A SIMULATION STUDY OF THE DYNAMIC BEHAVIOR OF A NEWFOUNDLAND SEASONAL FISH PROCESSING OPERATION

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by

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ABSTRACT

In today's highly competitive fishing industry, a fish plant manager must operate his plant to maximum efficiency and take whatever action he deems necessary to keep ahead of his fellow competitors. There are limited fish resource and markets available and if he doesn't remain competitive, other fish processing plants will force him out of business. The supply of fish to the Newfoundland processing plants has been one of the major factors in determining the production patterns. Besides the problem of the supply of fish, there are other variables which the plant manager encounters, such as changes in prices of raw material, labour rates, equipment breakdowns, selling price fluctuations and market demands, etc.

Other requirements for an efficient plant operation are related to the managerial skills, mainly one of predicting or forecasting what actions need to be taken. These skills relate to the extent to which management is able to quickly and accurately analyse and establish the best course of action.

The objective of this study was to develop a computer model, which would be able to simulate a fish processing operation with various input parameters. These parameters would relate to raw material quantities and prices, finished product order demands, selling prices, labour productivity, labour rates, plant and equipment capacities and other variables of the processing operation.

The study undertook to develop a systems dynamic model of a Newfoundland inshore fish processing plant. The procedure of systems dynamics was based on Forrester's works in industrial dynamics, (Forrester

1960). A model logic was developed based on the actual physical observations of the plant. After the model logic had been tested on the computer, simulations were performed based on the initial data input of the plant. The model was built to simulate every day operation for a 300 working day year. Various computer simulations were performed for a selected number of changes in the initial data input and possible economic and production outcomes were compared.

These comparisons relate to profits, cash flows, sales revenue and costs, assets and liabilities, profit return ratios, production rates, freezing rates, inventory holdings, employment, etc. The exercise of developing a systems dynamic model and its subsequent use as a simulation tool to assist management in decision making has been adequately demonstrated.

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CHAPTER 1

INTRODUCTION

1.1 General Fisheries Background

The total annual catches of fish in the world from 1960 to 1976 have increased from 30 million tons to 70 million tons (Annual Statistical Review, 1977). Fisheries scientists have voiced that the upper limit of fish catches has been reached and predict that the chances of reaching 100 million tons per year are rather small, (Davis, 1973). The biological, physical and economic limits to the total tonnage of fish which can collectively be taken from the sea are already being considered on a global plan by the Food and Agricultural Organization (FAO) of the United Nations.

Management related to the maintenance of aquatic resources has many facets. Input to management of aquatic renewable resources has come from philosophers, fishery scientists, politicians, government institutions and public attitudes. Those managing have been concerned with allocating and managing a given resource for the production of food or industrial products, with using it for recreational purposes, or simply with its preservation for aesthetic reasons.

During the past two decades, increased attention has been paid to socio-economic aspects of fisheries, at both catching and processing levels. There seems to be a consensus that socio-economic objectives must play a more important role in managing the harvest of fisheries resources, and socio-economic goals are perhaps more variable and controversial than those established for conservation purposes.

The FAO report[1] on economic aspects of fisheries management has proposed some generally accepted criteria for good economic performance, which apply to fisheries and other industries. These criteria related to the production of useful goods from the sea require joint use of labour, capital and natural resources so as to maximize the total value of yield over total social and economic cost. However, one socio-economic objective or a set of such objectives may not apply equally to all nations or even to all regions within a nation.

In developed countries where fisheries have been historically a major activity, management goals have been strongly associated with the maintenance of the resources and/or the maintenance of certain options for its citizens, such as alternate employment or part-time employment to supplement their incomes from other sources. In developing countries, the objectives of fisheries exploitation have largely been to generate goods and services that contribute to the Gross National Product, to produce a supply of protein foods and to provide sources of foreign currency.

In recent years Canada's total fish catch has varied from 1 to 1.3 million metric tons per year (Annual Statistical Review, 1977). The contribution of fisheries to the value added in commodity producing industries in Canada was about one percent, the major proportion of this being contributed by the Atlantic Provinces and British Columbia (Annual Statistical Review, 1977).

The percentage labour employed in the fisheries compared with the

1 Prepared by FAO, 1966, as a result of a meeting of biologists and economists in Rome in 1965.

total employment in Canada is about one percent. In comparison, the labour employed in Newfoundland and Labrador fisheries is about 13 percent of total employment. Newfoundland catches about 50 percent of the total Canadian catch from ICNAF[1] areas. The total annual fish catches around the waters of Newfoundland during the last five years have ranged between 630 million to nearly one billion pounds per year (Annual Statistical Review, 1977).

The Newfoundland fishery industry is on the whole highly labour intensive, in the sense that manual labour as opposed to machinery is used at almost all levels of fishing, particularly the inshore fishery, unloading of fish at wharf, and manual processing into consumer products. Much of Newfoundland's economy depends on its primary fishing industry. For almost four centuries, the economic life of Newfoundland depended on a single industry, the fishery, and almost on a single product, the processing of cod fish, though in recent years other species such as haddock, perch, flounder, greysole, turbot and mollusk are also processed.

1.2 Background to Newfoundland Fishery

The initial settlement pattern of the European migrants who came to Newfoundland was to exploit the rich fishing ground that surrounded the island. When initial settlement took place during the 18th. and 19th. centuries the primitive methods of the fishery required close contact with the resource. As numbers of fishermen increased, small fishing communities eventually came to settle the

1 International Commission for Northwest Atlantic Fisheries

entire coastline of the island.

Until late in the 19th. century the fishery remained virtually the sole base of the Newfoundland economy. In fact, the fisheries share of the export trade did not drop below 70 percent of the annual export value until 1922 (Copes 72).

The Newfoundland fishery up until recent decades was solely an inshore fishery, a fishery of small boat operations conducted by independent fishermen who either owned or shared a boat. These boats, because of size, stayed close to port with individual fishing trips of less than one full day. Their effective fishing time was curtailed by rough weather and ice closure. The larger part of the inshore catch was cod, a major portion of which was caught in traps in a short season in June, July and August. Most of the cod was salted and sun-dried by the fishermen (and their families).

After World War II, within the Newfoundland fishing industry a modern sector developed. This modern sector consisted of the establishment of fish freezing operations to supply a fast growing United States market for frozen foods (Table 1.1). To spread overhead cost and a market need for a balanced variety of groundfish species (cod, haddock, redfish and flounder), the fish plants needed a year-round supply of raw material. The established inshore fishery being highly seasonal and mainly one specie (cod), could not fulfill these criteria. In consequence, several companies operating fish processing plants acquired fleets of deep sea vessels (mostly trawlers) that could operate at sea for trips that would last up to ten days on a year-round basis.

TABLE 1.1

NUMBER OF FISH FREEZING PLANTS

IN OPERATION IN NEWFOUNDLAND

1954 - 1971

YEAR	IN OPERATION DURING YEAR	OPENED, NOT OPERATING PREVIOUS YEAR	CLOSED, OPERATING PREVIOUS YEAR
1954	18	6	1
1955	21	4	1
1956	21	-	-
1957	16	1	6
1958	19	3	-
1959	20	1	-
1960	20	1	1
1961	22	2	-
1962	24	2	-
1963	32	8	-
1964	32	2	2
1965	34	2	-
1966	34	-	-
1967	34	3	3
1968	32	-	2
1969	33	4	3
1970	36	3	-
1971	36	1	1

- nil

SOURCE: Canada, Department of Fisheries & Environment, Economics Branch, St. John's.

This gave them an adequate range to tap the stocks of the various species required to give the desired product mix. This sector became known as the offshore fishery.

These large fish freezing plants also took some quantities of fish from inshore fishermen who operated within supply range of the plant. However, the inshore fishery was not substantially affected by the establishment of an offshore fishery.

In the meantime the inshore fishery was also changing in regard to the processing of the catches, however, it still remained a relatively small boat operation conducted by independent fishermen. While fishermen prior to World War II had mostly salted their own fish,now small processing plants were established for mechanical drying of salt fish and others for freezing of fresh fish. These fish plants would buy fish from the individual fisherman in a raw or semi-processed state where further processing took place and finally the disposal of the finished product in foreign markets. These fish plants were dependent entirely on inshore supplies.

One further major development in the inshore fishery was the emergence in the early 1960's of a "middle distance" fishery, using vessels in the range of 35 - 65 feet in length. These larger inshore boats had increased seaworthiness, range and comfort, thus requiring more adequate harbour and service facilities than were offered by most outports in Newfoundland. This caused these vessels to be concentrated in a smaller number of larger outports where specialized facilities were available.

1.3 Economic Importance of the Fishery in Newfoundland

Even since the first European migrants settled in Newfoundland, the fishery has played a dominate role in Newfoundland's economy. One hundred years ago the industry constituted the sole economic support of the island since Newfoundland's commodity-producing industries consisted almost entirely of fish products. In 1973 the fishing industry contributed 13.7 percent to the value of production in the province's commodity-producing industries (Table 1.2) and absorbed about 13 percent of the total labour force (Table 1.3). In comparison, the fishing industry contributed only 1.1 percent to the total value of production in Canada's commodity-producing industries (Table 1.2) while absorbed only about 0.9 percent of the total labour force (Table 1.3).

Considering the important economic significance of the 200 mile fisheries limit which came into effect January 1977, the contribution of the fisheries to Newfoundland economy can only grow in importance. With the 200 mile fisheries limit, Canadians and hence Newfoundlanders will have sole ownership of the resources within this limit, thus being able to regulate the quantities and types of species to be harvested at any particular time. This important control of the fish stocks will mean that Newfoundland will have access to larger harvesting quotas while at the same time managing the fish stock to obtain optimum yield.

One further note to the growing importance of the fishery to Newfoundland's economy is the recent closure of two of Newfoundland's largest commodity-producing industries, the Come-by-Chance Oil Refinery and the Newfoundland and Labrador Liner Board Mill and expected closure

TABLE 1.2

CONTRIBUTION OF FISHERIES TO COMMODITY - PRODUCING INDUSTRIES IN NFLD. & CANADA, 1965-1974

(PERCENTAGE)

YEAR	NEWFOUNDLAND	CANADA
1965	12.5	1.0
1966	10.7	1.0
1967	10.6	0.9
1968	10.2	0.9
1969	12.8	0.9
1970	10.9	1.0
1971	11.1	0.9
1972	12.6	1.0
1973	13.7	1.1
1974	8.7	0.8

SOURCE: Canada, Department of Fisheries and Environment, Annual Statistical Reviewof Canadian Fisheries, Volume 9, 1955-1976.

