Integration of information in logistic operations

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Abstract
In practice, material planners often are not provided with a clear insight into the performance and process information due to the absence of integral control feedback. Therefore, the decision maker develops a rather limited internal model of the logistic system to be controlled. In order to make effective decisions a material planner needs an accurate and integral 'mental model', both at the aggregated and at the detailed level of control. The question is how and what type of information should be offered to the material planner. A laboratory experiment, in which the decision making environment of the material planner is simulated, was set up to deal with this question. The effects of two different ways of information feedback on the control performance were investigated in this experiment. Two groups of subjects were compared. Both groups were offered aggregated feedback (total information of all commodities to be controlled), but only one group was offered also extra detailed information (separate information of each individual commodity item). The decision situation of the first group, where detailed feedback was absent, represented current organizational practice: subjects have to memorize a large quantity of relevant performance and process information. The results of the experiment showed, that the group which had access to both aggregated and detailed feedback obtained a significantly better logistic performance. It is expected that the added value of this type of integrated feedback will even be higher in the more complex reality.

Keyword Codes: H.5.2.; H.1.2.
Keywords: Information Interfaces and Presentations, User Interfaces; Information Systems, User/Machine Systems;

1. INTRODUCTION

One of the research projects at the Graduate School of Industrial Engineering and Management Science at the Eindhoven University of Technology concentrates on the decision making behavior of material planners. The object of investigation is the improvement of decision process and control performance by means of redesigning information feedback systems and decision support systems. Case studies performed in the Dutch automobile, aircraft and furniture industry during 1989 till 1991 revealed the absence of necessary information feedback for the logistic operators controlling the material supply.

Material supply is a part of the basic organizational function of 'purchasing'. It includes the procurement, the transportation and stocking of material for the users in the production process: the components factories and assembly lines. The external supply of the hundreds and thousands of components needed in a factory is distributed among material planners (MPs). An MP is responsible for the supply of a specific set or package of commodities. A high service level and low integral cost represents a good task performance; the objective is to supply the required material of the correct quality and in the correct quantity in the correct place and time, with minimal integral costs.

The logistic performance is mainly determined by the way MPs manage their logistic control parameters. A first important control parameter is the frequency with which an MP orders material from external suppliers to cover future material demand. A high order frequency, or low order quantities, implies a desirable high stock circulation rate. A practical problem is that the processes of supply and demand are not deterministic but stochastic in nature. Disturbances occur which put in risk the availability of material. The unreliability of external suppliers - i.e. late deliveries - disturbs the planned supply of material. An MP can use a second control parameter, 'safety time', to compensate for this effect. The unreliability of the consumption of material in the factory - i.e. quality rejection or sudden modifications of production plans - disturbs the planned demand of material. An MP can use a third control parameter, 'safety stock', to compensate for this effect. Safety stock and safety time serve as buffers in the process. If no buffers are used, run-outs of material can occur easily. Run-outs might cause very expensive production stops and should therefore be avoided.

2. THE CRITICAL COMPONENT IN HUMAN CONTROL: THE MENTAL MODEL

In cybernetics a distinction is made (Bemelmans, 1991) between : the controller (the material planner), the controlled system (the commodity package) and the environment (the disturbances in the input, throughput and output). The MP is the human controller of the logistic process and performs several general cognitive functions (Kragt, 1983):
(a) detection and discrimination of signals, from a visual display unit or directly out of the process;
(b) interpretation of the signals in relation to each other so that the controller knows what is happening;
(c) prediction of the future state of the process if no actions are taken;
(d) decision which actions lead to the best results or reduce undesirable outcomes.

Effective prediction and decision making is only possible, if the controller has a fairly accurate *model* of the controlled system. Landeweerd (1978) mentions the concept of 'mental model' when he refers to the internal representation of the functioning of a controlled system. The internal representation relates to the 'image' of aspects of reality in the long-term memory of a human controller: the relationships between process variables and actions (figure 1).

