PRODUCT DIVERSIFICATION AND QUICK RESPONSE ORDER STRATEGIES IN SUPPLY CHAIN MANAGEMENT

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Quick Response is a new supply chain management system designed to meet the changing requirements of an increasingly more competitive market in the apparel sector. (Hunter et.al. 1992 and Kincade et.al. 1993). The main objective of this study is to build a System Dynamics simulation model of the portion of the textile and apparel pipeline including the retailing and wholesaling processes to search for inventory decisions and policies that yield reduced costs/increased revenues in terms of the retailer. As seen in Fig.1, the model not only includes the main components of supply chain, but also incorporates how product diversity may affect sales. There are two conflicting effects: first, as the product diversity of the store increases, the probability that customers' preferences will be matched increases toward 1.0 asymptotically. (See Fig.2a). This graph not only makes sense, but can also be obtained by probabilistic analysis, using Binomial probabilities (Barlas & Aksoğan 1995). The opposite effect of increasing diversity implies lower stocks of each product type ("Typesupply"). Thus, as the ratio typesupply/demand decreases, higher fractions of demand will be lost due to type stockouts (as shown in Fig.2b). Therefore, the conflicting effects of product diversity is potentially worth investigating dynamically.

The second major originality of the model is that it involves two decisions made at discrete points in time (every seven days), intermixed with continuous flows of processing of goods in the supply pipeline. This "hybrid" system requires that the traditional order rate formulation -which yields steady-state errors in inventories- be modified. (See Fig. 3a, especially the Apparel Manufacturing Inventory). The solution is to use the following modified order rate formulations:

Store_Order_Rate = IF (Time/7 - INT(Time/7))>0 THEN 0 ELSE
(Des_Store_Inv - Store_Inv)/Store_Inv_Adj_Time +
(Des_Transfers - Smth_Goods_Trans)/Transfer_Adj_Time + 7*Est_Sales

and

Man_Order_Rate = IF (Time/7 - INT(Time/7))>0 THEN 0 ELSE
(Des_Man_Inv - Smth_Eff_Inv)/Man_Inv_Adj_Time +
(Des_Goods_in_Prod - Smth_Goods_in_Prod)/Prod_Adj_Time +Store_Order_Rate

Observe that, in addition to multiplying the estimated daily sales by 7, three variables must be smoothed: Goods transferred, manufacturing inventory (effective) and goods in production. Only then, is it possible to have the inventories to reach their desired levels, as seen in Fig.3b. (The selection of orders of smoothing and smoothing constants may involve substantial analysis, as discussed in Barlas & Aksoğan 1995).

In order to examine the different effects of product diversity, we experiment with diversity = 40, 20 and 18. As we decrease diversity from 40 to 20, the probability of the store's product line matching customer preferences decreases, but this effect is offset by a decrease in "percent demand lost due to type stockouts" (since type_supply/demand is higher). The result in this case is increased sales. (Compare fig.4a and b). As we further decrease diversity from 20 to 18, lowered probability of customer preference matching this time dominates the effect of decreased percent demand lost due to stockouts; hence lower sales. (Fig. 4c). In this particular example, we see that a diversity of 20 is "optimum." The reader is referred to Barlas & Aksoğan (1995) for much more extensive analysis of this and other related issues.

REFERENCES

Barlas, Y. and A. Aksoğan. 1995. A Dynamic Systems Analysis of Quick Response Strategies in Apparel Industry. Research Paper FBE-IE-10/95-15. Boğaziçi University, Dept. of Industrial Engineering, İstanbul, Turkey.

Hunter, N.A., R.E.King and H.L.W. Nuttle. 1992. An Apparel Supply System for Quick Response Retailing. *Journal of the Textile Institute* 83(3): 462-471.