TABLE 1.3

EMPLOYMENT IN THE FISHERIES COMPARED WITH

TOTAL EMPLOYMENT FOR NFLD. & CANADA

1955 - 1973

(PERCENTAGE)

YEAR	NEWFOUNDLAND	CANADA
1955	19.6	1.7
1956	18.0	1.6
1957	19.4	1.6
1958	23.9	1.7
1959	23.6	1.6
1960	23.0	1.5
1961	24.2	1.5
1962	23.7	1.5
1963	23.2	1.5
1964	23.2	1.4
1965	21.9	1.4
1966	19.7	1.3
1967	18.3	1.2
1968	18.5	1.2
1969	17.6	1.1
1970	17.3	1.0
1971	14.9	1.0
1972	14.0	0.9
1973	13.2	0.9

SOURCE: Canada, Department of Fisheries and Environment, Annual Statistical Review of Canadian Fisheries, Volume 9, 1955 - 1976.

or phasing out of mining industries such as St. Lawrence Florspar mines, Buchans mines and the Bay Verte Asbestos mines. With these closures causing serious unemployment, Newfoundland has been forced to find alternative employment opportunities.

Given all of the above factors, one can only assume that the fisheries in Newfoundland in the foreseeable future will continue to play an important role in Newfoundland's economy.

1.4 Newfoundland Seafish Landings

The Newfoundland commercial seafish fisheries consist of three major species groups. These three major species groups are groundfish, pelagic and shellfish (Table 1.4). This section will deal only with these groups and will ignore others such as seals, whales and seaweeds because of their special institutional, social and physical factors.

On the whole, landing of groundfish have been, and continue to be, the most important by far in terms of both quantity and value of landing (Table 1.4). In the period since 1961 the groundfishery has never accounted for less than 61% of total volume, nor less than 73% total landed value (Table 1.5). Indeed, in the early years of this period, groundfish accounted for over 90% of volume while in 1976 made up something in the order of 75% of total volume. Of the species of groundfish landed in 1975 and 1976, cod, small flatfish, redfish, Greenland turbot and catfish account for about 99% of all groundfish (Table 1.6).

The pelagic fisheries rose from a level of minor importance in the early 1960's to a position where, because of an expanded herring fishery, they accounted for over one third of the landed volume in

TABLE 1.4

COMMERCIAL SEAFISH LANDINGS, QUANTITY AND VALUE

BY SPECIES GROUP, NEWFOUNDLAND, 1961-1976,('000 lbs.& $'000)

	Groundfish		Pelagic		Shellfish		Total	
	(Q)	(V)	(Q)	(V)	(Q)	(V)	(Q)	(V)
1961	432,412	11,808	28,498	1,118	23,705	1,551	486,615	14,477
1962	491,802	14,165	29,341	1,266	5,237	1,493	526,380	16,924
1963	523,614	16,345	33,478	1,514	9,492	1,865	566,584	19,724
1964	497,678	17,574	34,580	1,506	27,631	2,592	559,889	21,672
1965	534,942	18,881	42,361	1,484	20,992	2,573	598,295	22,938
1966	571,930	21,144	76,267	2,111	14,551	2,409	662,748	25,664
1967	567,033	21,901	192,659	3,662	18,390	2,380	778,082	27,943
1968	618,057	20,934	327,374	4,400	4,318	2,521	949,749	27,855
1969	611,327	21,384	381,449	5,043	5,217	2,811	997,993	29,238
1970	612,014	25,940	363,435	5,971	5,939	2,843	981,388	34,754
1971	539,476	26,400	317,351	6,101	11,394	3,146	868,221	35,647
1972	480,883	26,359	159,151	4,661	7,051	4,533	647,085	35,553
1973	514,880	35,669	147,665	6,854	11,647	4,745	674,192	47,268
1974	389,204	30,978	120,273	6,479	11,815	4,625	516,292	42,082
1975	427,644	31,975	115,754	6,593	18,274	5,415	561,672	43,983
1976	564,871	46,456	146,855	8,318	36,098	7,901	747,824	62,675

SOURCE: Canada, Department of Fisheries and Environment,
Economics Branch, St. John's.

TABLE 1.5

COMMERCIAL SEAFISH LANDINGS, PERCENTAGE DISTRIBUTION

BY SPECIES GROUPS, NEWFOUNDLAND, 1961-1976

	Groundfish		Pelagic		Shellfish		Total	
	(Q)	(V)	(Q)	(V)	(Q)	(V)	(Q)	(V)
1961	89.0	81.6	6.0	7.7	5.0	10.7	100.0	100.0
1962	93.4	83.7	5.6	7.5	1.0	8.8	100.0	100.0
1963	92.4	82.9	5.9	7.7	1.7	9.4	100.0	100.0
1964	88.9	81.1	6.2	6.9	4.9	12.0	100.0	100.0
1965	89.4	82.3	7.1	6.5	3.5	11.2	100.0	100.0
1966	86.3	82.4	11.5	8.2	2.2	9.4	100.0	100.0
1967	72.8	78.4	24.8	13.1	2.4	8.5	100.0	100.0
1968	65.0	75.2	34.5	15.8	0.5	9.0	100.0	100.0
1969	61.3	73.2	38.2	17.2	0.5	9.6	100.0	100.0
1970	62.4	74.6	37.0	17.2	0.6	8.2	100.0	100.0
1971	62.1	74.1	36.6	17.1	1.3	8.8	100.0	100.0
1972	74.3	74.1	24.6	13.2	1.1	12.7	100.0	100.0
1973	76.4	75.5	21.9	14.5	1.7	10.0	100.0	100.0
1974	74.4	73.6	23.3	15.4	2.3	11.0	100.0	100.0
1975	76.1	72.7	20.6	15.0	3.3	12.3	100.0	100.0
1976	75.6	74.1	19.6	13.3	4.8	12.6	100.0	100.0

SOURCE: Canada, Department of Fisheries and Environment, Economics Branch, St. John's

TABLE 1.6

QUANTITIES OF SEAFISH LANDING, NEWFOUNDLAND, 1975-1976

SPECIES	1976 QUANTITIES LANDED-LBS. INSHORE	1976 QUANTITIES LANDED-LBS. OFFSHORE	1975 QUANTITIES LANDED-LBS. INSHORE	1975 QUANTITIES LANDED-LBS. OFFSHORE
Cod	196,261,454	67,335,931	138,675,956	32,233,052
Redfish	1,802,149	86,547,932	1,802,785	88,436,213
Small Flatfish	11,340,174	170,774,740	7,175,410	134,492,449
Greenland Turbot	9,053,241	12,437,606	7,611,845	10,045,688
Catfish	620,590	5,384,269	371,056	2,994,985
Other Groundfish	881,379	2,431,068	1,375,319	2,429,321
TOTAL Groundfish	219,958,987	344,911,546	157,012,371	270,631,708
Herring	28,363,714	79,489,345	26,835,627	66,802,082
Caplin	9,034,872	12,157,326	9,610,309	507,377
Mackerel	8,463,113	3,336,221	5,298,497	1,454,046
Salmon	4,436,614	-	4,505,890	-
Other Pelagic Fish	693,947	880,176	327,351	412,240
TOTAL Pelagic	50,992,260	95,863,068	46,577,674	69,175,745
Squid	21,827,726	886,438	7,052,522	-
Lobster	4,968,933	5,272,560	3,738,381	-
Queen Crab	1,596,742	242,793	2,069,393	2,363,581
Shrimp	414,375	106,149	280,784	2,744,681
Other Shell Fish	66,024	715,819	15,897	8,681
TOTAL Shell Fish	28,873,801	7,223,759	13,156,977	5,116,943

SOURCE: Canada, Department of Fisheries & Environment, Economics Branch, St. John's.

1970 (Table 1.5). In 1976 the pelagic fisheries made up approximately 20% of the total volume. As earlier mentioned, herring accounts for most of the landing im the pelagic fisheries, however, other major pelagic species are; caplin, mackerel and salmon (Table 1.6).

The Newfoundland shellfish fisheries has been fairly stable in total, if the effects of squid landing are discounted. In squid landing there have been years where it has been virtually nonexistent and others where it was fairly high such as 1976. Today the shellfish fishery make up in the order of 2 to 3 percent of total landing while contributing11 to 12 percent in landed value as would be expected (Table 1.5). The major species of the shellfish fishery in 1975 and 1976 were squid, lobster, queen crab and shrimp (Table 1.6).

In addition,to the actual species of fish landed it is equally important to consider the numbers of fishermen and values of vessels and gear utilized. Over the past 15 to 20 years the number of fishermen engaged in the Newfoundland fishery has shown an increasing trend from 1956 to 1964 and then declining fairly steadily, however, 1973 showed signs of another increasing trend (Table 1.7). Copes (72) points out in The Resettlement of Fishing Communities in Newfoundland that employment in the fishery is related to the level of unemployment. When unemployment is high, Newfoundlanders go into the fishery while they leave the fishery when there are employment opportunities elsewhere.

The value of fishing vessels employed and investment in fishing gear show a somewhat different trend (Table 1.8). The trend in both cases has generally been upward.

TABLE 1.7

NUMBER OF FISHERMEN IN NEWFOUNDLAND SEA

FISHERIES, BY EXTENT OF EMPLOYMENT[1],

1955 - 1973

YEAR	FULLTIME	PART TIME	OCCASIONAL	TOTAL
1955	- -	- -	- -	16,000
1956	- -	- -	- -	14,956
1957	- -	- -	- -	16,469
1958	- -	- -	- -	18,364
1959	- -	- -	- -	18,430
1960	- -	- -	- -	18,291
1961	- -	- -	- -	18,756
1962	13,181	3,466	3,170	19,817
1963	14,714	3,515	3,178	21,407
1964	15,897	3,520	3,198	22,615
1965	14,299	4,364	3,038	21,701
1966	12,673	4,094	3,519	20,286
1967	12,138	4,191	3,485	19,814
1968	11,372	4,062	3,921	19,355
1969	1,958	8,560	7,252	17,770
1970	1,855	7,282	8,628	17,765
1971	1,024	5,024	9,913	15,961
1972	712	4,105	9,635	14,452
1973	903	3,996	10,414	15,313

1) The classification of fishermen beginning in 1969 is based on the time spent in fishing activities, as follows: fulltime - 10 months or over: part time - 5 to 10 months; occasional - less than 5 months. Prior to 1969, the concept of occupation rather than time spent in fishing activities was used; the term "fulltime","part time" and "occasional" referred to fishermen for whom fishing was the "only", "main" or "secondary" occupation, respectively.