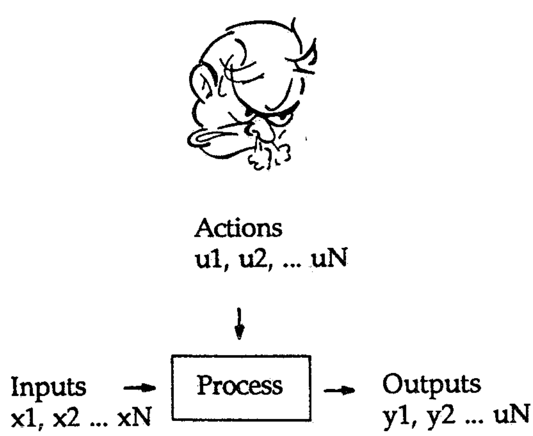


Figure 1: The mental model (Landeweerd, 1978).

The contents of the mental model of a human controller could be 'primitive', 'intuitive' or 'rational' (Bemelmans, 1991). A primitive model is often the result of a non structured decision situation: variables are partially known; the relationship between variables (structure) is not known; decision making is based on heuristics. An intuitive model is the result of a partially structured decision situation: the controller knows almost all relevant variables, but has only a intuitive notion of the relationship between these variables; control is based on experience and intuition. Only if the decision situation is completely structured a rational model could be developed by the human controller: all variables and relationships are known; decision making is based on rational calculation.

The better a decision problem can be defined, the better the quality of the mental model can be. Unfortunately, the decision environment of the MP is often not fully structured in practice, on the contrary. As a consequence, the MP develops a limited mental model; control is based upon intuition or individual experience. The primitive or intuitive model is of insufficient quality to make rational decisions c.q. to adjust control parameters accurately.

Research in Dutch industries shows that the logistic control parameters are often set inaccurately or reset much too late or too infrequently by MPs (Den Boer, 1992). The factual decision making behavior appears to strongly differ from the expected decision making behavior. The explanation of these deviations are found in the low quality mental model of the MPs. Two causes underlie the MPs difficulties with effective control parameter setting. Firstly, human cognitive abilities are fairly limited in complex, stochastic and dynamic system control (Brehmer 1990); the decision environment of the MP belongs to this type of control. The human decision maker has a bounded dynamic and static memory span, shows systematic biases (Hogarth 1980) and is prone to various human errors (Reason, 1990) especially in dynamic and complex system control. Therefore, the quality of the individual experience of the MP can be considered to be at least doubtful.

Secondly, the information systems and performance feedback mechanisms on the tactical control level of MPs are often absent or of insufficient quality in current organizational practice (Wijngaard, 1991, Den Boer, 1991). Feedback of performance information of the individual commodities is not available. Also, MPs lack information about the correctness of parameter settings per commodity related to a certain norm or target, and the precise performance effects caused by former control actions, are seldom known. For all that, this type of information at the *elementary control level* i.e. per individually controlled commodity is necessary for effective control behavior. It is found that feedback mechanisms are not only poorly designed at the detailed level, but also at the aggregated level (information about the performance and process variables of the total commodity package).

The absence of detailed and aggregated performance and process feedback influences the quality of the mental model in a negative way. The model of the controller can only be of a primitive or in the best case of an intuitive nature. This keeps the MP away from accurate parameter adjusting. Therefore, it seems sensible to think of ways to support the human controller to build up an appropriate knowledge model to facilitate an effective adjustment of logistic control parameters.

3. SUPPORTING THE DEVELOPMENT OF AN INTEGRAL KNOWLEDGE MODEL

The task environment of an MP is dynamic, stochastic and very complex in nature. The complexity is the result of the large amount and heterogeneous contents of the commodity package an MP controls. The commodities or product items in a package strongly differ from each other. These differences relate to:

. Item characteristics : product item type, price, material demand and annual turnover.
. Environmental disturbances : uncertainties in the demand and supply.
. Control parameter setting : choice of order frequency, safety time and safety stock.
. Logistic performance : service level and stock circulation rate.

