# Information Network and Risk Management

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ABSTRACT

With a new information system, the "order-production-distribution" system can be managed as a whole in terms of corporate performance. But there is a possibility that such a system can be damaged easily from degraded information conveyed through an information network. This paper is concerned with an approach to dealing with degraded information in light of risk management with the system dynamics philosophy.

## INTRODUCTION

A new information technology has been changing the management of the corporation. For instance, the companies that developed international information networks can get inventory information within a shorter time than before, and as a result, succeed in not only decreasing their inventories, but also in improving their financial figures. It is possible to say that information technology can help management evaluate the value of inventory in terms of corporate performance. It is also possible to say that with the new information technology, the "order-production-distribution" sytem can be managed as a whole in terms of corporate performance.

Most technologies have nagative sides as well as positive sides. Information networks are no exception. Many accidents, such as computer crime and damage to the cable, can easily destroy or degrade information quality conveyed through an information network. Also, bias and noise are unavoidable in information networks.

In order to manage these nagative sides, concern for computer security is not enough because it does not say anything about how to respond to degraded information.

This paper is concerned with an approach to dealing with degraded information in light of risk management with the system dynamics philosophy.

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The philosophy of system dynamics can be illustrated in figure 1. People, materials, money, orders, and capital equipment constitute the sides of a pentagon, and the information network connect each side with a set of policies, the center of the pentagon. With simulation runs, it is necessary to find a robust set of policies to guard against changes of environment and risks that threaten the information network.

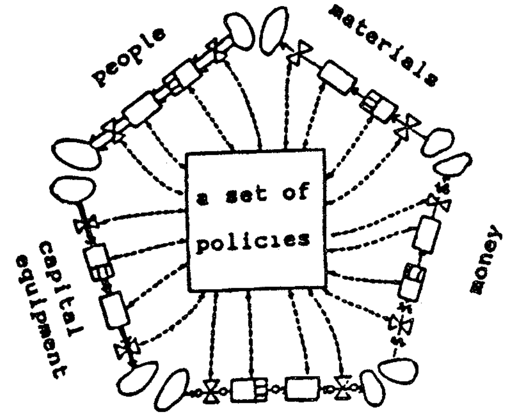


Figure 1. Philosophy of system dynamics

With a scheme of figure 1, the "order-production-distribution" system of a hypothetical firm will be modeled in the following section. Then simulation runs will show how the impact of degraded information affects the corporate performance. Improvement of the system model will be designed by changing the information network.

"ORDER-PRODUCTION-DISTRIBUTION" SYSTEM

Assuming that a new information technology such as videotex is used in a hypothetical firm not only for connecting cutomer orders but also connecting internal information, the "order-production-distribution" system of the firm is illustrated in figure 2. This paper is greatly concerned with the "order-production-distribution" system, so people, money and capital equipment are not included in detail.

Part A is a policy that decides production rate by processing customer orders. Part B is a policy that decides shipment rate by processing production completions. SW1, SW2, SW3 and SW4 are the accident points where degraded information invades the information network because of many accidents such as computer crime and damage to the cable.

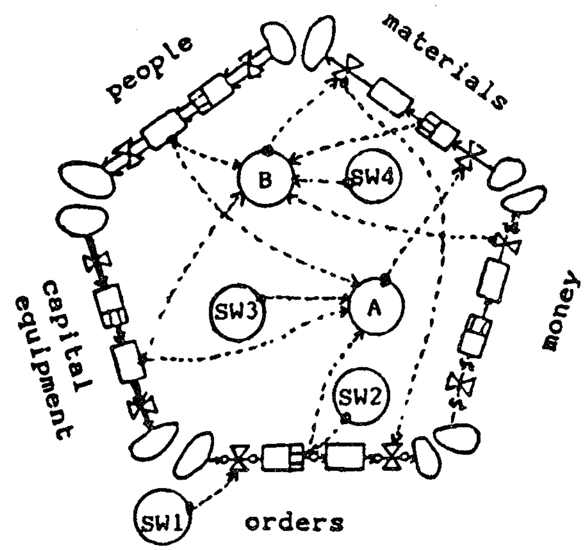


Figure 2. "Order-production-distribution" system

Swl is the accident point where customers order to the firm through the information network. SW2 is the accident point where customer orders are processed in the firm. SW3 is the accident point where production rate is informed to the production department. SW4 is the accident point where distribution orders are informed to the traffic department. At this point, a deposit of a customer's bank account is also checked.

