Oil Logistics Modelling

0755996

Abstract

This paper highlights some of the dependencies involved in the operation of a typical oil rig logistics system and how agents can help define the behaviour of processes involved in its operations. A model of the logistics system is built using the tkeden package.

1. Introduction

Modern companies and institutions of today use computational power to build informed decisions involving the analysis of logistical operations. Decisions which are wrongly made can lead to the breakdown of a successful model and lead to acute overspending and inefficiency in the business area.

There are many logistics modeling packages available on the market such as the MACS [6] warehouse management and control system. This is a very complex tool which allows the manager of a business to work out how much efficiency can be gained from certain techniques and effective cost cut backs. The MACS model works by a command prompt system where the user cannot not graphically view the layout of their setup. Also there is a plug in for a logistics package which allows the manager to see the trucks which are on the road, detailed stock tracking, detailed reports on all drops and journeys. This type of package is key to a large logistics infrastructure such as of an oil company that not only transports oil by trucks, but also by ships.

The applicability of an Empirical Modeling – EM approach on oil logistics in the light of the MACS package available on the commercial market for capturing similar behavior, is discussed.

2. An Oil Logistics Overview

Oil is extracted by drilling many kilometers into the earth below. Once the drilling has taken place a pump is used to extract the oil from the ground and fill it into tanks ready for a refining. The refined product is then transported internationally. Transportation can take place either by road, rail or sea.

Problems arise when the transportation link between the refinery and final destinations breakdown. This can be due to a variety of reasons, for example there could be a problem with the pump system, a fire could have broken out at the refinery, the transportation by road may not reach the ship in time and so the ship will have to pay heavy penalties to occupy dock space, which other ships have a time slot booked for.

Hence it can be seen just from these small examples that there can be many combinations of problems which can occur solely during the transportation of the oil from one place to another. The delay in transportation means heavy fines and penalties that the oil company has to incur.

2.1 Management

Management wish to cut as many costs as possible but find it increasingly difficult to avoid certain situations due to the lack of workers in a specific area. To increase workers or resources in an area it can take many months to receive authorization for such a task.

Due to the nature of the oil scenario, there is no one formula which can compute the absolute optimal working scenario and for this reason, strategists

and managers use these kind of models to simulate scenarios and work out possible problems which can occur and the most cost effective solution to them.

2.2 Available Applications

A logistics software package (MACS) can be used by a firm to ease many manual tasks which have to be performed and can offer a very dynamic solution to managing a group of tasks in one user interactive model.

The benefits of such software include

1. An actual event which does not have to occur for it to be modelled.
2. If the models out come is a failure this does not mean a real life situation has also failed. The model can be reloaded and another scenario can be setup very quickly.
3. The fact that this software is only being used to model such behaviour means that the only factors which can govern the speed and outcome or hinder the solution are computational constraints such as processor speeds and available memory for example.
4. For very complex models with a lot of parameters, solutions can be arrived at quickly and efficiently.

3. Empirical Modelling Concepts

Empirical Modelling was created by Meurig Beynon and Steve Russ at the University of Warwick. This area deals with creating computational programmes which are not bounded by the user constantly having to edit lines of code to produce certain results. The aim of EM is based on the Human Computer Interaction field, hence by making it easier for humans to be able to change a model using a drag and drop procedure as opposed to going into some coding technique to find a line of code which corresponds to a certain procedure and has some effect on a graphical user interface – GUI. Hence Empirical Modelling uses a direct visual approach for the user. This allows the user of a model to amend a model without coding.

3.1 Concepts

An Empirical Model is said to be informed by past experience and is subject to modification in the light of future experience. An Empirical model is based on three fundamental concepts

1. Observables
2. Dependency
3. Agency

Observables are features of the situation or domain that we are modelling to which we can attach an identity.

Dependency captures the relationship amongst the observables that we are modelling in a domain and provides an overview of how the observables are linked within a change which may occur within a model. There is a key difference in a dependency in EM and a constraint within object oriented programming for example, a constraint is defined as a “limitation or restriction”[1] hence in essence a constraint cannot be changed within an object oriented program. In terms of an EM model dependency on the other hand the relationships are the users’ current expectations about how a change in one variable will affect the value of another in an open ended exploration. The concept of dependency can be seen in a spreadsheet and has been an inspiration to many pieces of work associated with end user programming paradigms.

Agency is the idea of an agent which is an entity in the domain being modelled that is perceived as having the capability of initiating a change in state. The development of an EM model involves the agent evolving with the construal.