An item in a commodity package has a unique and dynamic IECP structure. 'Unique' means that each item has specific item characteristics (I), a particular risk of disturbances (E), an individual control parameter setting (C) and as a result a different logistic performance (P). See the objects of figure 2. 'Dynamic' means that the environmental and item characteristics may change, and thus the related control parameter setting and resulting logistic performance. See the arrows in figure 2.

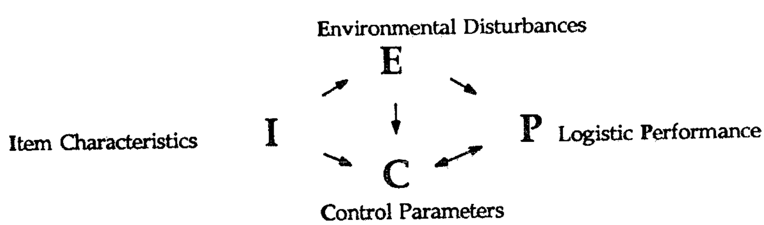


Figure 2: The IECP dynamic structure

The large amount of unique items in the controlled package causes a cognitive problem for the MP: "How do I maintain a good overview and insight of the causes and effects of the parameter control in my heterogeneous package". In three case studies, performed at production plants in the Netherlands, the following conclusions emerged:

Most MPs find it very difficult to identify structural changes of the IECP structure of an individual item in time. We call this the *dynamic knowledge problem*. Examples of questions are:

- Has the control environment changed for this item, so that parameter adaptations are necessary ?
- What is the exact effect of former adaptations of control parameters on the performance of this product item ?

Furthermore, MPs find it difficult to discriminate between items in the package at the same point in time. We call this the *stationary knowledge problem*. Examples of questions are:

- Which items cause the most frequent or severe run-outs ?
- Which are the major causes of those run-outs ?
- Which items are responsible for most of the stock expenses ?

A major problem in material requirements planning is to identify those product items which ask for a (potential) adaptation of control parameters. This requires periodical diagnosis and evaluation of all products items. Concrete tactical control information is needed to execute these activities properly. Figure 2 shows that changes in E, I and P influence the control parameter setting. So, it is important to provide this type of dynamic information as feedback to the planner.

Basic assumptions of integration.

When thinking of ways to support the human controller to build up an appropriate knowledge model we have to make two basic assumptions. The first is that effective feedback for the MP should be ***integrally related to all four factors*** in figure 2, and not only to one or two of the factors (e.g. only P; this happens frequently in organizational practice). The second assumption is that effective ***integral*** feedback should provide information both at the ***detailed control level*** and at the ***aggregated level***, and not only at the aggregated level as we often find in organizational practice (provided that there is feedback at all). In the following part of this article an attempt is made to test the second assumption; the first assumption is believed to be obvious.

The next section of this article describes a laboratory experiment, in which the decision making environment of the MP is simulated. The effects of two different ways of information feedback were investigated in this experiment. Two groups of subjects were compared; both groups were offered integral aggregated feedback (total information of all commodities to be controlled), but only one group was offered also extra integral detailed information (separate information of each individual commodity item). The decision situation of the first group, where detailed feedback is absent, represented current organizational practice: subjects have to memorize a large quantity of relevant performance and process information.

4. DESIGN OF THE EXPERIMENT

Subjects.
Twenty eight subjects participated in the experiment. The subjects were undergraduate students of the Eindhoven University of Technology with an average age of twenty three years. The subjects had followed courses in logistic theory at the Graduate School of Industrial Engineering and Management Science and were considered to have enough background knowledge to take in part into the experiment without problems.

Instruction.
The target of the experimental task was to guarantee effectively the material supply of a small commodity package in a factory. The commodity package consisted of eight commodities: accumulator, axle, bolt, engine, cable, bearing, pump and transformer. These materials should be available each week in the right quantities in order to match the demands of the assembly line. The experiment extended over 45 simulated weeks devided into 15 runs. Control information was offered to the subjects (Ss) by means of a visual display unit. The Ss could control the process and ask for information by key-board commands. Two performance variables were of utmost importance in the task: the *service level* and *total costs* of the commodity package. The Ss were instructed to firstly obtain and maintain a service level of at least 85%, and secondly to minimize the total costs of the controlled commodity package. The service level per run was expressed as the ratio of the amount of commodities with no material shortage divided by the total amount of commodities. The total costs consisted of: express delivery costs, safety stock costs and material shortage costs.