- - not available

SOURCE: Canada, Department of Fisheries and Environment, Annual Statistical Review of Canadian Fisheries, Volume 9, 1955 - 1976.

TABLE 1.8

VALUE OF FISHING CRAFT AND

INVENTORY VALUE OF FISHING GEAR IN NFLD.

1955 - 1973

YEAR	VALUE OF FISHING CRAFT ($'000)	VALUE OF FISHING GEAR ($'000)
1955	10,000	4,200
1956	9,426	4,294
1957	10,002	4,674
1958	10,481	5,164
1959	10,711	5,286
1960	11,512	5,636
1961	11,004	5,982
1962	12,494	6,213
1963	16,739	6,606
1964	18,884	7,321
1965	25,140	10,028
1966	30,669	9,614
1967	52,234	9,300
1968	58,412	9,428
1969	55,740	9,168
1970	53,674	10,512
1971	50,608	11,257
1972	57,091	13,311
1973	70,849	14,578

SOURCE: Canada, Department of Fisheries and Environment Annual Statistical Review of Canadian Fisheries, Volume 9, 1955 - 1976.

1.5 Newfoundland Seafish Processing

1.5.1 General Background to Newfoundland's Seafish Processing

We have looked at the Newfoundland seafish fisheries in terms of the species groups landed. We now briefly examine the fish processing industry in terms of the types of products that are produced. There are basically eight different categories of types of product that are separated by nature of the production process involved or species utilized. Data on these major categories of seafish products produced are shown in Tables 1.9, 1.10 and 1.11.

Frozen seafish products are by far the most important type of output for the processing industry. There has been a noticeable upward trend in recent years with the apparent levelling off caused by non-increasing total groundfish catches. The value of frozen seafish products however, has generally increased over the years. In 1975, frozen seafish products accounted for 67 percent of the total seafish products.

Production of salted and pickled seafish products, while holding second place in terms of value of output, has undergone a significant overall decline in volume. These outputs are made up of salted groundfish and pelagic species, primarily herring.

Next in importance is fresh seafish products. The output of these products have been continually increasing with the main species being cod and salmon.

Fishmeal and oil production are next in importance. These products are by-products of filleting and freezing operation, however, their output

TABLE 1.9

QUANTITY OF SEAFISH PRODUCTS, BY TYPE, NEWFOUNDLAND, 1961-1975

YEAR	Fresh ('000 lbs.)	Frozen ('000 lbs.)	Smoked ('000 lbs.)	Salted ('000 lbs.)	Pickled (bbls.)	Canned (cases)	Meal (tons)	Oil (gals.)	Other ('000 lbs.)
1961	13,561	65,082	896	72,752	24,393	4,984	9,654	753,873	27,231
1962	24,301	73,879	812	86,031	21,577	2,790	10,962	650,483	1,062
1963	17,045	79,105	647	84,694	22,602	1,884	11,513	801,641	22,499
1964	16,165	84,757	661	70,522	75,244	1,554	12,939	627,051	35,804
1965	12,053	108,566	414	60,419	24,460	1,570	17,464	511,574	27,729
1966	14,094	122,060	485	55,137	34,158	1,963	20,596	463,502 (1)	22,502
1967	12,632	104,103	321	50,065	27,355	2,020	29,455	21,417	24,432
1968	14,443	130,972	431	45,478	18,196	2,212	48,301	32,474	10,160
1969	12,459	141,261	447	39,891	38,789	1,804	53,306	32,958	48,003 (2)
1970	15,662	148,102	134	24,490	120,913	7,955	50,565	28,641	48,004
1971	21,071	142,389	57	18,653	163,141	5,541	38,490	23,069	53,565
1972	16,078	128,828	344	14,642	158,092	12,027	25,028	8,727	39,446
1973	15,278	141,629	214	13,066	126,232	10,809	25,496	11,157	44,204
1974	18,270	102,937	323	10,770	110,948	7,692	18,802	5,674	33,482
1975	15,630	116,578	364	10,571	74,079	7,563	18,229	8,064	25,823

(1) Quantity of Oil in 1966 in '000 lbs.

(2) Frozen Offal for Animal Food Included From 1969 on.

SOURCE: Canada, Department of Fisheries and Environment, Economics Branch, St. John's.

TABLE 1.10

VALUE OF SEAFISH PRODUCTS, BY TYPE, NEWFOUNDLAND, 1961-1975

($'000)

Year	Fresh	Frozen	Salted	Pickled	Smoked & Canned	Meal & Oil	Total (1)
1961	4,401	15,060	9,839	717	205	1,261	32,589
1962	5,199	17,525	13,103	653	183	1,576	38,384
1963	5,911	19,501	14,211	702	155	1,843	43,020
1964	6,332	21,007	12,621	2,224	170	1,904	45,600
1965	6,147	28,471	11,968	772	127	2,825	51,437
1966	6,899	32,845	13,201	1,000	182	3,543	58,862
1967	6,373	26,479	12,402	996	160	5,767	53,196
1968	7,803	32,249	11,072	572	192	8,751	61,052
1969	8,089	39,469	9,667	1,143	178	9,613	68,625
1970	10,284	47,377	7,220	3,916	509	11,087	81,646
1971	10,524	59,537	6,419	4,814	295	8,340	92,776
1972	10,346	65,345	5,969	7,448	698	4,924	98,382
1973	8,141	98,069	7,620	7,479	1,240	9,700	143,541
1974	11,321	71,520	9,040	7,701	957	6,841	113,070
1975	13,357	79,797	8,065	5,782	900	6,284	118,514

Note: (1) Total includes other seafish products (mainly bait) and frozen animal food after 1969 but excludes other marine products such as seal skins.

SOURCE: Canada, Department of Fisheries and Environment, Economics Branch, St. John's.

TABLE 1.11

VALUE OF SEAFISH PRODUCTS, PERCENTAGE DISTRIBUTION BY TYPE, NEWFOUNDLAND, 1961-1975

Year	Fresh	Frozen	Salted	Pickled	Smoked & Canned	Meal & Oil	Other	Total
1961	13.5	46.2	30.2	2.2	.7	3.9	3.9	100.0
1962	13.5	45.7	34.1	1.7	.5	4.1	.4	100.0
1963	13.7	45.3	33.0	1.6	.3	4.3	1.8	100.0
1964	13.9	46.1	27.7	4.9	.4	4.2	2.8	100.0
1965	12.0	55.4	23.3	1.5	.2	5.5	2.1	100.0
1966	11.7	55.8	22.4	1.7	.3	6.1	2.0	100.0
1967	12.0	49.8	23.3	1.9	.3	10.8	1.9	100.0
1968	12.8	52.8	18.1	.9	.3	14.4	.7	100.0
1969	11.8	57.5	14.1	1.7	.2	14.0	.7	100.0
1970	12.6	58.0	8.8	4.8	.7	13.4	1.7	100.0
1971	11.3	64.2	6.9	5.2	.3	9.0	3.1	100.0
1972	10.5	66.4	6.0	7.6	.5	4.9	4.0	100.0
1973	10.6	68.3	5.3	5.2	.8	6.7	3.1	100.0
1974	10.0	63.2	8.0	6.8	.7	6.0	5.3	100.0
1975	11.2	67.3	6.8	4.8	.7	5.3	3.9	100.0

SOURCE: Canada, Department of Fisheries and Environment, Economics Branch, St. John's.

to a large extent is dependent on the herring industry.

The last two categories of seafish products are smoked and canned outputs. The canned products have been primarily crab, while the smoked output caters to a specialized market.

The degree to which most products are processed are dependent primarily on the export market. Because of the population size of Newfoundland and Canada, except for the central Canada area, there is no significant market in Canada for the industry's output. The main market for Newfoundland fish products has been the United States where import restrictions are placed on processed products. It is doubtful however, that the Newfoundland processing industry, as a whole, would have the financial and technical capability to produce highly processed products if a market did exist. This accounts to a fair extent the importance of frozen and cured products in the total output of the industry. This dependence on one major market for the majority of sales however, has resulted in a number of periods of market crises in the past, the most recent being the 1967 - 69 and 1974 - 75 periods.

1.5.2 The Frozen Seafish Processing Industry

The inshore frozen processing industry consists mainly of groundfish and pelagic with some shellfish. The main species processed are cod, greysole, flounder, herring, mackerel and squid. Each particular freezing plant does not necessarily process all these species, however, they do normally operate with a wide variance of species types because of their dependence on the inshore fishery. The normal production process for processing these species is shown in Figure 1.1. This process is commonly called "The Production of Fish Fillets".

The production of fish fillets consists of the following stages: unload fish from ships hold; de-ice and sort; dress, wash and weigh; filleting (cut); skinning; weighing; trimming; pin bone removal; sorting; polyphosphate dipping and weighing; packing; freezing and storage. The processing of fish fillets in Newfoundland is labour intensive rather than machinery dependent.

After the fish are unloaded at the wharf they are transported to the processing plant where they are first sorted by size and species, dressed (removal of the gut from the fish) if necessary, washed and weighed before further processing. Whether fish are dressed at the freezer plant depends on the distance of transportation from wharf to the processing plant and the particular plant's policy on the buying of undressed fish. To preserve quality, the fish should be dressed as soon as possible upon harvesting.

The filleting of fish is normally done manually, using a very sharp knife as described pictorially in Figures 1.2a and 1.2b. Filleting machines are available for filleting fish, however, at present they are not being used extensively in inshore freezer plants.