Part A and part B, including SW1, SW2, SW3 and SW4, are explained in detail in order.

Part A connects accepted order rate OC to production rate PR, under the restriction of production capacity that consists of people and capital equipment. The restriction is set at 150 units per hour, while customer order rate is set at 100 units per hour. This hypothetical firm begins to produce goods when a customer order is received. But, because of the capacity restriction, all orders do not always equal the production rate. In case that customer orders are greater than the restriction, there remain unfilled orders for production UPO. When the clerk is unable to inform customer orders to the production department because of computer crime or damage to the cable ( SW3 = 0 ), accepted order rate from customers OC must be added to unfilled order rate for production UPO automatically. The following equations specify these relationships which are illustrated in figure 3 with the flow diagram.

OC.KL = (OOO.K/TPO)*SWITCH(1.0,S.K,SW2) 3,R
TPO = 2 C
where
OC = accepted order rate from customers (units/hour)
OOO = customer orders on order (units)
TPO = time for being accepted to the firm (hours)
SWITCH = the value equals 0 or 1 (it is explained in the next section).

UO.K = UO.J+DT*(OC.JK-SR.JK) 4,L
UO = 2450. N
where
UO = unfilled customer orders (units)
SR = shipment rate (units/hour)

IPO.K = OC.JK+UPO.JK 5,A
IPO = OC N
where
IPO = information for production order rate (units/hour)
UPO = unfilled order rate for production (units/hour)

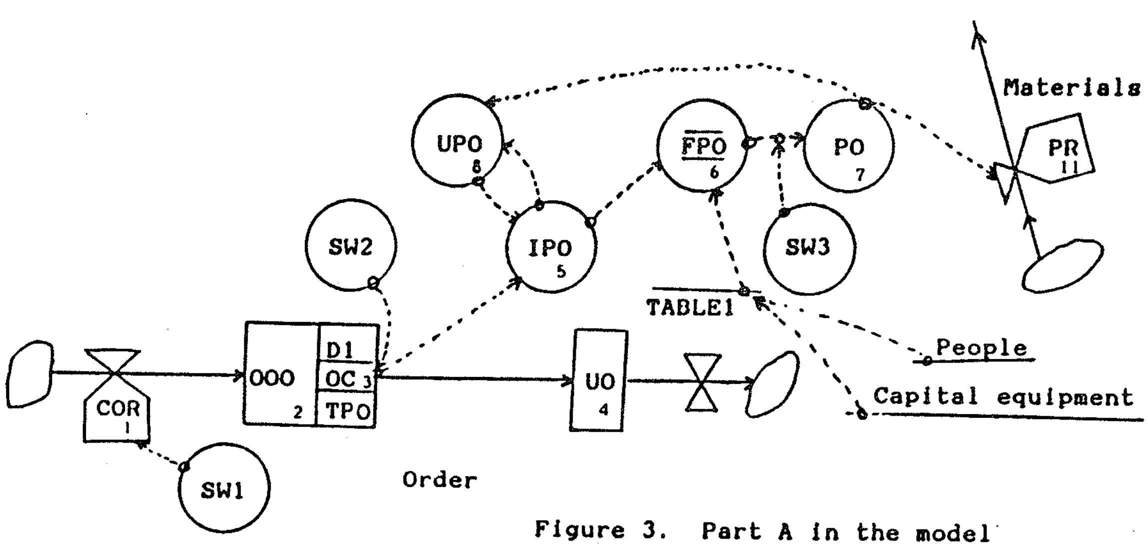


Figure 3. Part A in the model

FPO.K = TABHL(TABLE1,IPO.K,0.,150.,150.) 6,A
TABLE1 = 0.,150. T
FPO = OC N
where
FPO = final information for production order rate (units/hour)
TABLE1 = table for decision of production order rate (dimensionless)