The experiment started with a written instruction about the targets and contents of the material supply task. Next, several standard exercises were performed to demonstrate the key-board control functions. Questions could be asked and were subsequently answered. The instruction and exercises lasted one hour.

The operational decision task.
Every 'monday morning' of a week the subject is shown control information about his or her commodity items on a visual display unit (figure 3). Each item has a name, a specific supplier, a certain planned demand per week and carries different logistic costs. Orders for material are placed automatically with suppliers. The normal weekly order quantity is equal to the planned demand in the third column of the control screen. The figures in this column - and also the buying price of one commodity (column 2) - stay the same during the experiment. However, the figures in the columns four through seven do not.

Status :		Run number : 3 Total runs : 15		Week number : 9 Total weeks : 45		
Column : (1)	(2)	(3)	(4)	(5)	(6)	(7)
Commodity :	Price :	Planned demand :	Real supply :	Real demand:	Safety stock :	Express delivery :
Accumulator	220	450	461	452	2	0
Axle	13	7450	7347	6134	100	0
Bolt	3	38500	40549	38724	500	0
Engine	4000	25	24	26	1	1
Cable	8	12050	12051	12048	0	0
Bearing	83	1200	1180	1200	15	5 ("unaccepted")
Pump	1333	75	72	75	0	3
Transformer	400	250	255	240	0	0
Menu : 1 EXPRESS DELIVERY		2 GENERAL COMMODITY INFORMATION			3	TO NEXT WEEK

Figure 3. An example of the 'weekly control screen'

The operational control problem a S is faced with, is that the weekly factual supply and demand (column 4 and 5) differ from the planning (column 3). This information becomes just known at the start of a week. The process uncertainty may cause expensive material shortages if no actions are undertaken. If the real supply plus the safety stock (column 6) is not enough to cover the demand, a subject has to place express devilery orders with a second and more expensive supplier. An extra problem is that express deliveries will not always be accepted by this second supplier, and therefore material shortage may still happen. The Ss are informed by means of pop-up information screens about the commodities where express deliveries are rejected and/or material shortage occur. The Ss do not know beforehand what commodities may cause most severe problems; the distribution functions of the uncertainty factors concerning supply, demand and acceptance level of express deliveries are hidden for the Ss, but they learn about these factors and consequences during the execution of the experiment.

The tactical decision task.
Ss are forced, in order to obtain and maintain a minimum service level of 85%, to create a safety stock for those commodities that have turned out to be prone to uncertainties. Every three weeks (i.e. at the end of a run) the Ss are able to lay in new safety stock or change a former setting of the safety stock for any commodity. The adjusted safety stocks will be directly available in the first week of the next run (column 6, figure 3). The Ss are supported in this task by means of an 'evaluation screen' (figure 4).

Aggregated control information is presented on the evaluation screen, i.e. information about the performance, the process and actions of the Ss related to all commodities over the last run. The total costs are represented in Dutch guilders and the fraction costs of the three cost factors (shortage, stocking, ordering) were presented in percentages below. Distinct cost ratios have been attributed for shortage, stocking and express ordering to each commodity item. This was known by the Ss at the start of the experiment. This information about the item costs can be retrieved easily by all Ss at any time during the task. A screen pops up, after the menu command 'general commodity information' both at the weekly screen and at the evaluation screen. In general, the cost ratios were defined as follows: any case of material shortage costs 300% of the commodity price, any express ordered piece of material costs 10% and any piece of safety stock costs 20% of the commodity item price.