After the fish are filleted, the fillets which have skin on one side are weighed and skinned. A skinning machine is used for removing the skin from the fillets. The fillets are then trimmed and the pinbones are removed. The trimming operation removes fins, lugs and blood marks which may be left on the fillets during the filleting operation. Pin

UNLOAD FISH FROM SHIP'S HOLD

↓

DE-ICE AND SORT

↓

DRESS[1], WASH AND WEIGH

↓

Offal (Head & Bone) → FILLETING (CUT)

↓

SKINNING

↓

WEIGHING

↓

TRIMMING, BONE, SORTING

↓

WEIGHING

↓

Boxes and other Material → PACKING

↓

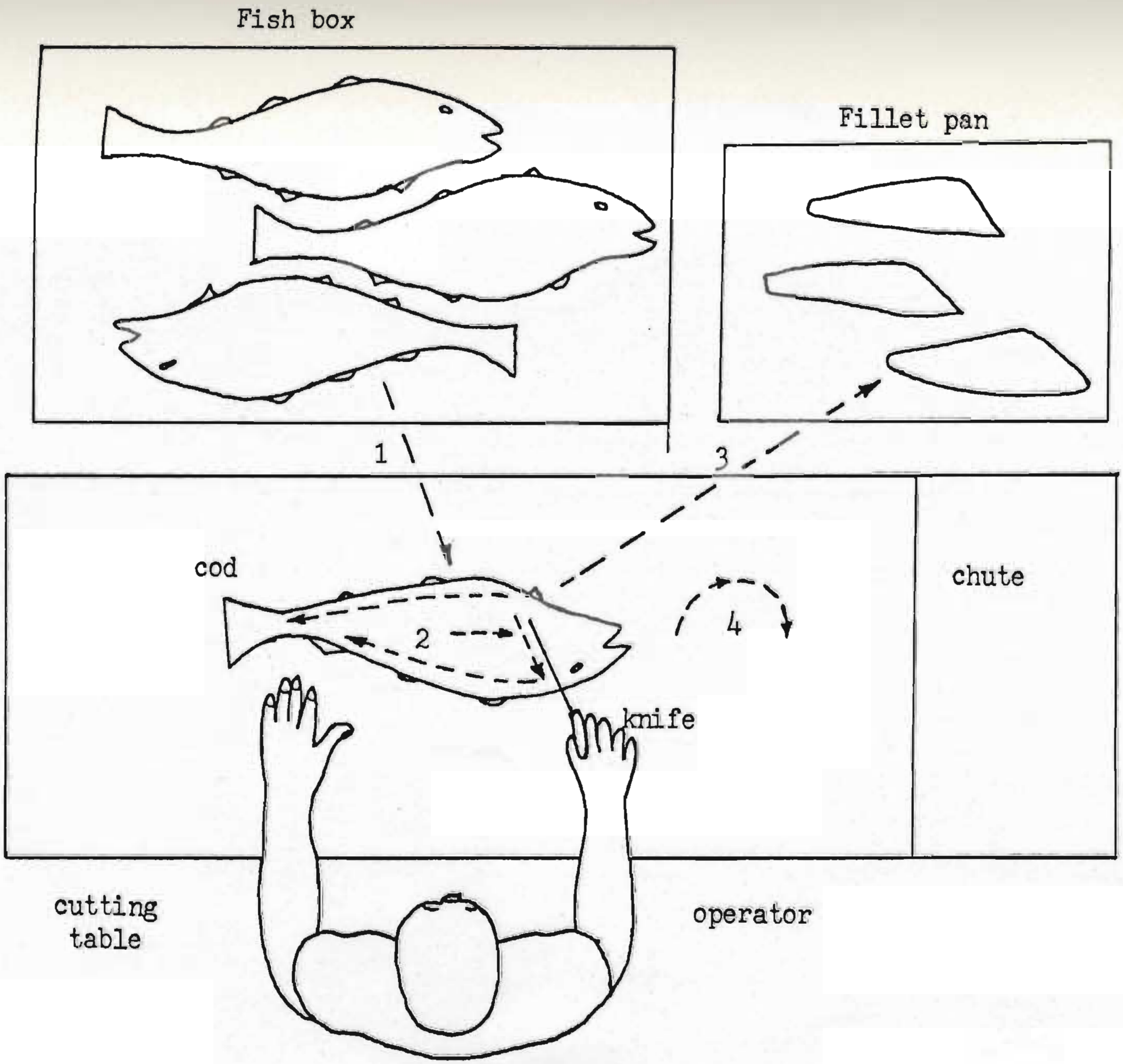
FREEZING

↓

STORAGE

Figure 1.1 Operation Chart for the Processing Operation of Fish Fillets

1 Offshore fish is usually gutted.
Inshore fish is often not gutted and therefore requires gutting on shore.



Filleting operation:

1) Get and put fish on table (LH)
2) Fillet side no. 1 (LH & RH)
3) Place fillet in pan (LH)
4) Turn fish 180° (LH & RH)

Figure 1.2a Filleting operation - cod

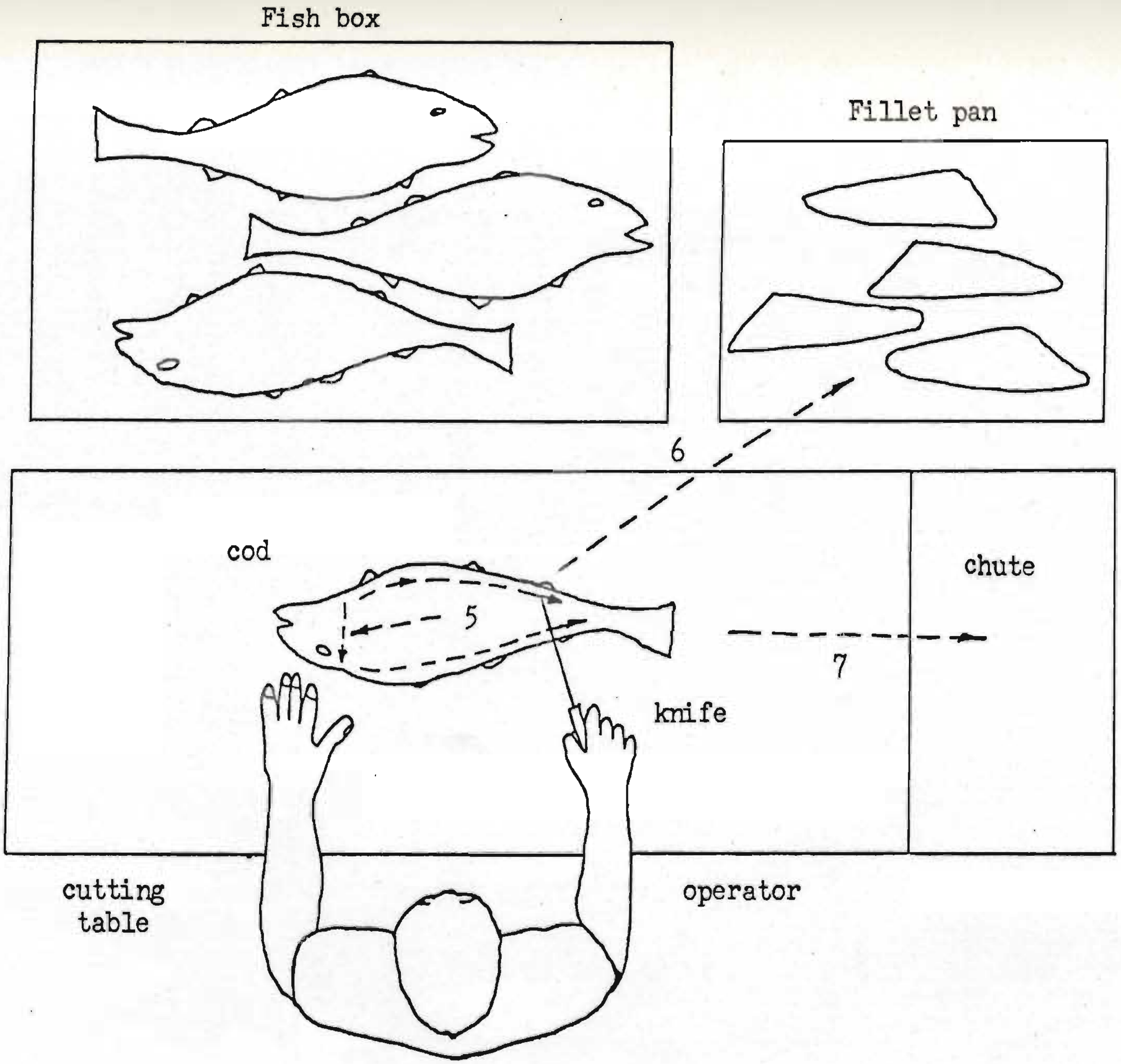


Figure 1.2b Filleting operation - cod

Filleting Operation

5) Fillet side no. 2 (LH & RH)

6) Place fillet in pan (LH)

7) Place head and bone in the chute (RH)

bones are removed by making a V-cut using a sharp knife. Prior to packing, the fillet is dipped in polyphosphate which protects the fillet later when it is thawed.

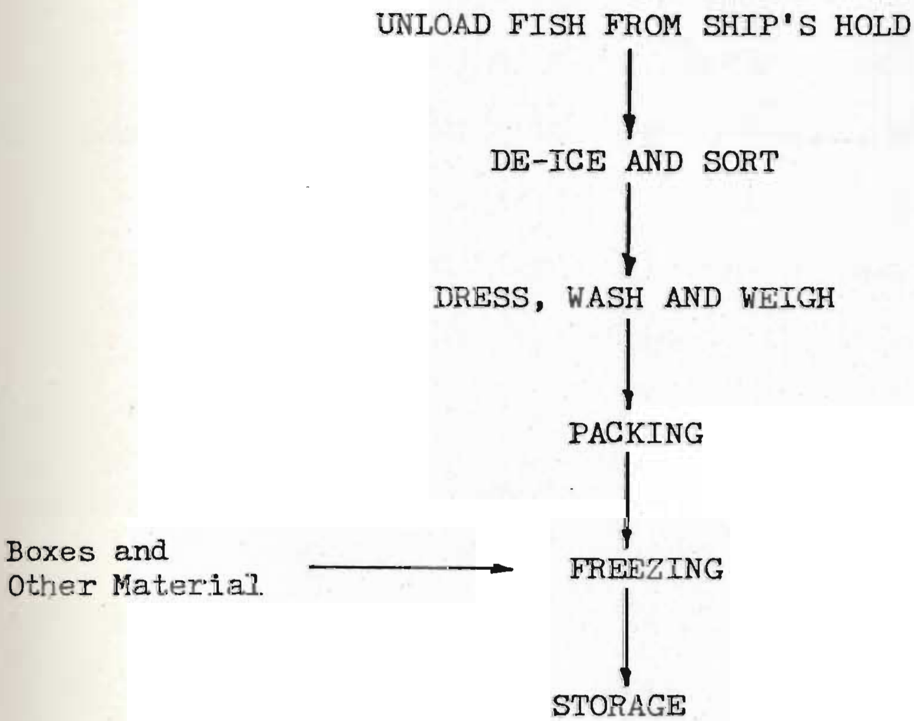
Depending on the type of species and pack required by the consumer, the fillets are sorted by size, weighed and either packed in 1 lb. and 5 lb. boxes, 13 lb. and 16 lb. fillet blocks or individually (quick) frozen. The fillet boxes or blocks are frozen in plate freezers whereas the individual fillets are frozen by passing them through a tunnel of cold air (-40^{o} to $-60^{o}C$). The fillets are then held in cold storage until shipped to markets.