PO.K = FPO.K*SWITCH(1.0,S.K,SW3) 7,A
PO = OC N
where
PO = production order rate (units/hour)

UPO.KL = IPO.K-PO.K 8,R
UPO = 0 N

PR.KL = PO.K 11,R
where
PR = production rate (units/hour)

Part B connects production completions PC to shipment rate SR, under the restriction of distribution capacity that consists of people and capital equipment. This restriction is set at 150 units per hour, which is the same restriction involved in production capacity. This hypothetical firm begins to distribute goods to the customer after checking or transferring the deposit of the customer's bank account, when information of the production completion is informed to the traffic department. In case that production completions are greater than the restriction, there remain unfilled orders for shipment. When the firm is unable to transfer the balance of the customer's bank account because of deficit ( SW4 = 0 ), or when the clerk is unable to inform production completions to the traffic department due to computer crime or damage to the cable (SW4 = 0 ), production completions must be added to unfilled order rate for shipment USO automatically. The following equations specify these relationships, which are illustrated in figure 4 with the flow diagram.

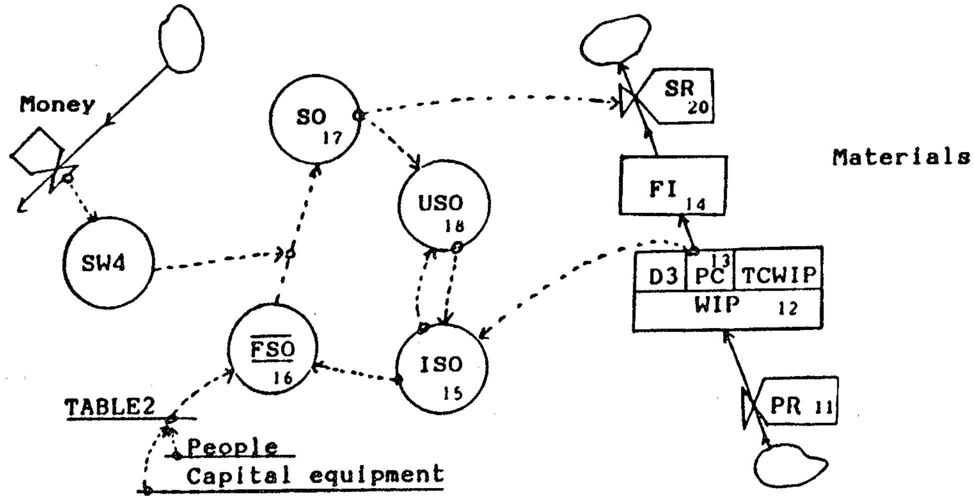


FIGURE 4. Part B in the model

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PC.KL = DELAY3(PR.JK,TCWIP)                                        13,R
TCWIP = 24                                                            C
where
PC = production completions (units/hour)
TCWIP = time to complete work in process (hours)

FI.K = FI.J+DT*(PC.JK-SR.JK)                                       14,L
FI = 25.                                                              N
where
FI = finished product inventory (units)

ISO.K = PC.JK+USO.JK                                               15,A
ISO = PC                                                              N
where
ISO =  information for shipment order rate (units/hour)
USO = unfilled order rate for shipment (units/hour)

FSO.K = TABHL(TABLE2,ISO.K,0.,150.,150.)                           16,A
TABLE2 = 0.,150.                                                      T
FSO = PC                                                              N
where
FPO = final information for shipment order rate (units/hour)
TABLE2 = table for decision of shipment order rate (dimensionless)

SO.K = FSO.K*SWITCH(1.0,S.K,SW4)                                   17,A
SO = PC                                                               N
where
SO = shipment order rate (units/hour)

USO.KL = ISO.K-SO.K                                                18,R
USO = 0                                                               N

SR.KL = SO.K                                                       20,R
where
SR = shipment rate (units/hour)
```

EFFECTS OF DEGRADED INFORMATION

With simulation runs of the model described above, effects of degraded information will be tested. But, first, setting the flow of parts in equilibrium, it was analyzed that it takes 15 hours for the system model to achieve equilibrium again, gradually in response to STEP increase change in customer order rate by 20 percent. The nature of the model structure was assured not to be cyclical.

To specify degraded information, a function SWITCH is used to express a sudden stop in the information network due to many kinds of accidents such as computer crime or damage to the cable. When an accident happens, which is specified as SWn = 0, the value of SWITCH(1.0,S.K,SWn) becomes 0. The time is set in a function STEP when an accident happens and ends.