Status : Run number : 5 / Total runs : 15 — Week number : 17 / Total weeks : 45

Column : (1) Commodity :	(2) Price :	(3) Planned demand :	(6) Safety stock :
Accumulator	220	450	50
Axle	13	7450	200
Bolt	3	38500	3250
Engine	4000	25	3
Cable	8	12050	3000
Bearing	83	1200	200
Pump	1333	75	4
Transformer	400	250	0

AGGREGATED FEEDBACK :

PERFORMANCE:
Service level : 73 %
Total costs : 340450
Safety stock costs : 45 %
Material shortage costs : 30 %
Express delivery costs : 25 %

PROCESS:
Demand higher than supply : 40 %
Accepted express deliveries : 2

ACTIONS:
Tried express deliveries : 5
Safety stock value devided by the total turnover value : 2 %

Menu : 1 ADJUSTING SAFETY STOCK — 2 DETAILED CONTROL INFORMATION * — 3 GENERAL COMMODITY INFORMATION — 4 TO NEXT RUN

Figure 4. An example of the 'evaluation screen'. Comment: The option 'detailed control information' in the menu (number 2) was only available to the Ss of one of the two experimental groups.

The evaluation screen (figure 4) presents besides total costs and the service level of the total commodity package, additional aggregate process and action information. The difference between attempted and accepted express deliveries is e.g. indicative of the delivering flexibility of the suppliers. And the lower the percentage 'demand higher than supply' is, the less risk there is for material shortages apart from the human interaction. Finally, the more safety stock is used by the Ss, the higher the percentage 'safety stock value devided by the total weekly turnover value' will be.

Experimental design.
In order to investigate the added value of detailed control feedback the 28 Ss were split up in two groups; each subject participated in only one experimental condition. The argument to choose for a 'between' instead of a 'within design' was the expectation that serious differential transfer would otherwise occur. The Ss in one of the two groups could retrieve control information also at the level of the individual commodities, the Ss in the other group could not do this. This last situation represents current organizational practice. The Ss of the group provided with detailed information could ask for additional performance, process and action information for any commodity item via the evaluation screen (figure 4). The detailed information was presented by means of a 'detailed feedback screen' (figure 5). The first column of this screen presents the moving average of the information variables over the last three runs. The figures in the second column show the facts over the latest run. The potential advantage of registration and feedback of detailed information is that the cognitively limited human controller is released from this heavy task.

RUN : 4	Selected commodity:	* ACCUMULATOR *
	MOVING AVERAGE last three runs	LAST RUN
PERFORMANCE:		
Service level :	53%	66 %
Total costs :	114500	102335
Express delivery costs :	12 %	30 %
Safety stock costs :	19 %	45 %
Material shortage costs :	69 %	25 %
PROCESS:		
Demand higher than supply :	30 %	40 %
Accepted express deliveries :	3	1
ACTIONS:		
Tried express deliveries :	5	2
Safety stock value derided by the total turnover value :	1 %	2 %

Figure 5. An example of a 'detailed feedback screen' of a selected commodity item.

The experiment was executed in four quiet and closed laboratory centres at the Eindhoven University of Technology. The Ss were spread over the laboratories and kept under supervision. The Ss were forbidden to speak to each other, but could ask the supervisor for help if necessary. The Ss were suggested that they had their own individual computer 'micro world' with specific dynamic and stochastic characteristics. In reality, all Ss were offered the same micro world with the same disturbances. The only difference was the (non) availability of extra detailed control information.

Apparatus.
A simulation program was developed by Berends (1991) and installed at the laboratory computers. The software registered of each individual S the key-board commands per second and registered the aggregated and detailed control information of all commodities per weeks and run; e.g. the performance, the operational and tactical decision behavior and the information asking behavior could be printed out per individual afterwards.