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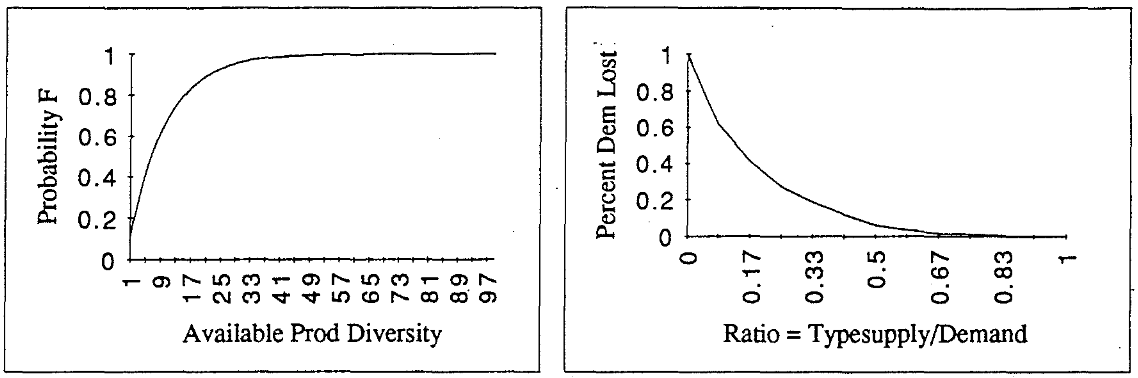
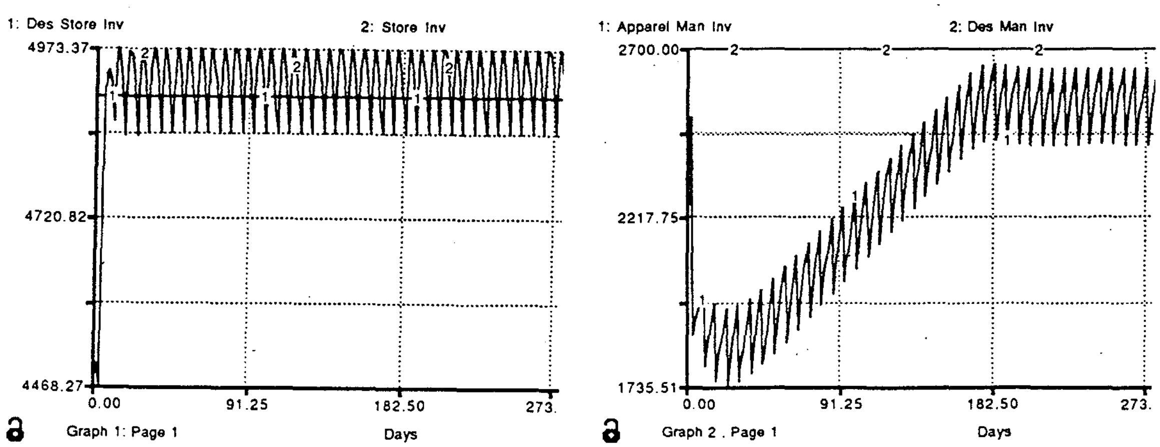
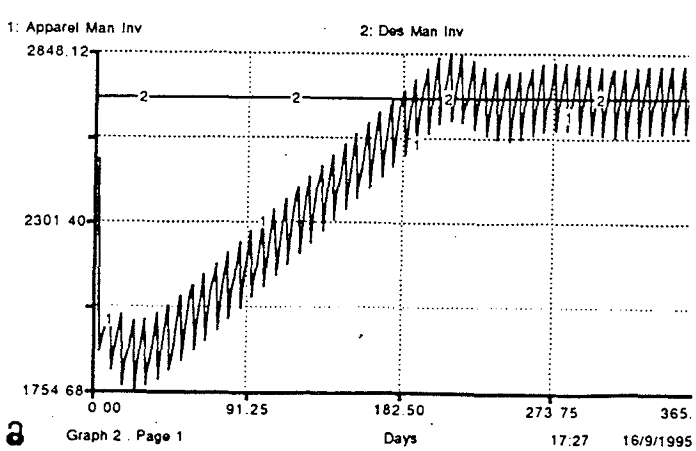


a b

Figure 2. (a) Probability of store's matching customers' preferences as a function of product diversity.
(b) Percentage of demand lost as a function of stock of each product type/demand.