The by-products from the dressing, filleting, skinning, trimming and pin bone removal operations are sent to the offál plant where fish-meal is produced.

With regard to the Newfoundland Fishery, the market restrictions control extensively the degree of processing of any species. Some species in particular, herring, mackeral and squid are exported mainly in a frozen round state (Figure 1.3)

Species such as crab and shrimp follow an entirely different processing method, but do use the plant's freezer and cold storage facilities.

The inconsistent supply of any one species in the inshore fishery has resulted in Newfoundland freezer plants becoming multi-species processing plants. The production process for the species is set up so they are readily adapted to many species which change frequently. Most plants have one section for the filleting of fish while other sectors are used for the processing of species such as crab or shrimp. The labour required in these processing plants is mainly semi-skilled, thus workers normally perform many activities which may frequently change.



<u>Figure 1.3</u> Operation Chart for the Processing Operation of Round fish.

CHAPTER 2

PURPOSE OF THE STUDY

2.1 Introduction

The quantity of marine renewable resource (fish) in the sea at any particular time depends on the inflow and outflow of fish to the area. The inflow rate of fish depends on the rate of spawned eggs and inward migration. The outflow rate depends on the death rate due to natural causes, pollution, predation, outward migration, and the quantity of fish harvested. The difference between these inflow and outflow rates determines the level this resource will attain at any particular time.

The resource is harvested by small and large vessels using sophisticated electronic detection devices, where it is processed either on board or brought to shore based plants. Many different kinds of end products are produced depending on the market requirements and demand. Technology and human employment is inputed at various stages of harvesting, processing and marketing operations.

The type of equipment and human skills used for harvesting and processing on board the vessels are nets, fish containers, captains, seamen, freezing facilities and equipment, etc. The marine resource is unloaded at wharf, which again requires equipment and human skills, such as unloading equipment, containers, hoist operators. The transportation and stowage operations require trucks, plant freezers, cold room holding facilities, and laborers.

During the transportation, storage and unloading operations, some amounts of marine resource are rejected due to the type of technology used and the efficiency of equipment and human effort. The rejected marine resource is converted into fish meal production, further processed into other products, or discarded to decay and/or recycled in the sea.

The processing of fish into various consumer products depend on many factors such as market demand, availability of raw material, plant processing capacity, labour availability and efficiency, quality requirements, cost of raw material and labour, selling price, etc.

Depending on the type of product, the quantities for harvesting and production of goods, hiring rates for personnel, provisions for factory space, purchase of equipment, vessels, gear; payment of money, etc., are determined.

The above is not a complete description of a fishery operation, however it is a start upon which a more elaborate framework can be developed.

The concept of developing a dynamic model of a fishery operation can be considered new to the Newfoundland scene. Though the techniques of dynamic modelling have been known for some years now, its application to real world problems have been few. The main difficulties in its application have been the enormity and complexity of such problems and particularly the nature of the dynamic behavior of industrial systems.

The Newfoundland fishing industry, though it may not be considered enormous compared to some other industries in Canada or elsewhere, has many variables which are complex and at time significantly interact with each other, as well as with the external environment.

Presently there are certain marine species which are over-exploited and other species which are under or un-utilised. It would be desirable to control the harvesting of an over-exploited species, however a change in harvesting effort will interact with the economics of processing and marketing operations. In the case of under or un-exploited species, research and development may be required in designing new or better techniques and skills, equipment and machinery, different types of products, different approaches to distribution and marketing.

The changes in market demands such as quantity, quality, price, delivery, etc. and the speed of response from distribution, processing and harvesting to such changes may depend on the inertia of individual components and the synergy of the fishery system. In real world situations the fishery system may either over respond or under respond and some times various parts of the system may not work in unison with each other.

An advancement in technology (automation) applied at a part of the total system may beneficially help the economic viability of an area, but it may in the short or long term adversely interact with, for example, resource availability, markets, employment and perhaps the social viability of a community.

Education and training of people working in the industry should assist in up-grading their knowledge and the understanding of the fisheries. As their level of knowledge and understanding increases, so would one expect their efficiency of operation and management to increase.

Society's acceptance of employment, individual and corporate earnings, job security and satisfaction, economic growth, migration, etc. are in some way reflected by socio-economic programs. The extent to which these programs affect the fishery system depends on the degree of interaction within and between resource exploitation, processing into end products, technology used, human employment, corporate viability, community viability etc. and such interactions may at times be accentuated by external environment.

The above are a few examples which depict to some extent the dynamic nature of the real fishery system.

2.2 Problem Areas in Fish Processing

Some of the problems associated with the operation of an inshore freezer plant are namely:

- Buying of raw material
- Processing of raw material
- Selling of the finished product

One of the major problems associated with the buying of raw material is the seasonality of the inshore fishery. Since the inshore harvesting season is mainly a six month operation, the fish plants have to make sufficient revenue to cover overhead expenses for the remaining six months they aren't operating. To help cover these expenses some Newfoundland inshore processing plants process blueberries in the off season where they make use of the plants' washing, freezing, packing and cold storage facilities.

Due to the particularly small size of the Newfoundland inshore boats, the climatic conditions dictate whether a fisherman would go out fishing or not on any particular day during the fishing season. To help alleviate this problem of fluctuating quantities of raw materials, plant owners normally buy fish from different areas which are transported by road to the particular plant.

In the Newfoundland inshore fishery the quantity of any one species may fluctuate rapidly from day to day, and from season to season. This problem requires the processing plant to buy many different species to help guarantee a steady volume of raw material.

The quality of the raw material is of prime importance to any fish plant processor. The quality of raw material will to a large degree govern the finished product market value. The prime causes of bad quality raw material are as follows:

- Unsanitary vessel holds
- No protection given from sun and weather
- Use of pitchforks
- Stowing fish too high
- Lack or improper use of ice
- Fish not bled or gutted on removal from water
- Fish left too long in gillnets
- Use of open trucks to transport raw material to fish plant

As one would expect, the processing sector depends primarily on the supply of raw material coupled with a market for the finished product. There are however some problems adherent to the processing sector. One of the prime objectives of the inshore processing industry is to get the most economical return for the raw material bought. Fish plant owners are continually trying for ways of increasing yields by reducing waste. An increase of only one per cent of finished product yield to raw material means considerable added revenue to the plant. At every stage in the production of the finished product, waste is occurring, of which filleting and trimming are the greatest.

The scheduling of production is also of prime importance in the inshore processing plants. As was discussed previously, the quantities and speciestypes change continuously, thus there is a continuous fluctuation in production. Since fresh fish with gut removed will normally retain its quality for only two days, it must either be processed within this limit or an inferior quality product will be realized. A fish plant normally will only buy up to its production capacity, however some plants freeze excess raw material if there is freezer and cold storage facilities available.

The most critical day of the week for buying of raw material is Friday since Friday's raw material must be processed prior to noon on Saturday since fish plant workers will not normally work Saturday afternoons and Sundays. Fish that is bought on Saturday is normally processed on Monday.

The quality of the raw material significantly affects the overall quality of the finished product, however it is the processing sector which passes the finished product onto the consumer. If high quality at the processing sector is not retained, such as segregation of bad quality raw material, removal of parasites and pin bones, then only the processing sector is responsible for an inferior market price.

There are naturally many other problems in the processing sector such as labour unrest, machinery breakdown, accidents, etc., however they are not classified as major problem areas in the fishing industry.

The main market for Newfoundland fish products has been United States, which have resulted in a number of market crises. To eliminate periods of market crises, the processing industry must attempt to obtain a more diversified market where the industry as a whole will not be so susceptable to wide fluctuations in prices and demand.

2.3 Operation of a Fish Plant From a Manager's Viewpoint

In today's highly competitive fishing industry, a fish plant manager must operate his plant to maximum efficiency and take whatever action he deems necessary to keep ahead of his fellow competitors. There are limited fish resource and markets available and if he doesn't remain competitive, other fish processing plants will force him out of business.

To keep a competitive edge, a manager must have two basic management skills, a technical skill and a predicting (forecasting) skill. Both skills are very important to the success of a particular manager.

The technical skill consists of performing the everyday activities of keeping the production process going. A partial list of such activities could include the following:

- Buying of raw material
- Obtaining appropriate labour and machinery
- Obtaining sufficient orders
- Allocating of appropriate skilled personnel to the different sectors of the plant
- Removal of work stoppages caused by machinery breakdown, labour, etc.
- Paying current accounts
- Following a general accounting system for the fulfillment of government regulations
- Producing budgets

The other basic skill is one of predicting or forecasting what actions should be taken under the existing conditions. Managers today continually ask the following question:

If I take a particular action, what will be the results and are they desirable or undesirable?

A partial list of applications of this question could be:

- What if there were a labour strike at my plant?
- Will I meet all my market requirements?
- Is there sufficient labour available?
- Should I introduce a labour incentive system?
- Should I be processing other species?
- What is my profit margin per species?
- What if a particular piece of machinery breaks down?
- What if there is a bad harvesting season?
- Do I have the cash required?
- Should I expand and if so where?
- Are my market areas stable?
- Am I too dependent on one species?
- Am I too dependent on one market?
- If excess raw material is available, should I freeze and process later?
- What if new technology was applied to my plant?
- What is the effect of an increase in finished product yield to raw material?
- What is the effect if my plant was more mechanized?
- Which sector of my plant is the limiting factor on the quantity of production?
- What is the effect of spoilage?
- What is the effect of changes in selling price of the product?
- What is the effect of change in demand of a particular product?
- What is the best product price?

2.4 Objective of the Study

The objective of this study is to develop a computer model, which would be able to simulate a fish processing operation with various input parameters. These parameters would relate to raw material quantities and prices, finished product order demands, selling prices, labour productivity, labour rates, plant and equipment capacities and other variables of the processing operation.

Some of the above mentioned factors are considered to be time variant and interact with each other in some related way. Because of the multi-factor, inter-dependent and time-variant characteristics of the production system, the intuitive or analytical econometric methods used by management in establishing processing strategies cannot adequately provide a basis for rational decision making in optimising its goals. The development of a computer model would therefore assist the processing operator to simulate the interactions between the various variables and indicate possible consequences without recourse to actual actions.