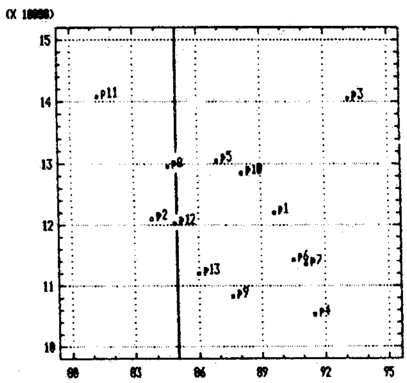
5. RESULTS

Performance deviations between groups.
The performance of the Ss was measured to the extent that they achieved the target of the task. Ss were instructed to firstly obtain and maintain a service level of at least 85%, and secondly to minimize the total cost of the controlled commodity package. The service level per run was expressed as the ratio of the amount of commodities with no material shortage divided by the total amount of commodities. The total costs consisted of: express delivery costs, safety stock costs and material shortage costs.

Service level.
The more frequently Ss exceed the 85% service level over the 45 weeks, the better their average service level performance would be. The number of Ss who failed to reach the average 85% service level target differed significantly between the groups (Fisher-exact-test, $P \leq .05$). Four of the thirteen Ss of the group withóut detailed feedback did not obtain the minimum target (31%), but all fifteen Ss of the group wíth detailed feedback succeeded (figure 6 and 7).

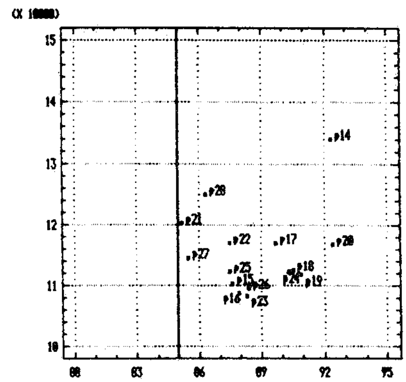
Total costs.
The better the Ss controlled the express delivery costs, safety stock costs and material shortage costs over the 45 weeks, the lower their total costs would be. The average total costs of Ss of the groups differed significantly (one tailed t-test, $P \leq .05$). The average total cost of Ss of the group withóut detailed feedback

were 121897 guilders per run, but the average total costs of the Ss of the group wíth detailed feedback was lower: 115220 (figure 6 and 7). This is an average cost reduction about 5,5 %.



X-axis: Average service level
Y-axis: Total costs (x 15)

Figure 6:
Service and cost performance of the Ss of the group withóut detailed feedback



X-axis: Average service level
Y-axis: Total costs (x 15)

Figure 7:
Service and cost performance of the Ss of the group wíth detailed feedback

The results demonstrate that the group with aggregated ánd detailed feedback obtained a better cost performance and service level in the simulated material supply task. This means that the hypotheses, that detailed information feedback will not positively influence the decision making behavior and logistic performance, should be rejected.

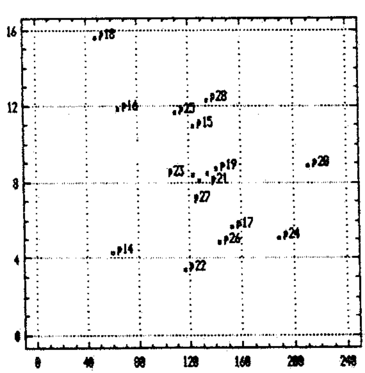
Besides this experimental outcome, two other interesting effects were found related to the decision behavior and information usage of the Ss. These *exploratory* findings are described below.

Table 1: Difference of the tactical decision frequency

Frequency of safety stock adjustments of the 8 commodities during the 15 runs		1 Group withóut detailed feedback (13 Ss)	2 Group wíth detailed feedback (15 Ss)
Average	:	32.8	46.5
Median	:	34.0	49.0
Standard deviation	:	9.1	15.2

Tactical decision frequency.
The frequency of safety stock adjustments of the eight commodities during the 15 runs deviated significantly between the groups (two tailed t-test, $P \leq .05$). The Ss with detailed information adjusted the safety stock more frequently than the Ss without detailed information (table 1). What is the explanation of this deviation ? The Ss of the group without detailed information support could only rely on their limited cognitive memory capabilities and probably adjusted only the safety stock of those commodities where former adjustments had obviously failed.

The Ss with detailed information support can reduce their *knowledge uncertainty* by simply asking for quantitative detailed information. They are able to consult a rational instead of an intuitive model. The detailed information provides certainty about e.g. the relative and absolute service level performance and cost performance of the commodities. Apparently, more knowledge certainty caused a more frequent and successful control behavior in this task.



