to Assets. This must be done by the following steps:

- First, the user must assign a Marine and/or Airbase to Asset in the region.
- Secondly, the user must define the route resources will use in supplying the Assets. The user can choose for dedicated trips, e.g. between a base and one asset, or choose combined supply runs, visiting multiple assets in on trip.
- Third, the user must define the inbound side of the marine and airbases, e.g. the vendors and personnel origins.
- Finally, the user must choose and assign resources to Marine- and Airbases.

Initially, the goal of the tool was set towards letting the tool calculate the best choices for each of these steps. It appeared however, that the vast number of interconnected variables defining the optimum base location, supply route, resource capacity and supply strategy, proved too much to capture in a single algorithm.
A simplified algorithm, capable of calculating the optimum vessel route, given a certain vessel size and asset demand, *is* designed and included in the tool. This algorithm presents a simulation solution to the travelling salesman problem with capacity constraints. This means it can define the optimum route from a base to a group of assets, while satisfying the constraint of a limited cargo capacity of the resource.

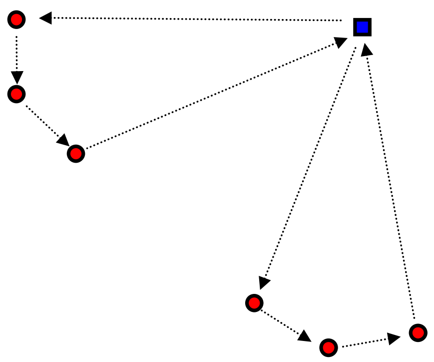

*Figure 0-2, routes between a base and two groups of assets*

**The processes in the Concept modelling tool during Concept Simulation**

The dynamics in the simulation process of the concept evaluation module are predominantly governed by the processes interaction of the object classes. In other words, the predefined processes of the 'active' objects in the simulation, control the simulation themselves.

*Assets Objects*

- Decreasing inventory levels to trigger material flow to the asset
- Requesting personnel shifts to be transported to the Asset
- Requesting personnel shifts to be transported from the Asset
- Handling/Unloading resources

*Marinebase objects*

- Handling/Loading Resources
- Managing own inventory levels and reordering at vendor if necessary

*Airbase objects*

- Handling/Loading Resources
- Transhipping Personnelshifts arriving from origins to Assets and vice versa

*Vendor / Personnel origin objects*

- Providing and dispatching material and personnel transport

**Verification of the tool**

The *verification* of the Concept modelling tool must demonstrate that the tool functions according to the design specifications and that the basic functions of the of the simulation model work correctly. For this purpose, a generic base-case is set up and analysed proving that:

- The interaction between the model elements is correct. A 'demand' is be followed by a 'supply' within the applied constraints of capacity and inventory.
- The difference in results between a 'static' and a stochastically influenced simulation show that the model is suitable for robustness analysis.
- A hand calculation versus a tool calculation of the performance indicators proves that the KPIs are calculated in the correct manner.

**Validation of the tool**

The goal of the validation step is to confirm that the Concept modelling tool produces evaluation results that are in line with the actual or future operation. For the validation step a region of the Southern North Sea is used. The input data for the validation case is sourced from the 'Southern North Sea Vessel Pool' and the local rotary wing operation company. After setting up the region according to the available input data, the results of the tool are compared with history data from the actual operations. During this validation was proven that:

- The simulation model creates a *supply strategy* which is comparable to the actual strategy. In this case, the number of vessel trips from a marinebase to a number of assets from tool results and actual data was compared and found to be approximately equal.
- The simulated capacity of a resource is in line with the capacity of the resource in an actual operation e.g. the impact of speed, range/capacity balance, turnaround times and weather downtime is interpreted correctly.

**Conclusions**

If the project's result is compared to the initial assignment, to indicate which tasks have been delivered and on what front gaps may still exists, it can be concluded that the outcome of this thesis is a tool that ultimately delivers the same result as the tool that was proposed in the initial assignment. This result is that it is possible to use this tool, with respect to all boundaries and assumptions formulated, to find an optimized logistic concept for a generic case.

Further, based on the results of working with the concept modelling tool, it can be concluded that especially the current tool structure of separate modules for building data sets, generating logistic concepts and evaluating this concepts forms a very powerful combination to gain more insights in the results and dynamics of the logistics of the integrated supply chain from vendor to asset. Setting-up and evaluating cases is quite intuitive and transparent. Part of the strength for future development is inherited from the object oriented data structure. But also from a design point of view, the options for future development are kept open by constructed the tool as modular as reasonably practical.

**Recommendations**

The tool operates in the area between global transportation problems and detailed planning and scheduling problems. The tool tries to solve a problem on a high level of aggregation, e.g. the optimum concept over the period of multiple years, by considering the individual loading and dispatching of resources. This is not a problem as long as the tool is used for the right purpose: finding the optimal concept. For any task more specific, more focussed on the smaller scale of planning and scheduling, the tool will need a much more specific and advanced algorithm for dispatching resources.

**Supply strategies**

The current tool is explicitly not for planning and scheduling tasks. It is however tempting to evaluate the possibilities to change to tool's development in that direction. This would require the algorithm for supply strategies to be more sophisticated than it currently is. And doing this would only be useful if the number of materials in the model is increased. But is the tool evolves in this direction, it would be possible not only to work with high level information from the ORP *select* phase but also to process data from for example I-logistics. This would add the functionality to evaluate not only future development but also evaluate *existing* operations.

**Other additions to the model**

In Chapter 4 the analytical or operation research approach for concept optimization is discussed. In this chapter, this method is dismissed as being unsuitable for this task. This does not mean that operation research methods are not useful to implement in parts of the current concept modelling tool. Operations research methods are suitable for solving static optimization problems and making these methods particularity suitable for calculations during the concept generation phase. If this methods prove to be able to handle complex, systems as logistic concepts are, on a button click, then a very powerful combination is created: A tool that self generates and self evaluates concepts *will* be able to find the optimum logistic concept autonomous.