(a)



(b)

Figure 3. The Dynamic Behavior of Inventories About Their Desired Levels.
(a) With Standard Ordering Policies, Yielding Steady-State Errors.
(b) With Improved Ordering Policies.

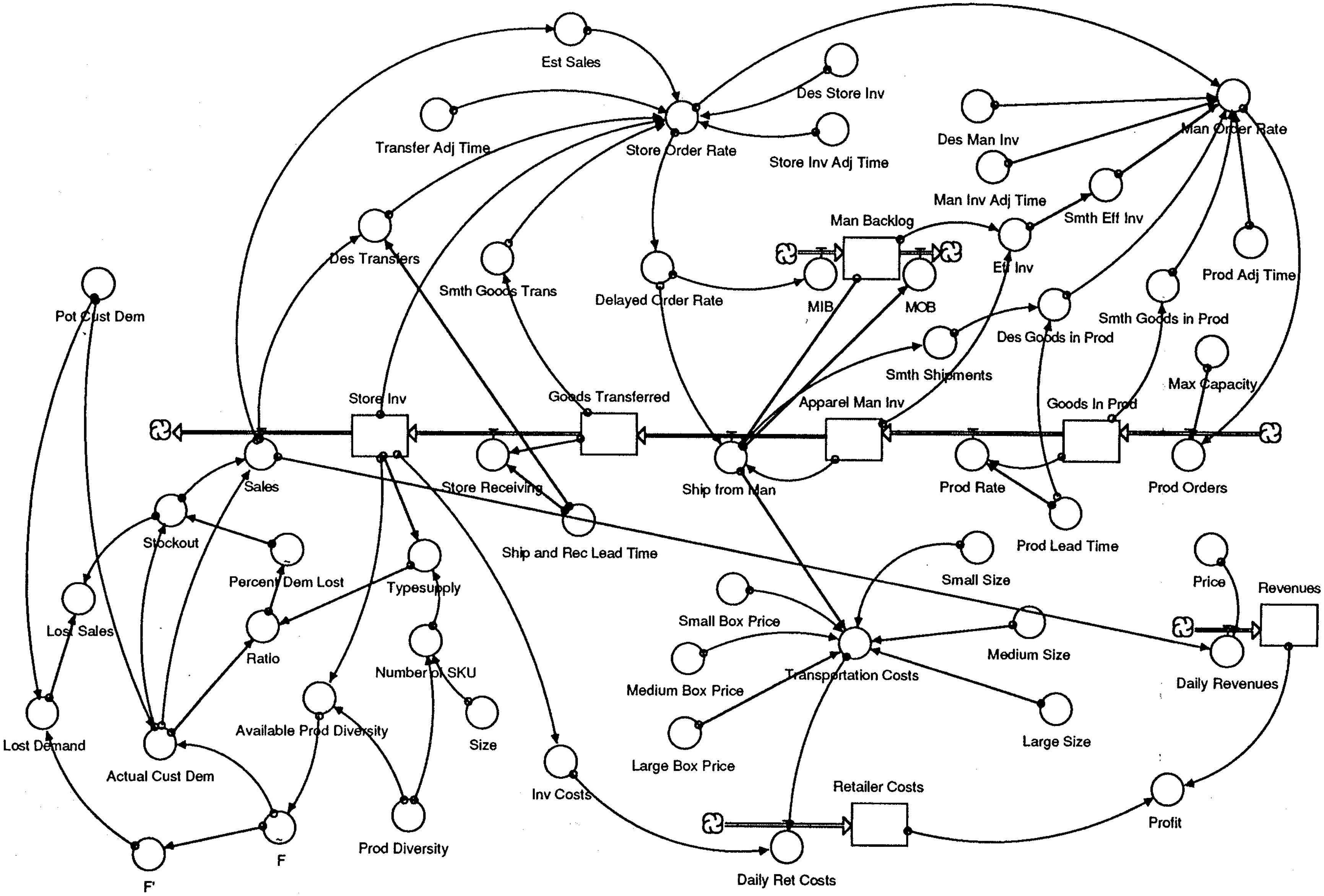