X-axis: Frequency of detailed information calls
Y-axis: Average processing time per call in seconds

Figure 8: Differences of detailed information usage of the Ss in the group with detailed feedback.

Information usage.
The frequency and duration of the information asking behavior differed substantially amongst the Ss of the group with detailed feedback. For example, subject number 18 asked 48 times for detailed feedback opposed to subject number 20 who asked for information more than 200 times (figure 8). This difference is about a factor four. Also, the information processing time differs

substantially amongst the Ss of the group with detailed feedback. For example - as shown in figure 8 -, compare subject number 22 to subject number 25. Both Ss roughly have the same information asking frequency, but subject 25 spends three times more on information processing.

Apparently, the actual use of the detailed information provided by the information system differs strongly from person to person. This result gives something to think about. Should the information processing behavior be standardized in the organization, or left completely free to the end user ?

6. CONCLUSION

In the experiment two groups of subject have been compared. Both groups were offered aggregated feedback (total information of all commodities to be controlled), but only one group was offered extra detailed information (separate information of each individual commodity item). The decision situation of the first group, where detailed feedback was absent, represented current organizational practice: subjects have to memorize a large amount of relevant performance and process information. The results of the experiment showed, that the group which had access to both aggregated and detailed feedback (i.e. integrated feedback) obtained a significantly better logistic performance. The explanation is based on the fact that Ss with detailed information support were able to consult an accurate and rational model of the controlled system as opposed to the other Ss who could only rely on their limited cognitive capabilities. The outcome of this experiment implies that designers of logistic information systems should not take the view that human controllers will develop an accurate mental model on their own accord in complex and dynamic system control. On the contrary, the human logistic controller should be aided in order to develop a proper and integral mental model. Because the effect of detailed feedback already turned out to be of value in the *semi complex* supply task (i.e. Ss controlled only eight commodities and had only two control modes at its proposal) it is believed that this type of integrated feedback will even be more valuable in the more complex logistic reality.

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References:

BEMELMANS, T.M.A. 1991, (In Dutch) Bestuurlijke informatiesystemen en automatisering. (Stenfert Kroese, Leiden).

BERENDS, E. 1991, (In Dutch) Simulatie materiaalverwerving; intern rapport T&A, *Ergonomie nr. 83*; Fac. Bedrijfskunde (Universtiy of Eindhoven).

BREHMER, B. 1990, Experiments with computer simulated microworlds: escaping the narrow straits of the laboratory as well as the deep blue sea of the field study. Paper presented at the symposium: *La psychology du travail et les nouvelles technologies*. University de Liège, 17-18 mai

DEN BOER, A. 1991, (In Dutch) Prestatieverbetering van materiaalplanner: een ontwerp voor beslissingsondersteuning; *Bedrijfskundigen informeren bedrijfskundigen, NOBO vijfde onderzoeksdag 1991*, Edited by the Nederlandse Organisatie voor Bedrijfskundig Onderzoek (Planeta, Enschede).

DEN BOER, A. 1992, (In Dutch) *Beslissingsondersteuning voor materiaalplanners*. Thesis (concept), (University of Technology, Eindhoven).

HOGARTH R. M. 1980, *Judgement and choice, the psychology of decision* (John Wiley & Sons, Chichester).

KRAGT, H. 1983, *Operator tasks and annunciator systems: studies in the process industry*, Thesis, University of Technology (De Witte B.V., Eindhoven).

LANDEWEERD, J.A. 1978, (In Dutch) *Interne procesrepresentatie bij leerling-operators*. Thesis, University of Technology. (Wibro, Helmond).

REASON, J. 1990, *Human Error*. (Cambridge University Press, Cambridge).

WIJNGAARD, J. 1991, (In Dutch) *Produktiemanagement, "Dan doe ik dit, ... en alles staat stil"*, Intreerede, 3 december (Rijksuniversiteit Groningen, Groningen).