CHAPTER 3

APPLICATIONS AND A CRITICAL REVIEW OF SYSTEM DYNAMICS

3.1 Background to Systems Applicationsin the Fishery

Applications of systems modelling in fisheries have mainly been in the area of ecosystems and resource management. Some of the approaches used in the modeling process have been based on intuitive mental methods, macroscopic statistical formulations, computer simulations and mathematical analysis based on control system theory. Although each of these approaches is considered to be reasonable in relation to the enormity and complexity of the variables, none could be considered comprehrensive enough to be a functional tool that a policy-maker can use in arriving at concrete decisions.

Some of the early applications in the use of computer in estimating fish stocks were by Beverton and Holt (1957). Later other research investigators refined Beverton - Holt's equations for estimation of yields and harvesting strategies, (Anderson, et al 1973, Ursin & Anderson 1975, Beyer & Lassen 1975).

System analysis has been successfully applied to the scheduling of fish trawler operations, (Haywood & Farstad 1976, Nickerson 1970). The White Fish authority of the United Kingdom has been using a simulation approach and other computer applications in the fisheres since 1965. Work carried out in this field include computer-aided cartography, analysis of trawler log data, statistical analysis of fishing data, trawler design, and computerisation of fishery business management.

The need for the development of simulation models for fisheries planning was recognized by the Food and Agriculatural Organization (FAO) at its meeting in Rome in January 1975. A recent study as a result of this FAO meeting has been the computer modelling of the sardine fishery in Morocco (Haywood & Farstad 1976). The main objective was to investigate, using model simulation, the likely outcome of different kinds of policies to assess the economic viability of all technically feasible options. This study was to indicate various development strategies regarding location, composition and phasing of the industry, showing implications on costs and benefits for the government and private enterprise.

Weissman, Kalan and Platts (1972) suggested the use of systems dynamics as a tool for resource management. They applied this technique to the study of Atlantic Menhaden Fishery. Although the model developed, as a case study, was incomplete at the time of publication (1972), enough work was performed and illustrated to conclude usefulness of systems dynamics as a simulation tool in the study of the fisheries.

Some of the operations research techniques such as linear programming, statistical and time series forecasting techniques, queuing theory, etc., could also be applied to certain problem situations in fishery operations. For example, linear programming could be applied for establishing optimum product mix, product distribution allotment or capital budgeting. Queuing theory could be applied to problems related to trawlers arriving and waiting at wharf for unloading and fueling.. Forecasting techniques could be applied to prediction of future order demand for fishery products. In the use of many of these operations research techniques, certain assumptions have to be made in establishing mathematical models. These assumptions may or may not be realistic in relation to real world situations. In some cases the assumed values of the parameters may remain constant for a certain period of time while in other cases, they continually change. Under a time-variant situation, the derived optimum solutions obtained through the use of deterministic mathematical models could not be considered to remain optimum. Thus, the use of such techniques have to be limited to problems of a static nature, where significant parameters do not change drastically within a certain period of time.

Though literature survey gives a great number of examples in industrial applications, none have been observed to be specifically connected with the fish processing operation.

3.2 Simulation Models in Industry

Simulation, as a technique, is one of the most talked-about methods in the field of management science. During the past decade, simulation has been increasingly applied to a wide spectrum of industrial problems, both theoretical and practical. In spite of the clear and growing use of simulation in industry and business the full potential of this technique remains largely unexploited, at least insofar as can be ascertained from the applications described in the literature. The reasons for this are numerous. Industrial phenomena are complex processes and not clearly understood for some areas. Sufficient knowledge of the effects of many variables has not been generally available and such relationships are necessary to the construction of viable and meaningful models.

Even though detailed knowledge may not be available, one should not preclude the fact that the nature of the process of identifying the various variables and constructing the model logic, in itself is an extremely valuable process. At least in the beginning the process would identify where reliable data and interrelationships are available and understood. Where data are considered doubtful, then proper procedures and information data gatering systems can be developed to obtain more reliable data. The process of data gathering, updating, validating and testing is a continuous operation, which the manager has to undertake in any case, in decision making.

Simulation models can be classified as follows:

1 Purpose
- a) Prognostic models
- b) Process or behavioral models

2 Degree of System Definition
- a) Tactical models
- b) Strategic models

3 Structural Characteristics
- a) Static/dynamic models
- b) Deterministic/stochastic models
- c) Aggregate/non-aggregate models

Almost all simulation models constructed have as their ultimate aim a predictive capability. Prognostic models are primarily intended to simulate the result of a system, whereas process models seek to simulate the dynamics of the system itself as well as future results.

In a tactical model, one is generally interested in exploring the impact of alternate decision rules or parameter values within well-defined and well understood structures. The strategic model applies when there is an interest in exploring the behavioral properties of ill-defined problems involving the elements and relationships which are poorly understood. Here certain behavioral relationships are assumed in the model and is then tested against reality. The emphasis, as with process models, is on understanding the dynamics of a system so that a theory can be constructed. Once the theory has sufficiently been validated, the model can be used to simulate the outcomes of the system under a wide variety of conditions.

A static model would seek to describe or predict some response of a system as if it occurred at a single instant of time. A dynamic model would seek to explore the changes occurring within the system over some period of time.

A deterministic model would contain no probabilistic elements. A stochastic model would contain one or more elements, or mechanisms, involving random or probabilistic characteristics.

An aggregate model is so structured that it can only answer questions of an aggregate nature. A non-aggregate model is so constructed as to yield information of a more detailed nature.

Solutions to complex problems can often be obtained more readily through simulation than by analytical solutions. Simulation overcomes the deficiencies of other methods for dealing with complex, interacting, dynamic processes which industry generally entails. This technique utilises a set of mathematical and logical relationships which represent the essential features of the process being studied, however complex these relationships may be.

Simulation offers an opportunity for relatively inexpensive experimentation. A simulation permits one to conduct a series of experiments on a computer, using the model developed to describe some process without recourse to actual field studies.

Analytical models which can yield optimum solutions can frequently be developed as a result of simulation studies. In developing and using a simulation model, insights are gained which, in turn, permit meaningful analytical solutions.

The non-technical manager can comprehend simulation easier than a complex mathematical analytical model. In general, a simulation model is simpler to understand and explain, for it in essence describes the behaviour of some process or phenomena.

Simulation has already been applied in many diverse areas of industry. New applications are being developed continually. Major potential areas of application are in strategic and long-range planning. The major advantage and stimulant to the use of simulation in industry lies in its ability to deal with complex, dynamic and interacting phenomena which are characteristics of industrial enterprises. If the processes permit adequate description, they can be modeled and simulated on the computer. Present trends are towards on-line simulations which can be set up by using time-shared computing facilities with continuous or discrete input data fed to the system. Such on-line facility provides for the provision of an adaptive component in order to account for changing nature of the industrial process.

3.3 A Critique of System Dynamics

The proposed study has attempted to use system dynamics in a part of the fish processing operation. Before a detailed description of system dynamics is illustrated (see next chapter) it would be appropriate to review in detail the historical development, concerns and critical analysis of some of the applications of modelling in industry and urban planning.

Although general in concept, Forrester's techniques were developed for use in modelling social and economic systems for which comprehensive dynamic models were not available. The first reported application was to the modelling of business-industrial systems (Forrester 1961) which was heralded as "a major break-through for decision maker" (Forrester 1958). During the period from 1958 to 1968 "industrial dynamics" was further refined and application made to a wide variety of problems in management analysis. The state of the art at this point in time is given by Forrester in "Industrial Dynamics - After the First Decade" (1968). Also during this time, there was a growing body of literature providing a wide range of viewpoints on the nature and usefulness of the new techniques. A detailed critique of industrial dynamics was provided by Ansoff and Slevin (1968). While it was conceded that industrial dynamics is one way of looking at the behavior of firms by means of simulation, in some cases the feedback structure may not be the most applicable or useful. Further, it was felt that there was little evidence of industrial dynamics claim to the status of a "general systems theory". In Forrester's response (1968), it was argued that in many instances not reported in the open literature, industrial dynamics had proven useful as a decision-making tool, especially where the modellers were experienced in the use of the techniques. In this regard, Ansoff and Sleven (1968) agreed that industrial dynamics suggested a promise of advantages which would result from a better understanding of the nature of industrial systems.

In 1969, application of system dynamics to the study of urban dynamics was reported (Forrester 1969). Forrester's urban model has since been the topic of numerous articles reflecting two distinct phases. The first was a series of critiques based on Forrester's results inspired by the fact that the response of the urban model to certain stimuli was contrary to popular belief among some urban specialists (Kadanoff 1971). The second phase of the response to "urban dynamics" has been the result of further development of the urban model for particular urban areas for which validation could be undertaken by both system dynamics specialists at M.I.T.'s A.P. Sloan School of Management and by others. It now appears that validation attempts have fully justified the urban dynamics models' "counter-intuitive behavior" (Porter et al, 1972).

Since 1971, attention has been focused on the "world model" developed at M.I.T. by Forrester (1971) and " The Limits to Growth" by Meadows et al, (1972). In addition, elaborations on several of the world model subsystems such as natural resources utilization (Behrens) and DDT movement in the environment (Randers & Meadows) have been made. The reaction to these models as reliable forecasting aids has been generally critical, as was the case in the initial phase following the development of the first urban dynamics model. As Warfield (1972) has pointed out, there are a limited number of ways to scientifically attack the world model (or, indeed, any model): First, one may question whether the model is sufficiently inclusive (i.e. are there missing elements which affect directly those elements included in the model?); second, one may question the synthesized relations assumed in the model; third, one may question the modeller's judgement of the desirability or undesirability of the state of the world predicted by the model as a result of certain inputs. Regarding the question of inclusiveness, the world model obviously does not consider a variety of elements generally described as "social feedback". Oerlemans et al, (1972) have demonstrated the stabilizing effect of one type of such feedback on the model's behaviour. There remains, however, two facts which limit the ability for dynamic models of social systems to be fully inclusive. First, many relations which are qualitatively described by social scientists are difficult to quantify and synthesize as structural elements. Second, the present state of knowledge in the social sciences may be such that even qualitative descriptions of some social processes are not available. However, a multi-disciplinary approach to the modelling building task will enable the social scientists to provide what information that is available about these processes. On the question of the correctness of the synthesized relations, only appropriate experts are qualified to comment. It cannot be overemphasized that a multi-disciplinary approach to the model analysis and synthesis stages is of paramount importance (Young et al, 1972). The question of model inference can be answered if the model builders relinquish the formation of value judgements concerning model inferences to the policy makers.