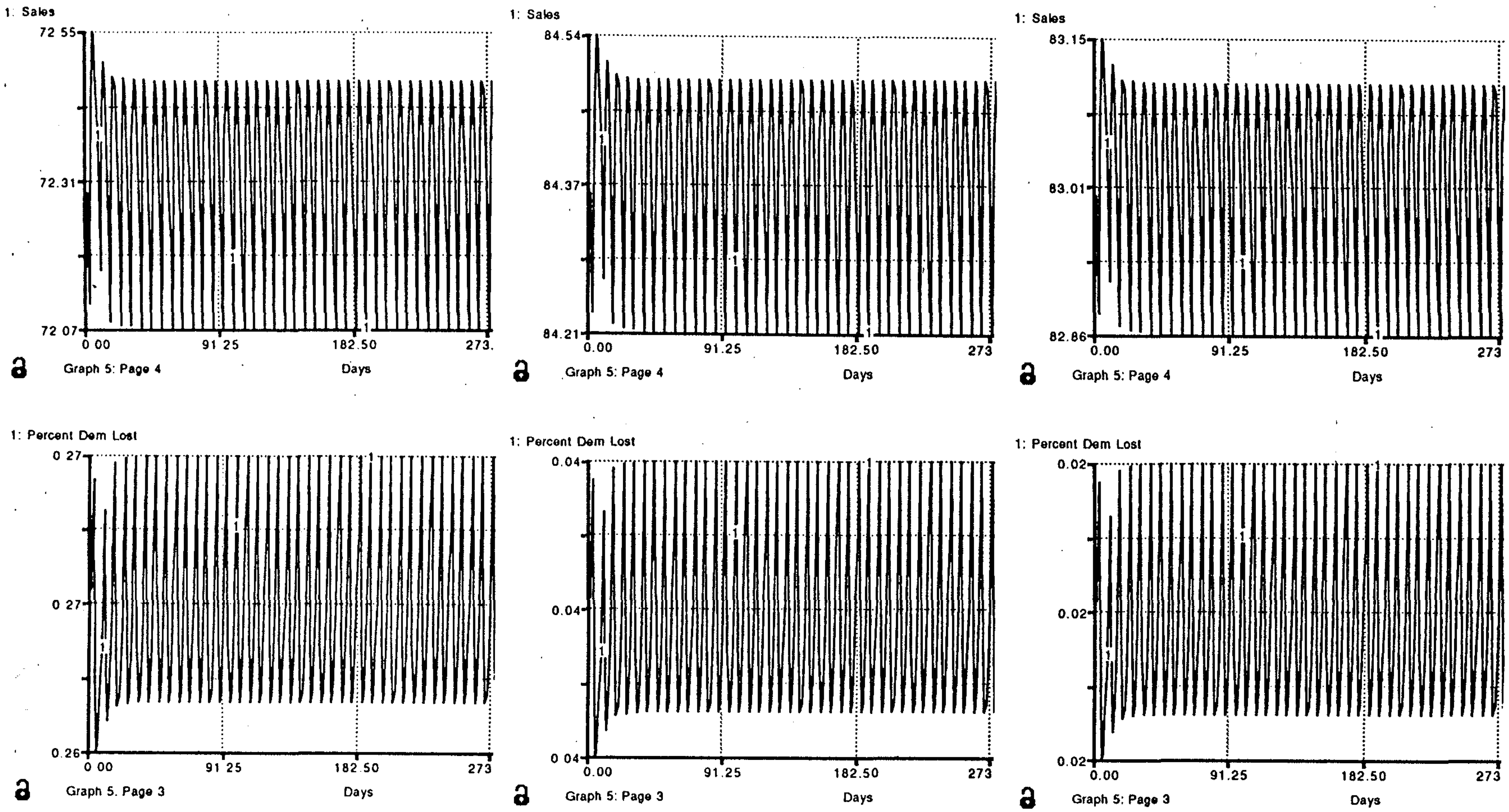


Figure 1. Stock-flow Diagram of the Model



(a) Diversity = 40

(b) Diversity = 20

(c) Diversity = 18

Figure 4. Sales and Percentage of Demand Lost, as Product Diversity is Varied.