```
S.K = 1.0+STEP(-1.0,STB)+STEP(1., STE)                                A
where
STB = time when an accident happen (working hours)
STE = time when an accident ends (working hours)
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STB is set at hour 5, and STE varies from hour 5.5 to hour 9, which means that the length of an accident is from half an hour to 4 hours.

Table 1 shows 7 combinations of SWn which are used for simulation runs to analyze the impact of degraded information to the system model. Each combination corresponds to a real accidents which happens in a part of the corporate system. For instance, in combination A, an accident damages the information network for receiving customer orders. In this case, the firm loses customer orders during the accident, but the operation of the firm does not get damaged directly.

| combination / SWn | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| SW1 | 1 | | | | 1 | | 1 |
| SW2 | | 1 | | | 1 | | 1 |
| SW3 | | | 1 | | | 1 | 1 |
| SW4 | | | | 1 | | 1 | 1 |

*When SWn is set at 1, the value of SWITCH becomes 0 during an accident.

Table 1. SWn for simulation runs

Assuming the length of an accident is 2 hours ( STB = 5, STE = 7 ), each combination is tested with simulation runs. Figures 5 and 6 show the response to combination G, in which the information network suddenly stops. That is to say, the values of COR at SW1, OC at SW2, PR at SW3, and SR at SW4, suddenly decrease to 0 simultaneously. After the length of the accident, the system is in the direction of equilibrium. Figures 5 and 6 show that it takes about 45 hours to achieve equilibrium again when the length of the accident is 2 hours.

Surprisingly, the performance of combination G is almost the same as the performance of combination A and E, except for the performance of unfilled order rate for shipment USO, information for shipment order rate ISO, and shipment order rate SO during the accident. The common factor of these combinations is customer order rate COD, which is the only external factor to the system model. Other combinations do not include this factor at an accident point. It can be said that the external factor COD is critical to the "order-production-distribution" system.

In this model, the influence of each internal factor is limited. Consider an accident only at SW3 which corresponds to combination C. Figure 7 shows that production rate RP suddenly becomes 0 at hour 5, and suddenly increases after hour 7 due to the increase of unfilled order rate for production UPO. As a result, this hypothetical firm keeps production capacity in motion for 4 hours. In this model the influence of feedback control is limited, therefore, internal factors do not change the overall performance.

Feedback control is an intrinsic of characteristic of company policies. It exists whenever information about the level of an accumulation returns as an input to the decisions that effect the flow rates from the accumulation (Lyneis, p50). There are two kinds of feedback controls in this model : one in part A, the other in part B. Both are for monitoring next order rate under the capacity restriction. However, in light of the above simulation runs, these feedback controls don't aggressively influence performance.

