FFI RAPPORT

EXPERIENCES WITH VECTURA

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FFI/RAPPORT-2003/01519

846-SYS/161

Godkjent
Kjeller 12. august 2004

Jan Erik Torp
Avdelingssjef

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Postboks 25, 2027 Kjeller, Norge

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UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE
(when data entered)

REPORT DOCUMENTATION PAGE

1) PUBL/REPORT NUMBER FFI/RAPPORT-2003/01519	2) SECURITY CLASSIFICATION UNCLASSIFIED	3) NUMBER OF PAGES 24
1a) PROJECT REFERENCE 846-SYS/161	2a) DECLASSIFICATION/DOWNGRADING SCHEDULE -	

4) TITLE

EXPERIENCES WITH VECTURA

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5) NAMES OF AUTHOR(S) IN FULL (surname first)

NILSEN Terje, BAKKEN Bjørn T

6) DISTRIBUTION STATEMENT

Approved for public release. Distribution unlimited. (Offentlig tilgjengelig)

7) INDEXING TERMS

	IN ENGLISH:		IN NORWEGIAN:
a)	Decision training	a)	Beslutningstrening
b)	System dynamics	b)	Systemdynamikk
c)	Logistics	c)	Logistikk
d)	Model	d)	Modell
e)		e)	

THESAURUS REFERENCE:

8) ABSTRACT

This report describes Vectura; the fourth of a total of five system dynamics models in the FFI-project 846 - *Implementering av beslutningstrener (BST II).* Vectura is a logistics model containing the following aspects: Transport, deployment, circulation, redeployment, quality, capacity and economics. The model is the key ingredient for a game where the player is making decisions as the national head of logistics in an international operation. The report gives a thorough description of the model's structure and configuration as well as describing how to make use of it in practice.

9) DATE	AUTHORIZED BY This page only	POSITION
2004-08-12	Jan Erik Torp	Director of Research

ISBN-82-464-0869-0

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE
(when data entered)

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EXPERIENCES WITH VECTURA

1 INTRODUCTION

1.1 Abstract

This report describes Vectura; the fourth of a total of five system dynamics models in the FFI-project 846 - Implementering av beslutningstrener / Implementing decision training (BST II). Vectura is a logistics model containing the following aspects: Transport, deployment, circulation, redeployment, quality, capacity and economics. The model is the key ingredient for a game where the player is making decisions as the national head of logistics in an international operation. The report gives a thorough description of the model's structure and configuration as well as describing how to make use of it in practice. A prototype of the model has been tested on 9 cadets specialising in logistics at the Norwegian War College (Army). The cadets report that the model is indeed relevant for the logistics discipline, and all of the cadets felt the game as very engaging.

1.2 Background

The background for the current project "Implementing decision training" (FFI-project 846), and the development of individual models, is the desire to achieve more efficient and effective training for military commanders (current and future). The training context is decision making at the operational to strategic level. Each of the models within the (MDT) framework is intended to give the player an understanding of consequences that may result from taking different courses of action, and what are the critical factors to consider in a dynamic crisis or warfare situation. Furthermore, the models should inspire to and stimulate discussions around the problems and situations posed by the model.

The purpose of this report is to give a brief conceptual description of the model Vectura, as well as a review of feedback from pilot users. This information may be of help for future users – players as well as instructors – to ensure that the best possible learning outcome is attained.

1.3 Development tools

The system dynamics software Vensim DSS for Windows (from Ventana Systems, Inc.) was used to develop the simulation model and user interface. The model is single-user only, so no network support was needed.

2 DECISION MAKING IN COMPLEX SETTINGS

Decision-making in organizational and managerial contexts is a highly complex task. This has long been recognized (Simon, 1956; 1978). Most real-life situations require that the decision maker has acquired the skills of his profession through real-life experience. This is a far-from-trivial demand, when decisions and their consequences are (widely) separated in time and space. Repeated instances of what might appear to be the same problem, in reality differ on important characteristics, which only contributes to the difficulties people have when it comes to make valid and robust inferences.

These difficulties are also present in the typical military staff exercise, where a higher-level combat/conflict situation is simulated. This kind of exercise requires considerable resources and takes days or weeks to conduct. Replays to investigate alternative outcomes are just too costly. However, the only "real-life" operational experience most military officers will get during their career, is what they get through more-or-less realistic exercises.

The main obstacle in contemporary development for higher-level military training seems to be the desire to achieve the greatest possible technical detail and accuracy in the simulations that are to support such training. In practice, the creation of higher-level simulations has been regarded as a problem of integrating/aggregating as many lower-level (tactical) simulations as possible, and in real time. As a consequence, development budgets "explode", and the real learning remains with the development team and the application testers.

Minimalist Decision Training (MDT), which will be described in this report, takes the opposite "angle of attack". With this approach, the simulation model focuses narrowly on the problem at hand, which (for an operational or strategic commander) is usually related to the perception and handling of dynamic dilemmas, featuring aspects such as time lags, feedback and non-linearities. Most, if not all, of the technical detail concerning weapon platforms is just left out of the simulation model.

3 MINIMALIST DECISION TRAINING (MDT)

A minimalist decision trainer (MDT) is a very simple and pedagogically designed simulation-supported system for use in the training of higher-level commanders (both existing and to-be). The training focus is to build and rehearse the commander's ability to quickly form a mental image of a combat/conflict situation, and to intuitively comprehend what are the likely combined outcomes of the inherent dynamics governing the situation, and the decisions made to act upon the situation. This ability is required when it comes to making rapid decisions of high quality – essential for achieving success in (over-)complex and "dramatic" situations.