It may be useful to point out that the application of system dynamics to the modelling of animal population dynamics has been investigated (Peppard 1972), and appears to offer considerable hope in providing an understanding of ecological system behavior.

In summarizing the criticisms of the application of system dynamics to the modelling of social and economic systems, there appear to be two legitimate areas of concern: First, on the question of inclusiveness of such a model and second, on the accuracy of the assumed relations (i.e. the structure) of such a model. It would appear that as first conceived, Forrester's industrial, urban and world models were vulnerable on both counts. Subsequent work by multi-disciplinary teams appears to have refined and properly validated the original models, particularly in the case of the urban model. It would appear that much of the criticism traditionally aimed at system dynamics models can be nullified by proper and careful application of the techniques by an appropriate multi-disciplinary team. This will ensure that the resultant model is inclusive for the intended purpose and that structural relationships are as accurate as is possible.

CHAPTER 4

DESCRIPTION OF THE SYSTEM DYNAMICS TECHNIQUE

4.1 Introduction

A model is a substitute for an object or system. Models serve many purposes and can be of any form. Everybody uses them to some degree, even a child when he plays. The main difference is the scope at which they are used. Any set of rules and relationships that describe something is a model for that thing. In a sense all our thinking depends on models.

Today, models related to social and technological systems have become so sophisticated that the unaided human mind cannot adequately construct and interpret their dynamic behaviour. System dynamics as presented here provides a foundation for constructing models to aid our mental process in dealing with time varying feedback systems.

To say that one can eliminate all problems of model building by converting mental models to models represented by explicit statements in the form of flow diagrams and equations is incorrect. However, since our model is in pictorial form it can readily be followed, validated and communicated to others.

Since most present day models have nonlinear equations with complex interrelationships, their analytical and mathematical solutions are very time consuming and at times impossible to solve, the simulation process using step-by-step numerical solution is the only technique available. The simulation technique does not give the general solution or tell all the possible behaviour patterns. Instead simulation gives one-time history of system operation corresponding to the inputed numerial values for the coefficients and initial conditions. For different conditions another full step-by-step computation must be made.

4.2 Structure of Dynamic System Models

The structure of a subject guides us in organizing information. The structure of a particular model should achieve the following objectives:

- Describe any cause-effect relationships that we may wish to include.
- Be of simple mathematical notation.
- Be able to closely depict a real life industrial, economical and social conditions.
- Be able to handle large quantities of variables readily.
- Be able to handle "continuous" interactions such that any artificial discontinuities introduced by solution-time intervals will not affect the results, but should be able to generate discontinuous changes in decisions when these are needed.

These objectives can all be met by use of a closed boundary which has feedback loops. A closed boundary means that one is only concerned with model interactions within the system that produces fluctuations and changes. Everything outside the domain of the system that does not influence the model is ignored. One should be careful that all model interactions are included within the system boundary. All decisions concerning these interactions within the model are made within a feedback loop. It is the interconnecting feedback loops that produce a dynamic model.

The building blocks for interconnecting feedback loops are basically levels and rates. Both are necessary, however, there are others that are needed to complement the use of these components.

The following sections will discuss in detail each of the features for the basic model structure.

4.2.1 Levels

A level is shown by a rectangle.

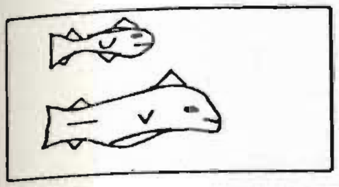
L E V E L

Levels are accumulations within the system. They may be material, inventories, goods in transit, equipment, factory space, bank balances, number of employees as well as various human, social, cultural and economic achievement levels. Levels are the present net values of those variables that have resulted from the accumulated difference from inflows and outflows during a particular time interval. A level may have any number of inflow and outflow channels.

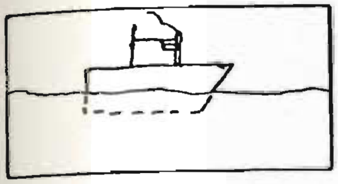
Levels may only be changed by the rates. The new level of a variable is computed by the accumulated differences of inflows and outflows over a particular time interval added to the previous value of the level. All values of levels are computed without the use of any other levels.

A level is a variable that continue to exist and to have meaning in a system once it is brought from a dynamic to a static state. If all inflows and outflows to a level were to stop, a level would continue to exist. Stopping the withdrawal and deposit of money from a saving account, for example, does not affect the existence of money in the saving account.

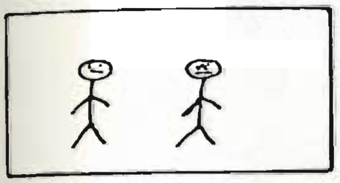
Figure 4.1 gives some examples of levels applied to the fishing industry.



Quantity of marine resource at a particular location in a given instant of time.



Number of vessels fishing for marine resources at a particular location in a given instant of time.

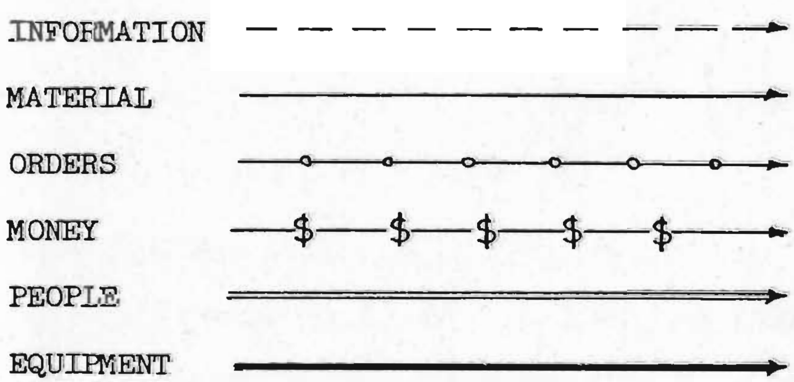


Number of people fishing for marine resource at a particular location in a given instant of time.

Figure 4.1 Examples of Levels as Applied to the Fishing Industry

4.2.2 Flows

Flows are represented by flowlines with each kind of flow line selected either to suggest the type of flow representation or to facilitate drawing.



Flows occur in systems representing quantities that move from place to place. The information flow is unique from the other flows in that there is no actual movement, only information about the variable. The information flow acts as an information linkage that causes the other flow types to act on one another. Information flow will contain the generation of various concepts that are inputs to decision making, such as, desired inventory level, projected size of plant, forecast of sales, desired employment level and knowledge for research results.

The material flow include all flows of physical goods whether in a raw, semi-processed, or finished state.

The order flow is the demand for goods and services. These orders result from decisions that have not been executed into flows in one of the networks.

Money flow includes the transmittal of money (cash) between money levels.

The personal flow is used as countable individuals not as man-hours of work. Company policies, labour union contracts and the availability of people initiate personal flow.

Equipment flow includes factory space, tools and equipment necessary in the production of goods. It describes the quantity of equipment purchased, in use and/or discarded.

The following are simple illustrations of flows that occur if one were to build a dynamic model of a Newfoundland fish processing plant that had a normal production capacity of Z lbs. of cod fillets per day assuming an unlimited supply of raw material, labour, machinery, etc.

Requisitions for Y lbs. of cod fillets per day

These orders would come from the customer to the fish plant manager who would schedule production for Y lbs. of cod fillets per day.

Hiring of operators for cod processing

Operators would come from the community to fillet round cod in the fish plant. The quantity of the flow depends on the productivity of the people hired, the Y orders of cod fillets and the dismissal rate.

Skinning machines used for cod processing

The flow of skinning machines into operation depends on the start-up or installation time, breakage, and the capacity of the piece of equipment.

Order information

Information about the level of orders received would schedule the rate of hiring.

Flow of cod fillets to customer

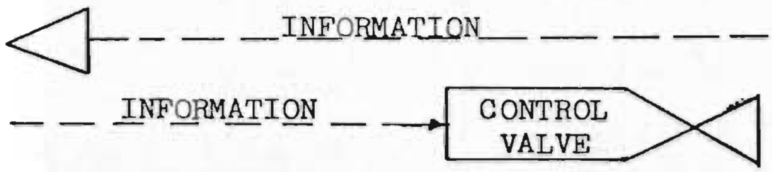
The flow of cod fillets (finished packed product) to the customer depends on the number of people employed and the quantity of equipment used in the shipping department.

Payment received for the cod fillets

The flow of cash to the fish plant depends on the shipping rate plus clerical delays in processing payments.

4.2.3 Decision Functions (Rates)

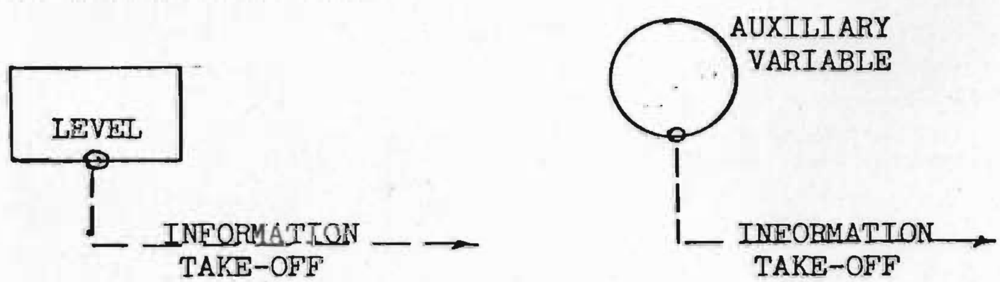
Decision functions are represented by a symbolic valve:



Decision function determines the rate of flow. They act as valves in flow channels to regulate the amount of flow into and out of a particular level. These valves serve the same purpose as a valve in a hydraulic system. The decision function receives only information as its input. An example of a decision function may be the quantity of a raw material a fish plant processor should buy. This decision might involve the following levels: present finished goods inventory level, present raw material inventory, backlog of unfilled orders, available supply of raw material, present employees, average usage rate, available equipment, plant capacity, cash flow, etc.

4.2.4 Information Take-Off

Information take-off is shown by a small circle at its origin and by a dashed information line.