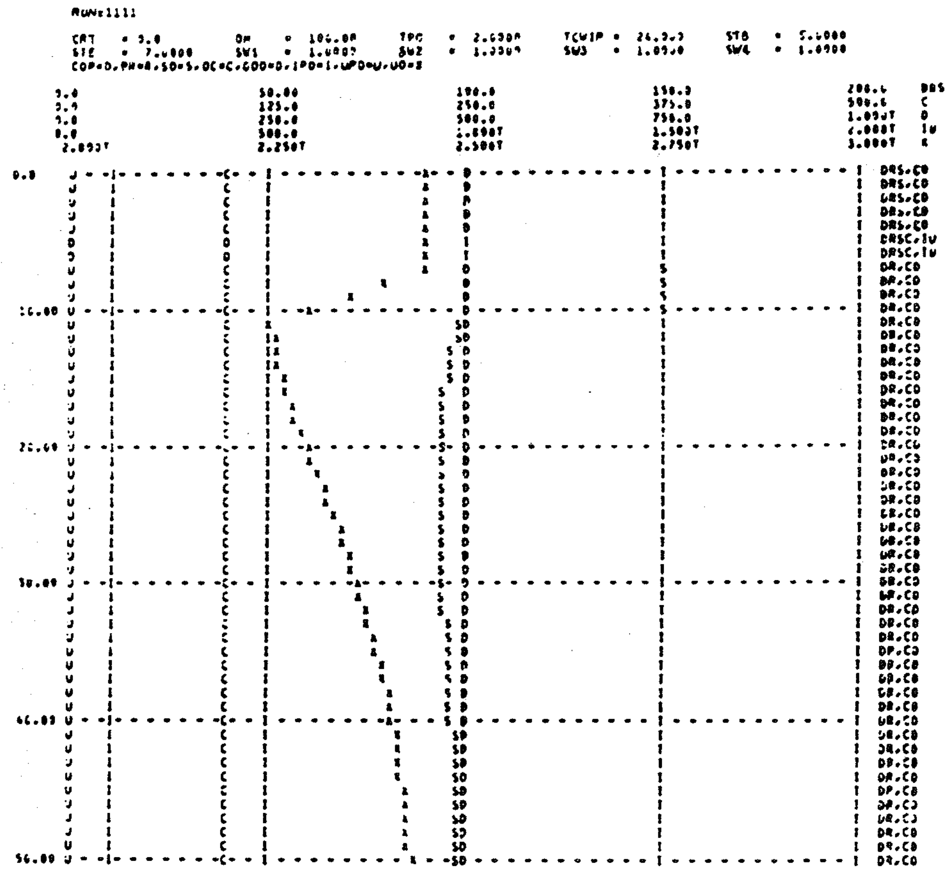

Figure 5. Combination G ( 1 )

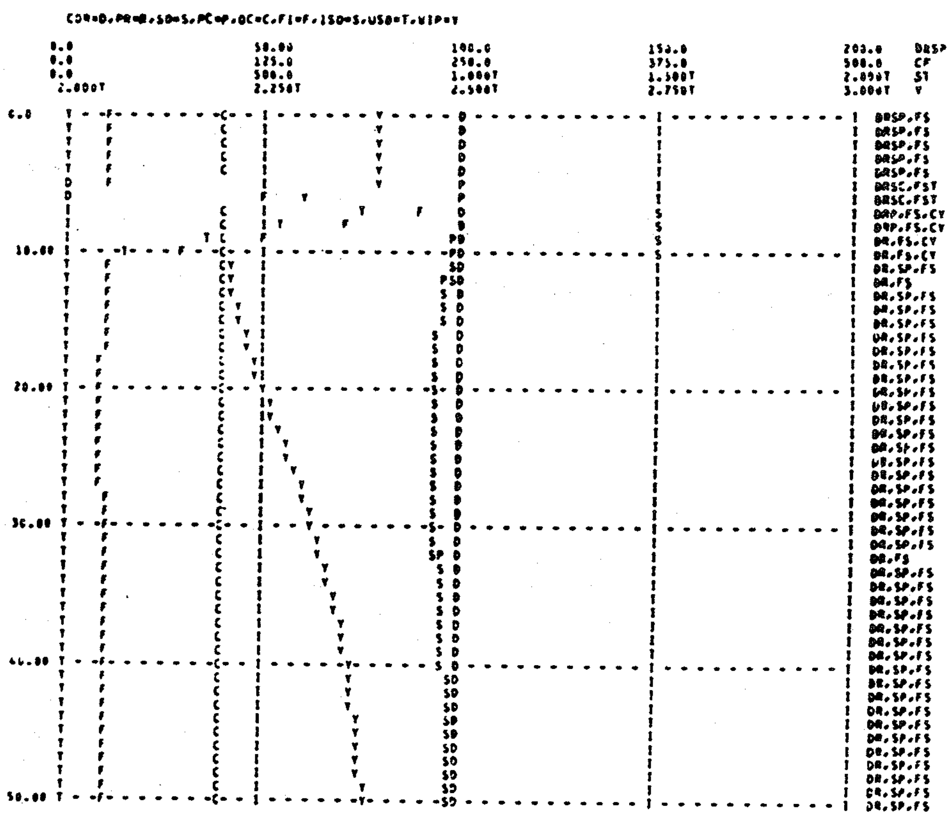

Figure 6. Combination G ( 2 )