MDT is aimed at putting a commander or the command group in charge of own logistics and operations resources in a scenario. The scenario may contain any implied or explicit mission. The resources reflect a combined joint operation; typically the lower limit of resources will be less than a hundred units representing land, sea and air resources, with upper limit being less than a thousand. The representation need not be restricted to the military organization – political, psychological, economical, and legal means of exerting influence may also be included.

MDT belongs to a class of training solutions referred to as “Management Flight Simulators” (MFS) – a term invented at MIT’s Sloan School of Management (Bakken et al, 1992). Instead of individuals flying a simulated aircraft, a management team “flies” the corporation, creating products that “fly in the marketplace” through making appropriate strategic, operational and tactical decisions. MDT represents the best of tabletop war games and MFS for its players: the operational level commander – or more typical – his associated command group.

Isaacs and Senge (1992) argue that microworlds used in a training context will alleviate many, if not most, of the so-called “barriers to learning” in dynamic environments. There is an apparent risk, however, that such tools – simplified as they are, and often to the extreme – could be misused. An example of such misuse could be to support short-sighted/narrow-minded views and policies, arising (more or less consciously) because of inaccurately formulated models or of misinterpreted feedback from the model.

4 DESCRIPTION OF THE VECTURA GAME

The game is about decision-making regarding logistics in an international operation. The player`s role in the game will be as commanding chief for the Norwegian part of the operation. The player will get a mission from the operations internationally commanding chief. The mission has a time limit (day of deployment, day of redeployment) and a defined need of capacity to meet. From his own authorities the player will receive a grant that is supposed to cover all costs regarding the mission.

The game has two phases where the first one is a planning phase and the second an operation phase.

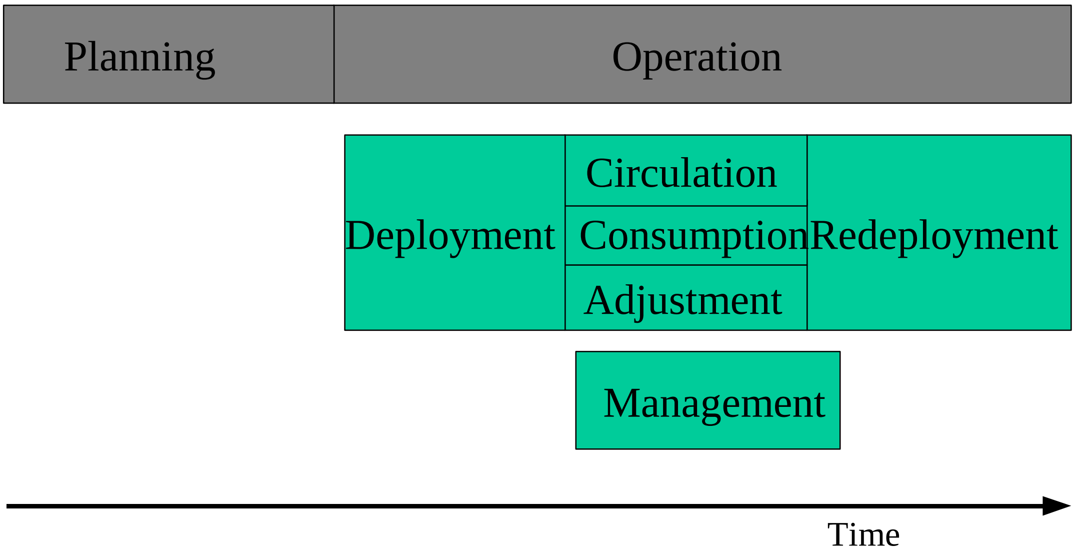

Figure 4.1: The game's two phases: Planning phase and operation phase

In the planning phase the player can experiment with different alternatives for solving the mission. For each alternative the player will receive feedback (estimate) from his staff: whether the alternative can be accomplished with the resources given, and also if the alternative gives the capacity needed to solve the mission. When the player is done with the planning phase and has decided on a plan, the player can go to the operation phase and carry it out.

In the operation phase the player will get daily reports about economics, resource status etc. from the area of operation. In this phase the player will also be met with challenges and dilemmas. Some of these challenges will rapidly increase in magnitude if not acted upon. The player's responsibility will be to intervene with the right measures at the right moment that will see to that the mission can be fulfilled with the resources available.