Construal is used to describe artefacts which embody a modellers understanding of a certain situation. The significance of such an artefact can be personal to a modeller hence working with a model within the head of the modeller. This cannot be considered in isolation from the context in which the artefact resides. The reference of the artefacts, follow the science of a scientific philosopher – David Gooding.

4. Application of Empirical concepts on the Oil logistics scenario

This section of the paper analyses the oil logistics model through the eyes of the three various fundamental concepts of Empirical Modelling.

4.1 Observables

The areas of a model which can be anchored by some identification in the model of an oil logistics situation could be for example

1. Type of transportation
2. Speed of transportation
3. Delays

As these parameters are all variable they can be viewed as observables which we will be looking to change within the model. Types of transport can be viewed as trucks, trains, ships and aircraft. The speed of transportation this can be viewed on a computerised system such as a Global positioning system or GPS giving the exact location of a vehicle or vessel and its speed and time to destination. The delays which can occur on any of the journeys can affect the time to a destination of a vehicle or vessel in a very big way. This could be in many forms from driver illnesses, road closures, rough seas, docking problems, trailer problems for trucks, docking paperwork release of shipments. In the oil industry this means major penalties to the company involved.

4.2 Dependencies

The dependencies which exist in the model of the oil logistics problem are based around the facts such as type of transportation being dependent on distance needed for travel. Then the dependency of speed of transportation being dependent on the type of transportation used, e.g. a truck maybe slower than a train.

Also there are delays which are dependent on the overall time taken to complete a logistical cycle. The dependencies of the model are not just limited to these areas, as for example there can be dependencies between the fact that a driver can be ill making a truck late, this would be under the "delay" category. Also there is the possibility of natural disasters and how they can upset the oil model from the oil rig all the way to the end logistics.

One of the major issues with oil rigs is the safety factor and how even though there is successful drilling of oil, there will always be a source of gas very nearby. Sometimes this gas comes to the surface and is pushed out of the small drilled hole through which oil is supposed to be extracted. The gas is very dangerous and in a gas eruption all electricity is turned off in the nearby area not a single naked flame is allowed anywhere near the eruption. In the past there have been many deaths and injuries due to gas eruptions. This is a dependency that is not to do with transportation, but if this scenario did occur, the pumping of oil into containers ready for transport would come to a halt. The modern day oil rigs do in some way cater for the problem of eruptions, however in the early times of oil extraction; this was always a problem area.

Throughout history there have been many examples of major disasters which have affected the oil industry in terms of its supply. Hurricane Katrina was one of these disasters which hit New Orleans in the USA in August 2005. This hurricane hit the oil

rich state of the deep south causing mass damage to not just the immediate area within its path, but also the after effects of this disasters caused major turmoil in the stock markets too. The total damage caused by this natural disaster was the highest in recorded history known to be of around $87 billion. Hence this is a dependency which is to be seen in terms of speed of delivery of a cargo, the workforce which is available after the event has occurred i.e. movement of workers from one area to another can also be considered a dependency.

This has captured some of the dependencies which are seen within the oil logistics model. There are many others, but this hopefully provides the reader with some insight into the area.

To calculate the estimated times for certain events to occur, mathematicians would use certain formulae based on speed distance and time, and then add some other elements to the equation such as delay parameters which will add to the total time and then there can be some statistical probabilities for random events such as hurricanes or other natural disasters. These models can then be algorithmically run to produce the outcome of a set of input parameters i.e.

Simple dependency model:

What will happen if there is

1. a truck holding 1000 barrels of oil
2. The truck is travelling at 50 miles per hour
3. distance covered is 1000 miles

A more complex dependency model will include the probabilistic outcome of an event occurrence e.g. a category 2 hurricane.

Empirical modelling on the other hand allows the user to view and select events which they think will occur and then have

real-time feedback on what the outcome of
an event will be. Hence in a way Empirical Modelling provides a very interesting modelling technique whereby the process of data collection can be minimised.

The very fact that not all managers are mathematicians means that any modelling which is produced not just in terms of this oil logistics model, but any other model for that matter should be straight foreword to create allowing complete user input for changes.

4.2 Agents

After analysing the oil logistics model to some extent it became apparent that a modeller would have to look at all possible angles and instances of an object. Many of these instances are identical to other instances of that objects behaviour.

It can be thus said that the agent is required in an EM model in effect to observe events and their dependencies. Here the agent will externally observe all the events and dependencies using all the information available to them.