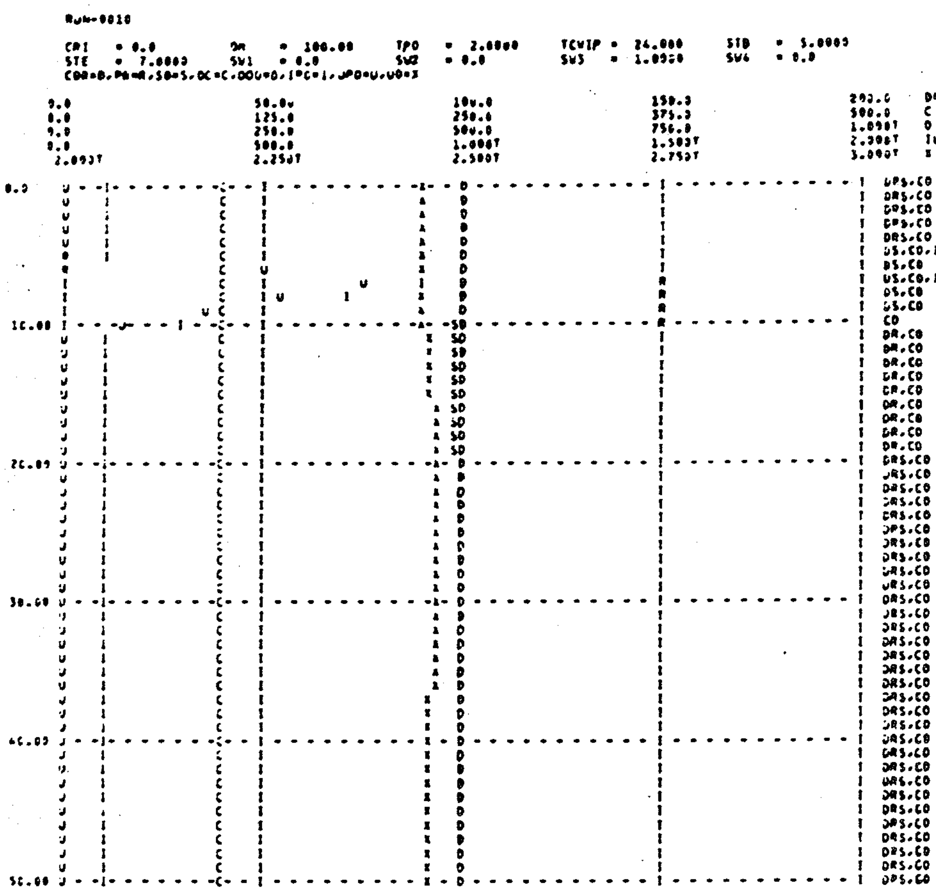

Figure 7. Combination C

Simulation runs in which the length of an accident is set at half an hour, 1 hour, 3 hours, and 4 hours, show that the performance is almost the same as the performance of the 2 hour accident in terms of the combinations. Of course, the longer the length of an accident is set, the longer it takes to achieve equilibrium. But, the character of these combinations discussed above remain unchanged.

## IMPROVEMENT OF THE SYSTEM MODEL

The system dynamics philosophy states that improvement of the performance can be achieved by changing the information network without changing other resources. In this "order-production-distribution" system, when accepted order rate from customer OC is informed directly to part B before ordered production completions, the impact of the accident at SW4 may be lessened to the performance. This is one way to protect the system against the accident which damages all the parts of the system simultaneously. If a system is carefully designed, risk management can be achieved without adding any data processing.