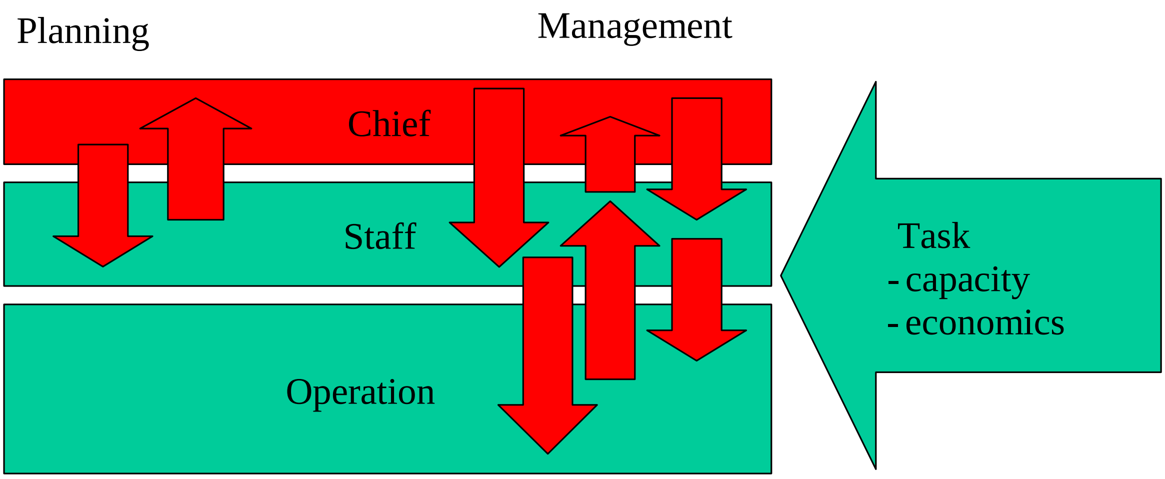

Figure 4.2: The game's course of events

5 MODEL STRUCTURE

5.1 The structure of the logistics model

In this section all the variables from the model are written in italics. The model's integrated structure is shown in appendix A.

The model has three dimensions (the number of elements in parentheses): Method of transportation (5), resource classes (7) and operation area (2). This means that a certain flow, for example transportation from the home area to the operation area, is a compound variable describing how different resource classes are being transported with various methods of transportation to different areas.

The model also describes transportation regarding:

- Deployment
- Resupply
- Circulation of personnel and materiel
- Redeployment

The central part of the model describes the physical flow of *resources in stock* (*ressurser på lager*) to *resources in the operation area* (*ressurser i operasjonsområdet*) and back (figure 3.2). If it is not enough *resources in stock* (*ressurser på lager*) then it will be refilled by the variable *stockbuilding* (*lageroppbygging*). When the stocks are big enough the resources will be *loaded* (*lastet*) on boat/truck/aircraft depending on which method of transportation chosen. During *transportation of* resources (*transport av ressurser*) accidents can happen and it will create *loss* (*tap*). After some time the resources will reach the operation area where they will be *unloaded* (*losset*). *Resources in the operation area* contains seven classes: Personnel (Personell), transport platform (transport plattform), firing platform (ildgivende plattform), supplies (proviant), consumables (forbruksvare), fuel (drivstoff) and ammunition (ammunisjon), where the four last classes are being used as *running consumption* (*driftsforbruk*) and *maintenance consumption* (*vedlikeholdsforbruk*) for the first three classes. When the personnel and platforms have been in the operation area for a while they will be transported back home for circulation, leave of absence, repairs etc. (*Return loading* (*Retur lasting*), *return of resources* (*retur av ressurser*), *loss during return* (*tap under retur*) and *return unloading* (*returlossing*))

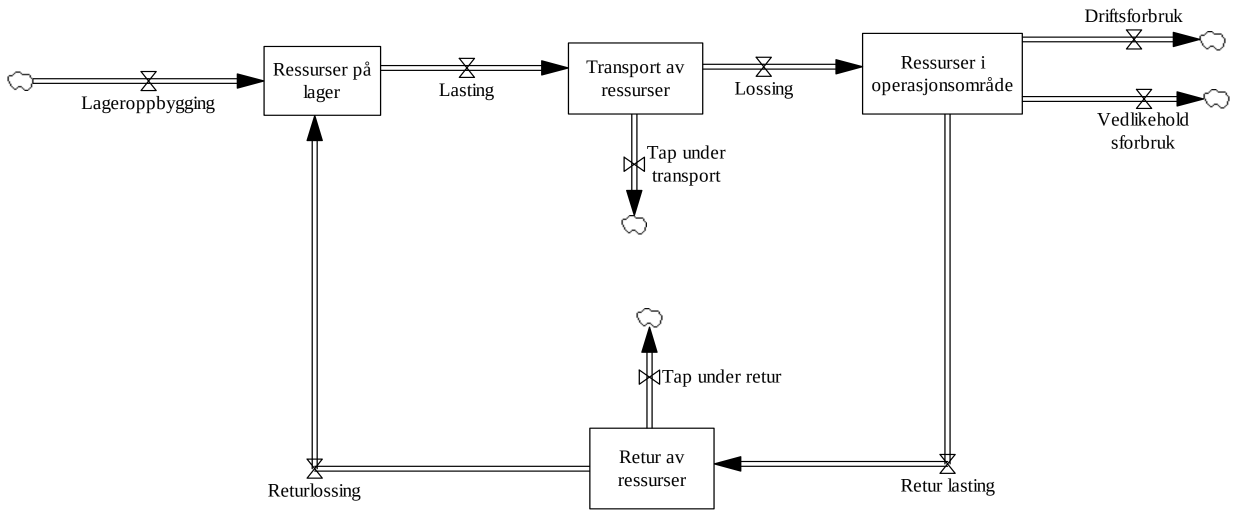

Figure 5.1: The core of the model

The model is designed such that the game leader among other things must set values for the variables *time for finished deployment (tidspunkt for ferdig deployering)*, *time for redeployment (tidspunkt for redeployering)* and *maximum transport capacity (maks transportkapasitet)* before the game starts. Based on a scenario the player must choose method of transportation and – distribution and *desired resources in the operation area* (*ønskede ressurser i operasjons-området*). With these choices made the game can be run without intervention from the player, just based on plans and decisions on a lower level that the model itself executes. But, during the game the player probably have to take new decisions to compensate for adjustments for own mistakes and external events.