In the oil logistics model an agent can make informed decisions on what it is

observing using tools such as satellite tracking systems, news feeds, weather feeds to name but a few. Hence if there is a problem with bad weather on sea, an agent can receive a streamed data service directly from a weather system which the agent can use in a way which is useful to the user and modeller.

Hence this means that a user of this type of automated system will quickly be informed of the occurrence of these events and can adjust their schedule accordingly which can save them time and hence save money for the firm.

It is by experience that I can say that global positioning systems cannot and do not always provide one with the complete shortest route to a destination. As the system uses a specified shortest path algorithm, however we know that there are many other factors to consider when driving on the roads such as traffic and accidents. This leads to the point that although agents are always contributing to a model, they only contribute by a set of user defined rules which prompt them to act in a certain way i.e. if event α occurs then raise flag γ and if event β occurs then raise flag φ. This is to some extent procedural programming and using constraints to produce to a certain extent a specified outcome - Ψ.

Agents are only able to provide information on what its constraints allow it to. This means that sometimes a specific incident may lead to the agent giving a certain type of information which will not aid the user of the system in any way, but instead hinder their progress. So how can an agent be continually aware through true constant learning and evolving, i.e. deciding what information is useful and what information is not useful? I feel that this is an example of the link between empirical modelling and artificial intelligence.

4.3 Artificial Intelligence

A paper published by Beynon[2] puts forward the idea about empirical modelling as a possible foundation of artificial intelligence outside the logicist framework. There are five foundational issues raised by Kirsh [3] and James[4] whereby an example of the historic Clayton Tunnel railway accident is given. The paper argued that a third person objective was needed and that in the account for AI there was an essential need for a subjective first person element.

Ultimately the paper referred to the fact that the “role that commitment plays in attaching an objective meaning to a phenomena, are seen to utilize a hybrid approach to AI in the conventional sense”[2].

It was also pointed out by Kirsh that core AI is the study of conceptualisation and should begin with “knowledge level theories” where as EM is empirically established i.e. it is “informed by past experience and is subject to modification in the light of future experience”

These theories can be used in the oil logistics model as the agents can learn by observing user input into the model also and can then use this information for future reference when informing a certain user on a specified situation.

Figure 1

5. Model

The model which has been created captures a scenario of the transportation of oil in barrels from the oil refinery to other destinations both domestically i.e. by road and rail, as well as internationally i.e. by sea. See figure 1.

There are dependencies of the speed on the type of transport initially used. The sea speed is different as it is in Nautical Miles and is different to land speed.

Also a delay has been included which shows the way in which any type of transport can be delayed as this is just a timing factor.

The Log Issues column gives a dependency between specified logistical problems and the speed of the transport.

Ultimately, all the different variables have a dependency on the end result which is the "logistics timing in minutes". My model is based on a tree hierarchical diagram whereby the most depended on object is at the top of the tree and on the far right bottom corner of the model there is the "no problems" button which means nothing is wrong and there is no issue.

When using the model one can see that a depressed button using a mouse click

will highlight it a different colour. I have set a destination distance for the road as 750miles, for the rail as 1000 miles and for the sea I have set the destination at 5000 miles away.

I have used very bright colours as in a book on human computer interaction[5] it states that the brighter colours are fun to play with and refreshes an otherwise dull screen for the user.

The advice in the HCI book is clearly a logical statement because and if a user is working with a model for many hours a day, looking at a very dull graphical user interface can become tiresome. Hence this type of layout may increase the productivity of the user, making them contribute more to a firm.

5.1 Limitations of the Model

The model created is by no means perfect. It was created as a prototype to be able to see exactly how empirical modelling can help in a scenario which already has models available in terms of other programming paradigms. I merely captured one instance of the oil logistics model with my EM model. However in the real world there are hundreds of factors which need to be taken into consideration when building a model of this type. Also tkeden is prone to many bugs and hence can be very tedious to model with on a large scale. Perhaps in the future the platform will work more smoothly.

6. Conclusion

When comparing the model which I have created to the MACS logistical model, I have seen that there are many limitations in terms of model parameters and variables which my model does not take into consideration. However I believe that a logistics problem would be far easier to model and solve using the EM methodology, as all variables are available for the user to see and they can interact with the model to produce instant results, which can learn from change. The increased computational power when modelling large scale models using EM could also be a problem. For this there may be some optimised methods which can be used for model solving which a developer can use as a guide in this area. I feel that EM modelling is far more user friendly over all even though tkeden is not as advanced as some other developing platforms on the current market, it has great potential for future modelling.

7. References

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