It is popular for risk management to introduce a duplex system against computer crime or damage to the cable. However, it has not been discussed where to introduce such a duplex system in the firm in order to improve the corporate performance. In light of the above simulations, it can be suggested that efficiency is achieved by introducing a duplex system for receiving customer orders. This is because customer order rate, which is the external factor to this system, is critical to the overall performance.

A new information technology can make office functions speed up, and as a result, a better performance is expected. However, as Forrester has demonstrated that speeding up office functions makes no significant contribution to the overall performance. The model discussed in this paper has shown a similar result. Simulation runs varying in time (TPO) from 1 hour, 2 hours, and 4 hours, show that there is not a considerable difference between them.

## CONCLUSION

In this paper risk management against many accidents such as computer crime or damage to the cable has been considered, using the "order-production-distribution" system model. Because of weak feedback control in this system model, changing the information network does not significantly contribute to the performance. However, this model suggests the critical point where a duplex system should be applied in the corporate system for risk management. It is possible to say that a robust set of policies can be designed with the support of a new information technology introduced to the appropriate point in the firm.

## REFERENCES

Forrester J. W. Industrial Dynamics. MIT, 1961.
Lyneis J. M. Corporate Planning and Policy Design : A System Dynamics Approach. MIT, 1980.

APPENDIX : Equation Listing for "Order-production-distribution" Model

```
*   INFORMATION NETWORK AND RISK MANAGEMENT
NOTE  (ORDER)
1R COR.KL=(OM+CRI*NOISE())*SWITCH(1.0,S.K,SW1)
NOTE 1R COR.KL=OM+STEP(CTEP,20)
NOTE C CSTEP=20.
C CRI=0,OM=100
NOISE 13
2L OOO.K=OOO.J+DT*(COR.JK-OC.JK)
N OOO=OM*TPO
3R OC.KL=(OOO.K/TPO)*SWITCH(1.0,S.K,SW2)
C TPO=2
4L UO.K=UO.J+DT*(OC.JK-SR.JK)
N UO=2450.
5A IPO.K=OC.JK+UPO.JK
N IPO=OC
6A FPO.K=TABHL(TABLE1,IPO.K,0.,150.,150.)
T TABLE1=0.,150.
N FPO=OC
7A PO.K=FPO.K*SWITCH(1.0,S.K,SW3)
N PO=OC
8R UPO.KL=IPO.K-PO.K
N UPO=0
NOTE   (MATERIAL)
11R PR.KL=PO.K
12L WIP.K=WIP.JK+DT*(PR.JK-PC.JK)
N WIP=OM*TCWIP
13R PC.KL=DELAY3(PR.JK,TCWIP)
C TCWIP=24
14L FI.K=FI.J+DT*(PC.JK-SR.JK)
N FI=25.
15A ISO.K=PC.JK+USO.JK
N ISO=PC
16A FSO.K=TABHL(TABLE2,ISO.K,0.,150.,150.)
T TABLE2=0.,150.
N FSO=PC
17A SO.K=FSO.K*SWITCH(1.0,S.K,SW4)
N SO=PC
18R USO.KL=ISO.K-SO.K
N USO=0
20R SR.KL=SO.K
NOTE
A S.K=1.0+STEP(-1.0,STB)+STEP(1.,STE)
C STB=5,STE=9
C SW1=0,SW2=0,SW3=0,SW4=0
NOTE   PRINT OUTPUT
PRINT COR,OOO,OC,UO,IPO,UPO,PR,WIP,PC,FI,ISO,USO,SO
NOTE   PROT OUTPUT
PLOT COR=D,PR=R,SO=S(0,200)/OC=(0,500)/
X      OOO=O(0,1000)/IPO=P,UPO=U(0,2000)/
X      UO=X(2000,3000)
PLOT COR=D,PR=R,SO=S,PC=P(0,200)/
X      OC=C,FI=F(0,500)/
X      ISO=S,USO=T(0,200)/WIP=Y(2000,3000)
NOTE SPEC DT=0.5,LENGTH=200,PRTPER=4,PLTPER=2
SPEC DT=0.25,LENGTH=50,PLTPER=1
RUN 0000
```