5.1.1 Deployment

The player has to choose *desired resources in the operation area* (*ønsket ressurs i operasjonsområdet*) that is perceived necessary to achieve the *desired capacity* (*ønsket kapasitet*) (appendix A.1). In addition the player has to decide *desired transportation* (*ønsket transport*) that implies choosing how big a portion of each of the resource classes that is to be transported with a particular method of transportation (appendix A.2). With this basis, the model will on its own start deployment on the right time for the different methods of transportation, such that the deployment is finished till *time for finished deployment.* Deviation from the planned deployment, for example as a consequence of actual *time of transportation* being longer than *expected time of transportation*, must be handled by the player.

5.1.2 Consumption

The units will be sent with enough supplies a number of days, "days of own supplies" *DOS*, in the deployment phase. Based on consumption, a minimum of consumption that should always be available *DOS minimum*, and *expected time of transportation* there will at *time for start loading consumption* start loading of consumption material (appendix A.1). The amount of consumption material that is being loaded is dependent on the sum of material going into running consumption and maintenance consumption (appendix A.3). Consumption is being transported according to the *desired transportation* – method. Running consumption is dependent on quantity of personnel and platforms in the operation area. Maintenance consumption is dependent on how many personnel and platforms there are in the operation area, and the chosen maintenance policy.

5.1.3 Circulation

Based on a determined *rate for circulation of personnel* (*rate for sirkulasjon av personell*) and *rate for circulation of platform* (*rate for sirkulasjon av plattform*) a certain amount of these resource classes will continuously be sent home for reconditioning and new personnel/material sent out (appendix A.3). Material that is being circulated will be transported in accordance with the chosen method of transportation.

5.1.4 Redeployment

On *time for redeployment* (*tidspunkt for redeployering*) all the material will be transported to the home area. Redeployment happens in accordance with the chosen method of transportation (appendix A.5).

5.1.5 Time of transportation

All transport will lead to wear and tear that reduces *quality on transport system* (*kvalitet på transportsystem*) (appendix A.6). If *wear and tear on transport system* (*slitasje på transport system*) is larger than the capacity *maintenance of transport system* (*vedlikehold av transport system*), then after a while the quality will be reduced. The wear and tear on transport system will be particularly large if the *utilization of transport capacity* (*utnyttelse av transportkapasitet*) is high. Reduced *quality on transport system* has consequences for *time of transportation* and can after a while reduce the ability to deliver material and supplies as planned.

5.1.6 Quality

Personnel and platforms that are being deployed will have a given quality. *Quality of personnel* (*Kvalitet på personell*) will during the operation deteriorate if one does not see to maintaining quality through circulation of personnel and upholding the relative joint capacity (appendix A.8). *Quality on platform* (*Kvalitet på plattform*) deteriorates if one does not see to maintenance and circulation (appendix A.7).

5.1.7 Capacity

The model’s starting point is that the one who has described the scenario and prepared the game also has defined a *desired capacity* (*ønsket kapasitet*) which consists of values for each of the five capacities: Intelligence, logistics, fire power, mobility and protection (appendix A.9). Desired capacity is a result of *mission category* (*oppdragstypen*), the capacity need for different categories of mission and the size of the mission. *Capacity* (*Kapasitet*) can be delivered if one sees to have a sufficient and balanced amount of resources of a sufficiently good quality in the operations area. The relation between desired capacity and delivered capacity is being expressed as relative capacity. Relative capacity is an expression for the ability to fulfill the mission.

5.1.8 Economics

Transport in connection with deployment, consumption, circulation and redeployment trigger off costs (appendix A.10). The same applies to consumption of running and maintaining the operation.

6 USER INSTRUCTIONS

6.1 User interface for the planning phase

By pressing the button Planning ("Planlegging") on the games first page the following user interface will appear:

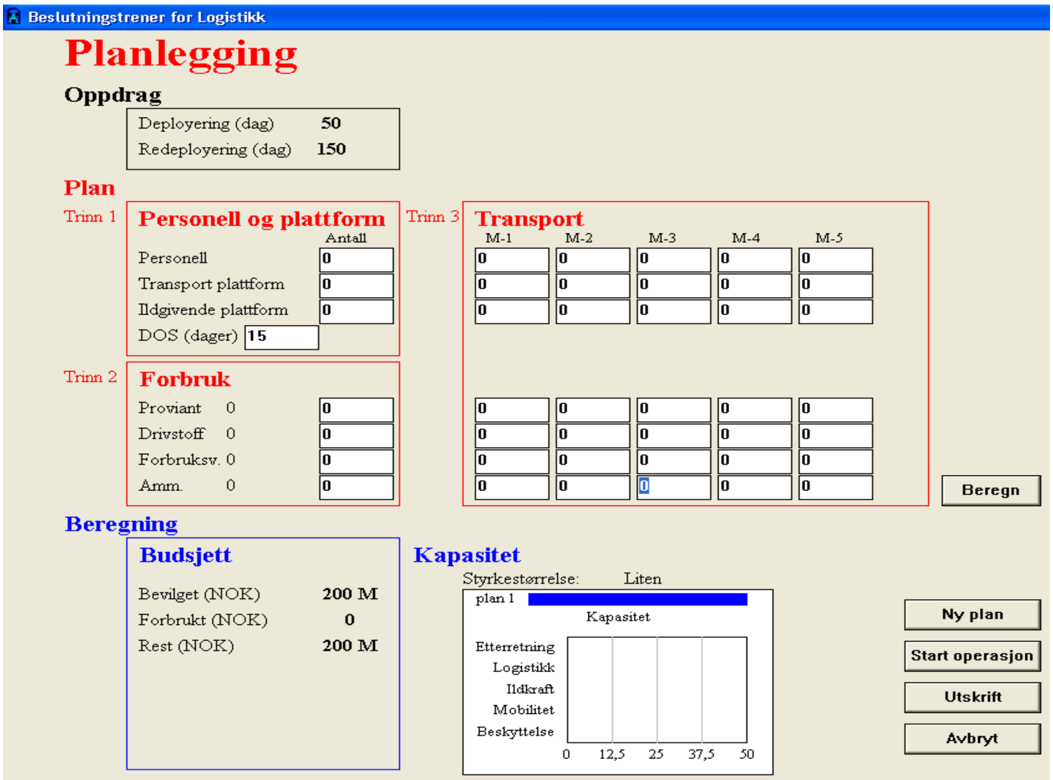

Figure 6.1: User interface for the planning phase

The player`s decisions will be recorded by typing numbers in the columns with a white background.

6.1.1 Decision-making in the planning phase

The decisions the player has to make in the planning phase can be divided into: (1) Personnel (Personell), platform (plattform) and DOS, (2) consumption (forbruk) and (3) transportation (transport). See figure 4.7.

Personnel, platform and DOS:
From a given scenario the player has to decide how many persons, transportation platforms, firing platforms and number of DOS (Days of own supply) that is desired in the operation area.

Consumption:
After having recorded the number of personnel, transport platforms, firing platforms and DOS, the player can use the button compute (beregn). The model will then compute the need of the four resource classes: Supplies, fuel, consumables and ammunition. In the figure 4.7 the numbers in the left column are computed values and the numbers in the right column are self-defined values. If the player wishes to use the computed values then he must avoid typing numbers in the right column.

Transportation:
When the player has decided how many of personnel, transport platforms, firing platforms, supplies, fuel, consumables and ammunition that is desired in the operation area, the player have to decide how these resource classes are going to be transported to the operation area. There are five different methods of transportation to choose from. For each resource class the player has to decide how many percent of the class that is to be to be transported with the different methods.

When the player is done typing in all the necessary values then push the button compute (beregn). The model will then run through the mission`s duration, and deliver information about the chosen plan.

6.1.2 Information in the planning phase

Information in the planning phase can be divided into three main categories: Mission (Oppdrag), budget (budsjett), and capacity (kapasitet). See figure 4.7.

Mission:
Mission information displayed continuously: (1) Which day the forces are going to be finished with deployment to the operation area (Hvilken dag styrkene skal være ferdig deployert til operasjonsområdet) and (2) which day the forces are going to be finished with redeployment to the home area (hvilken dag styrkene skal være ferdig redeployert til hjemmeområdet).

Budget:
For each plan the player tries out, the staff will compute how much it will cost to implement this plan. This cost has to be seen in connection with the grant given.

Capacity:
For each plan the player tries out, the staff will compute the capacity that is being generated for the five capacity areas. After that one takes the capacity one by one of the capacity areas and divides these on the total capacity, and get the columns shown in figure 4.8.

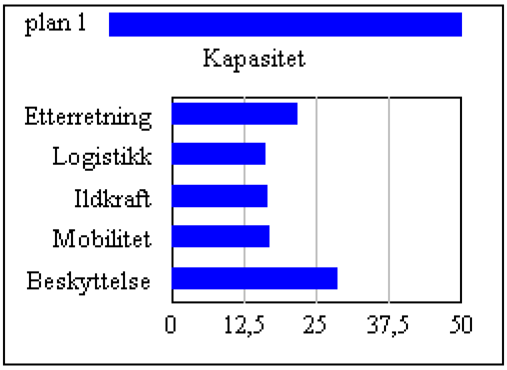

Figure 6.2: Computed relative capacity for a given plan

6.2 User interface for the operation phase

The user interface for the operation phase is shown in figure 4.9 where the player`s decisions are being recorded in the columns with a white background.

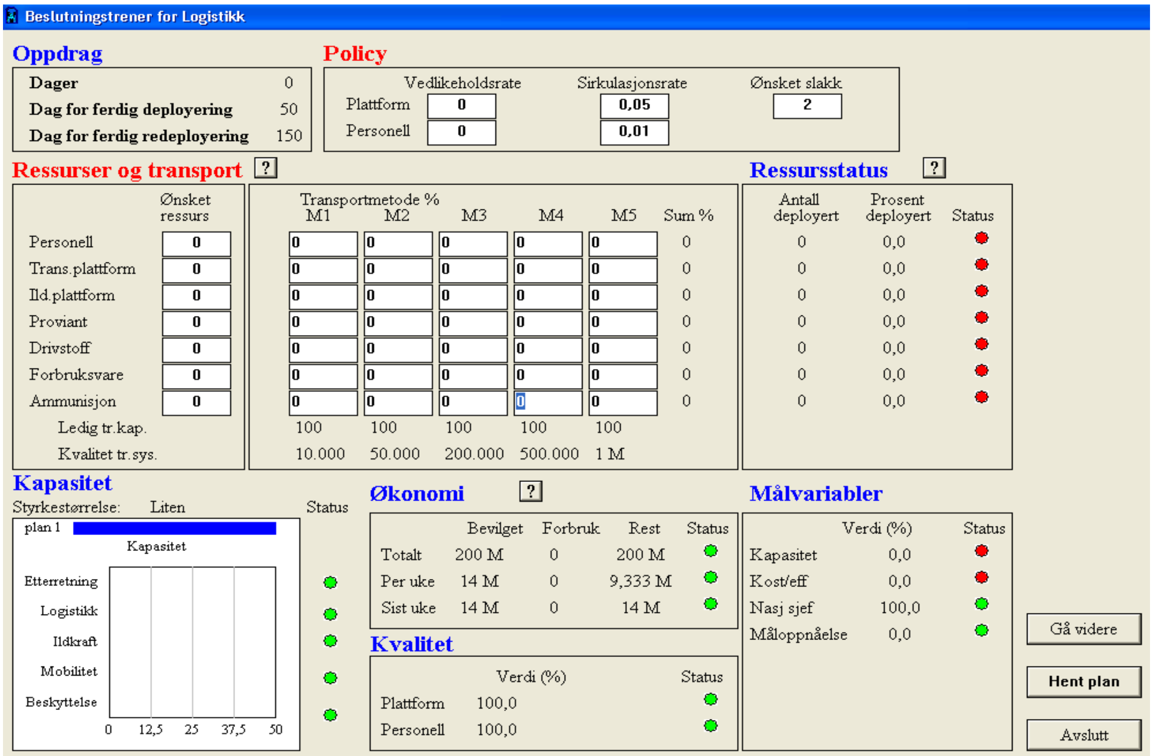

Figure 6.3: User interface for the operation phase

6.2.1 Decision-making in the operation phase

Decisions the player has to make in the operation phase are: Desired resources in the operation area (Ønsket ressurser i operasjonsområdet), desired transportation (ønsket transport), circulation rate (sirkulasjonsrate), maintenance rate (vedlikeholdsrate) and desired slack (ønsket slakk). See figure 4.9.

<u>Desired resources in the operation area:</u>

The player has to decide how much of each of the seven resource classes that is desired deployed to the operation area based on the capacity that is desired to be available in the operation area.

Desired transportation:

When the player has decided on the amount of resources that is desired in the operation area, he must decide how the resources are going to be transported. The player has a choice between five different methods of transportation where each of them has a transportation time, cost and maximal transport capacity tied to it. The player must then decide how many percent of a resource that is going to be transported by the different methods of transportation.

Circulation rate:

For the circulation rate there are two decisions to make, one for platforms and one for personnel. The player has to choose a decimal number (fraction) between 0 and 1. This decimal indicates how many percent (decimal*100) of the platforms or the personnel that are daily sent home for exchanging or leave of absence etc.

Maintenance rate:

The player has to set a value between 0 and 1 for maintenance rate for platforms and personnel. Maintenance rate for platforms affects the consumption of maintenance material, and as such will increase the need for resupplies with the consequences it will have for economics, transport system etc. Maintenance rate for personnel affects maintenance consumption and so will increase the need for resupplies. Measures that will increase the maintenance rate are for example rest and welfare measures.

Desired slack:

The player can enter a value for desired slack, a value that decides how long time in number of days that is desired allocated to unforeseen events in the time of deployment. This can cause the desired resources to be brought forward before the deployment time is over; something that will indicate that running and maintenance consumption starts before it is necessary. On the other hand if there is no slack, the desired resources can get to the operation area too late, and as a consequence get trouble with satisfying the capacity needed for the mission.

6.2.2 Information in the operation phase

There are eight main categories of information the player gets in the operation phase: Mission (Oppdrag), methods of transportation (transportmetode), resource status (ressursstatus), capacity (kapasitet), economics (økonomi), goal variables (målvariable), quality (kvalitet) og messages (meldinger). See figure 4.9.

Mission (Oppdrag):

Days (Dager): This number shows how many days the game has lasted.

Date for finished deployment (Dato for ferdig deployering): This number says how many days it should take from the game starts to the desired resources are going to be in place in the operation area.

Date for finished redeployment (Dato for ferdig redeployering): This number says how many days it should take from the game start to all of the resources that is not consumed is back in the home area.

<u>Methods of transportation (Transportmetode):</u>
Sum %: This number is the sum of the percentages the player has entered for the methods of transportation for each resource class. This number should be 100. If the number is smaller than 100, for example 90, then this will mean that 90% of the resource will be sent to the operation area, and if the number is bigger than 100, for example 110, then this will mean that 110% of the resource will be sent to the operation area.

Free transport capacity (Ledig transportkapasitet): This number says how many percent of the maximum transport capacity for each method of transportation that is free.

Quality of the transport system (Kvalitet transportsystem): This is a number between 0 and 100 that indicates the current quality level of the transport system, a number that can be different for the five methods of transportation. If this quality is getting low the consequences will be that the transport time to that/those methods of transportation it concerns will increase, and thereby risk that the resources do not get on time where it should be.

<u>Resource status (Ressursstatus):</u>
Number of deployed (Antall deployert): For each resource class it will during the game be reported how much/many there is available of it in the operation area.

Percent deployed (Prosent deployert): These values are the percentages that will appear by taking the number of deployed divided by desired resources in the operation area for each resource class.

Status (Status): This is a “traffic light” that varies between red, yellow and green and it indicates if the condition is as it should be between desired resources in the operation area and the number of deployed. There is a light for each resource class.

<u>Capacity:</u>
Capacity diagram (Kapasitetsdiagram): The columns in the diagram represent the different capacity types and their relatively capacity. The values result from the relation between capacity being generated for the five types of capacities and the total capacity (see figure 4.10).

Status (Status): This is a light that varies between red, yellow and green, and indicates how the capacity in the operation area satisfies the mission`s capacity need. There is a light for each capacity type (see figure 4.10).

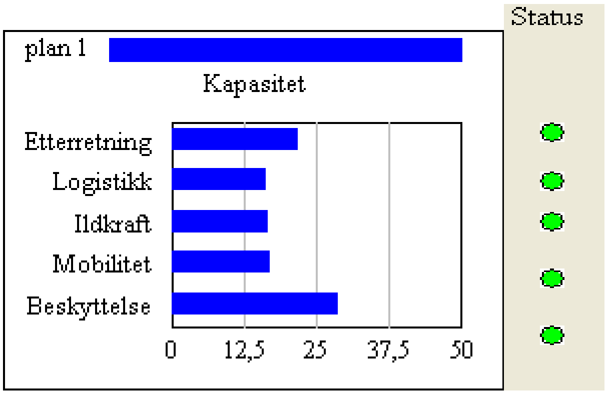

Figure 6.4: An example of capacity diagram and status

<u>Economics:</u>
Information about economics is divided into the following three categories: Total (Totalt), per week (per uke) and last week (sist uke).

Total (Totalt):
Granted (Bevilget) describes how much money is available for the whole operation. *Consumed (Forbrukt)* describes how much money has been used until now in the operation. *Remainder (Rest)* describes how much money is left for the rest of the operation. *Status (Status)* is a traffic light that describes the relation between money granted and money consumed.

Per week (Per uke):
Granted (Bevilget) describes how much money is available on average per week. *Consumed (Forbrukt)* describes how much money is consumed ob average per week. *Remainder* (*Rest)* describes how much money is at disposal on average per week for the rest of the operation time. *Status* (*Status)* is a traffic light that describes the relation between remainder per week against average granting per week for the rest of the operation time.

Last week (Sist uke):
Granted (Bevilget) describes how much money was granted the last week. *Consumed (Forbrukt)* describes how much money was consumed the last week. *Remainder* (*Rest)* is equal to what was granted last week minus consumed last week. *Status* (*Status)* is a traffic light that describes the relation between money granted last week and money consumed last week.

<u>Quality:</u>
Platform value (Plattformverdi): This value is a number between 0 and 100. Low platform quality can cause the actual resource capacity in the operation area to be lower/poorer.

Platform status (Plattformstatus): This is a traffic light indicating whether the platforms are in proper condition for operations.

Personnel value (Personellverdi): The value is a number between 0 and 100. Low personnel quality can cause the working capacity to diminish, which can influence the mission's execution.

Personnel status (Personellstatus): This is a traffic light indicating whether the personnel are capable of doing their tasks in a good way.

Goal variables (Målvariable):
There are four goal variables the player will be evaluated against: Capacity (Kapasitet), cost/effectiveness (kost/effektivitet), national chief (nasjonal sjef), and goal achievement (måloppnåelse).

Capacity (Kapasitet): This describes the relation between the actual capacity against the desired capacity for each time step.

Cost/effectiveness (Kost/effektivitet): This describes the relation between money consumed and the capacity achieved.

National chief (Nasjonal sjef): This describes the national chief's contentment with the operation. The contentment is dependent upon money consumed and goal attainment.

Goal attainment (Måloppnåelse): This says whether the upholding of capacity has been high enough. For example it can be that each day with an actual capacity of more than 90% of desired capacity is a day with complete goal attainment. This variable will give no value before the day when the forces are supposed to be in the operation area.

All the goal variables have two dimensions attached to them, and that is value (verdi (%)) and status (status). Value is a number bigger than 0, where a bigger number means better. Status is a light that can vary between green, yellow and red, where green is the best.

Messages (Meldinger):
During the game it will pop up messages on the screen about incidents in the operation area, examples could be like in figures 4.11 and 4.12.

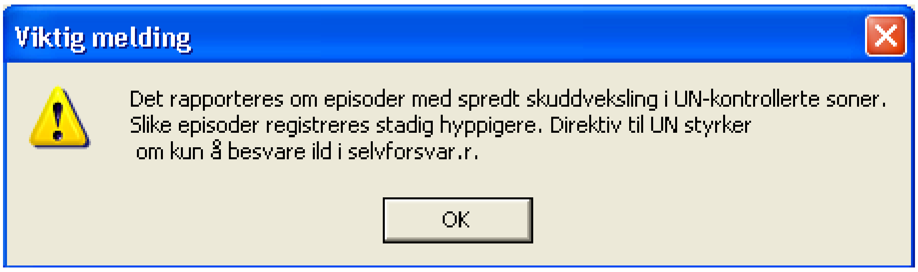

Figure 6.5: An example of message in the game

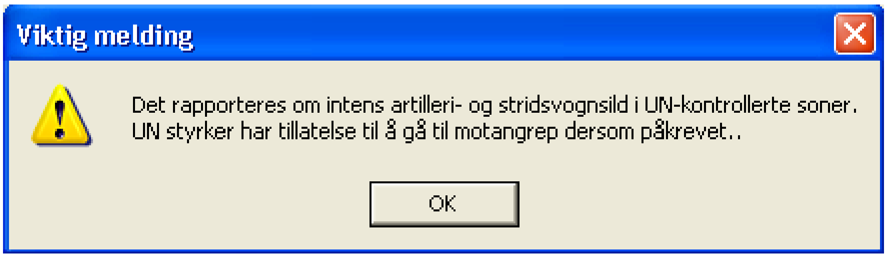

Figure 6.6: An example of message in the game

In the game there are three types of incidents that result in messages:

Intensity (Intensitet): For example a message about increasing combat intensity can raise the need for ammunition, then the player has to decide whether to send more ammunition to the operation area just to keep up his combat capacity.

Refugee (Flyktning): For example a flow of refugees entering the operation area. This will lead to an increased need for supplies in the area, and the player has to decide whether to send more supplies to the operation area just to keep up his combat capacity.

Transportation (Transport): A third type of incident that can happen is incidents regarding transportation. It can be a message that a supply ship is being torpedoed; resulting in that transport method M-1 being out of order for some days. Then the player has to decide how those resources being transported with M-1 are going to be transported with an alternate method for the time the method is inoperative.

The messages in the game will appear so early that it is possible for the player to be pro-active, i.e. react for example before the refugees are entering the area. These messages will be ambiguous to such an extent that the players will have consider the right remedies on their own. Later messages will give explicit message, but then it will be (a little) to late.

7 A PROTOTYPE TEST OF VECTURA

A prototype of the model has been tested on 9 cadets specialising in logistics at the Norwegian War College (Army). The general impression, as reported by the cadets, clearly indicates that the model is indeed relevant for the logistics discipline. In addition, all of the cadets felt the game as very engaging.

The prototype test proved valuable for feedback on the problems and issues conveyed in the model, as well as the model complexity, presentation format and other design aspects.

An open “enquete” conducted in class, immediately following the test play session, revealed the following opinions and suggestions:

- The model provided a unified/overall picture of the logistics process, and contributed to understanding of logistics at the a high level
- The model is probably best suited to illustrate logistics operations at the strategic/operational level

- The scenario events (pre-programmed) could be made more sensitive to actions made bye decision makers
- The scenario could be more concrete, e.g. tied directly to a specific role or function in the logistics organisation
- The messages generated (cf. fig. 4.11 and 4.12) could be more specific, i.e. directly address the event, and possibly include a broader range of “friction” elements
- Level of difficulty could be more matched with players competence and knowledge of the task in particular, and of logistics in general

A questionnaire was also administered after the test play. The questionnaire also contained assertions related to the users’ general “happiness” with the model. On a 1-6 scale ranging from “Strongly disagree” to “Strongly agree”, the ratings were as follows:

A. I would recommend this game to my fellow officers *score: 4.00*
B. The War College should use this kind of game in class *score: 5.22*

The relatively weak result on assertion A can be taken to imply that the game needs improvement, in the direction of making it more challenging. This kind of improvements can be made without altering the model itself, just the scenario parameters. However, the excellent score on assertion B implies that, when certain improvements have been made (see below), we might have a winning solution.

7.1 Suggested improvements

The cadets also offered direct suggestions for improvement. These suggestions are summarized below:

General suggestion for the task:
- Greater challenges
- More information
- Greater demands from scenario and events
- More variations

Altering scenario parameters can accommodate these desires. In particular, the “variation” requirement can be met by establishing a variety of parameter sets. These sets should describe scenarios of varying context and complexity.

Detailed feedback and suggestions:
- The scenarios realism could be increased is materiel from war plans (Norwegian KOP) were incorporated
- Scenarios could contain: more friction, unexpected events, greater consequences, larger span of context and complexity, and require responses (punish lack of response)
- A data log of choices made and graphic depiction of status variables would enhance the review process
- Introduce e.g. stock costs, order costs, and weather impact on transport, and storage loss factors

- Introduce more explicit differentiation on low vs. high intensity conflicts, which will have implications for time resolution
- Time resolution should be greater than 1 day for commander level
- Introduce "local purchases" as mode of transportation

8 CONCLUSIONS

This report has described Vectura, a logistics model containing the following aspects: Transport, deployment, circulation, redeployment, quality, capacity and economics. The model is the key ingredient for a game where the player is making decisions as the national head of logistics in an international operation. The report has given a description of the model's structure and configuration as well as describing how to make practical use of it. A prototype of the model has been tested on 9 cadets specialising in logistics at the Norwegian War College (Army). The general impression, as reported by the cadets, clearly indicates that the model is indeed relevant for the logistics discipline. In addition, all of the cadets felt the game as very engaging. The prototype test proved valuable for feedback on the problems and issues conveyed in the model, as well as the model complexity, presentation format and other design aspects. The excellent recommendation on a questionnaire implies that when some of the suggested improvements have been made, we might have a winning solution.

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