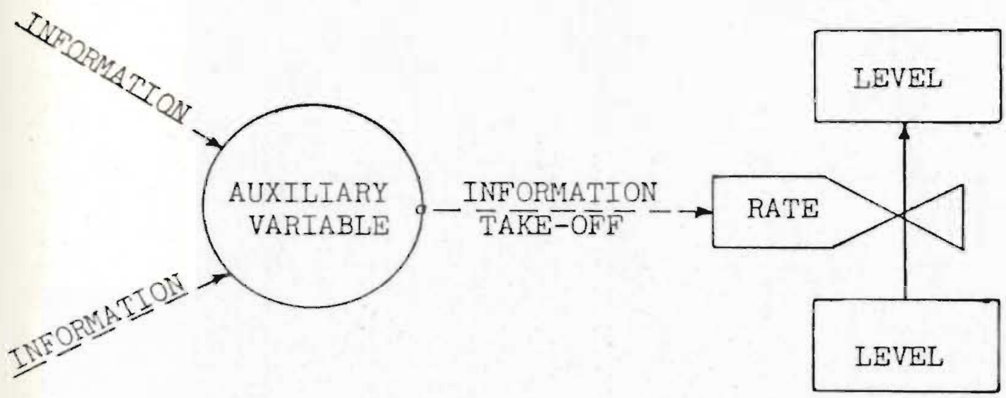
An information take-off is used only to transfer information about the magnitude of a variable not to represent flow of contents.

An information take-off about a variable can be taken without affecting or depleting that variable. No information flow, only information take-off, could exist at a level which is not itself information.

For example, an information line leaving a filleted cod inventory can only be an information take-off since the cod fillet transport flow would be shown by a material-flow line.

4.2.5 Auxiliary Variables

Auxiliary variables are shown by circles.

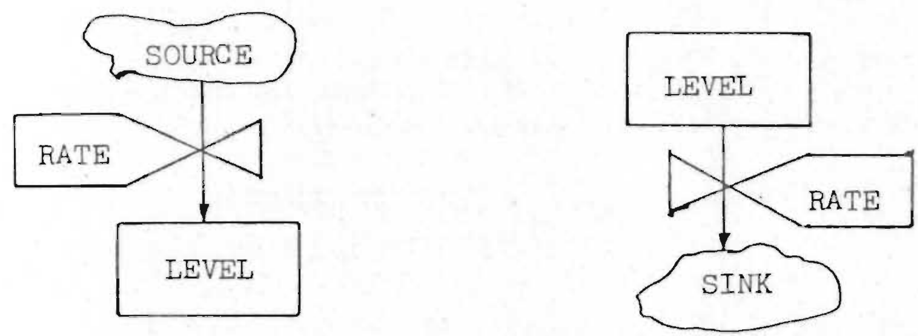


Auxiliary variables lie in the information flow channels between levels and decision functions. The incoming information lines are variables on which the auxiliary depends (levels, rates, constants or other auxiliary variables). The outflow is always an information take-off. No numerical value needs to be saved from one computational time step to the next. Any number of information lines can enter or leave an auxiliary variable.

Auxiliary variables could be eliminated from a model since they ideally can be substituted into the rate equation, however, such practices, at times make rate equations long, cumbersome and difficult to understand.

4.2.6 Sources and Sinks

A source and sinkare designated by the following symbols.

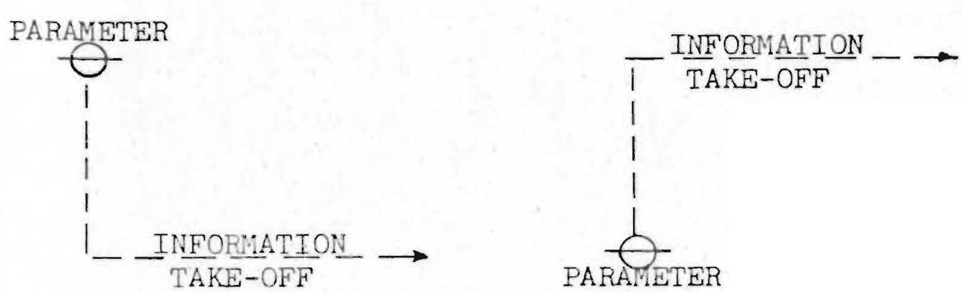


A source or sink lies outside the consideration of a model, since it has no significance to the particular model. A source occurs when flow enters the boundary of a model, and conversely, a sink occurs when flow leaves the boundary of a model.

If a model was built of a fish plant, the model boundaries could conceivably be raw material entering and finished goods leaving the plant. The methods used for harvesting the raw material and the individuals who consume the finished product would represent a source and sink respectively, since they would be insignificant to this particular model.

4.2.7 Parameter (Constant)

Parameter is shown with an underline or overline having an information take-off.

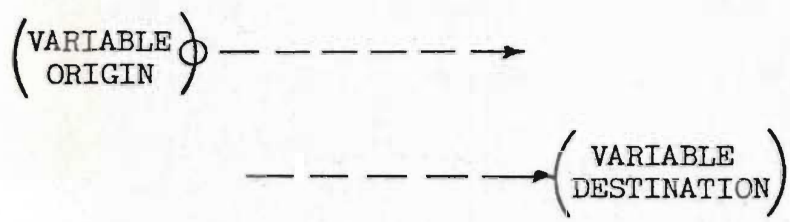


Parameters are those values which are constant throughout a simulation run of a model. They can, of course, be changed between successive runs. Parameters are always information inputs to rates, either directly or by way of auxiliary variables.

Examples of parameters could be the price of a particular type of finished product, price of raw material, labour productivity or machine capacity.

4.2.8 Variables on Other Diagrams

Variables that appear on other diagrams should be shown in the following manner.



Variable origin refers to a variable that is coming to this diagram from another.

Variable destination refers to a variable that is leaving this diagram and going to another.

4.3 Equations

In the preceding sections the basic concepts of system structure were discussed. To describe these concepts of system structure a suitable system of equations must be developed so that the dynamic model can be applied to a computer simulation program . The system of equations should be adequate so as to describe exactly the dynamic model.

The system of equations to be described will be formulated in a manner which can be used in the Dynamo Simulation Program created by Dr. Phyllis Fox and Mr. Alexander L. Plugh III. Before describing the types of equations to be used, the fundamental time sequence of computation will be described in terms of levels and rates.

4.3.1 Computing Sequence

When computing the successive time steps in the dynamic behavior of a system we need a standardized computational convention that controls the changing interactions of a set of variables as time advances. This implies that the equation will be computed periodically to yield the succesive new states of the system. The computation progresses in time steps as in Figure 4.2.

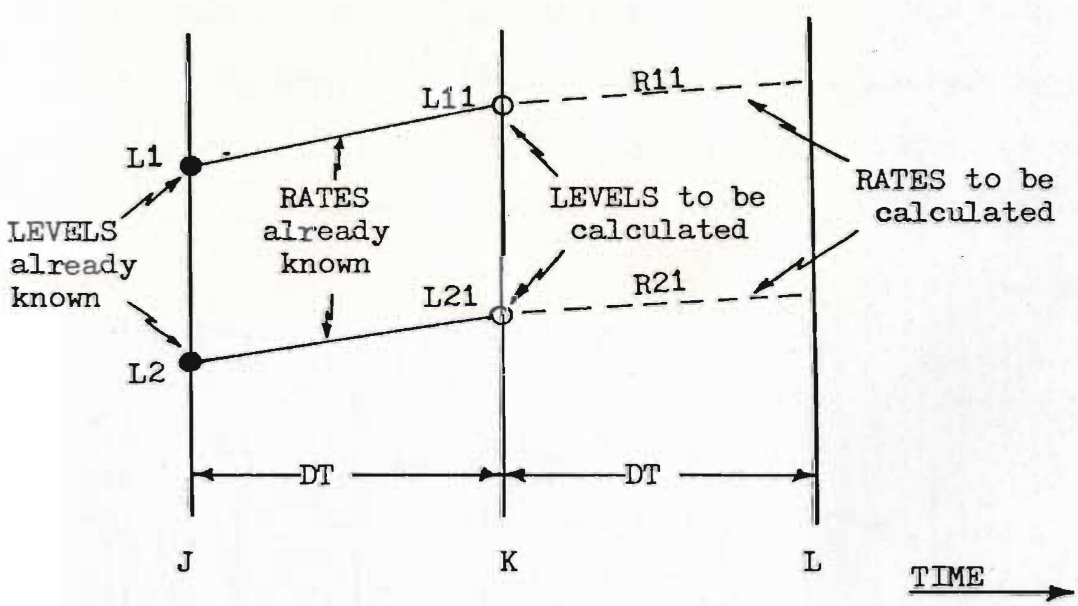


Figure 4.2 Calculations at Time K.

As shown in Figure 4.2, time is broken into the standard designations of J, K, and L with J representing the most recent time the computation was made, K representing the present and L used to designate the next point in time. The interval JK has just passed and information about it and earlier times is in principle available for use. No information beyond K, like the interval KL, or the time, L, or beyond, will ever be available for use in an equation being calculated at present time, K.

The equations are calculated at moments of time that are separated by the solution intervals, DT. The selection of the time interval space, DT, is dependent on how closely we wish to approximate any curve, Figure 4.3. Shorter and thus more numerous intervals would yield closer approximations of the curve. The value of DT for a particular model depends on the level of accuracy required such that further increases in the number of time intervals (DT) would produce insignificant differences in outputs. A and B in Figure 4.3 represent the units of time used in defining the system whether they are weeks, months or years. It should be understood that the interval time, DT, cannot exceed the desired time interval, A to B.

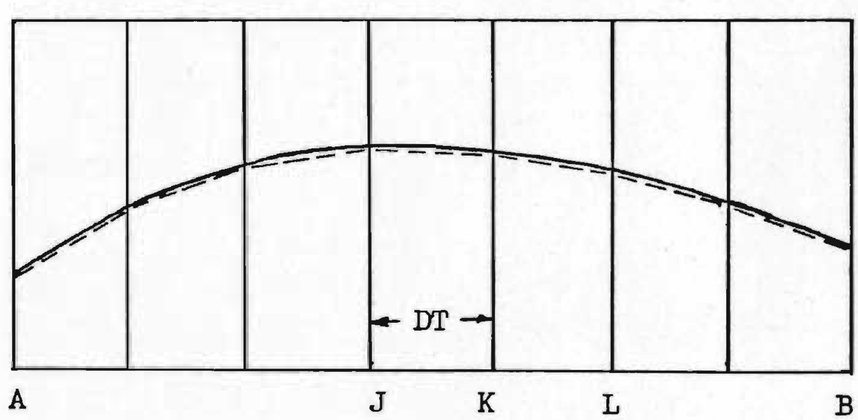


Figure 4.3 Straight line approximation to a variable level.

At the start of the computation at time K, there are available from the previous computations, L1.J designating the value of the level at time J and R11.JK and R12.JK, designating the value of the inflow and outflow rates respectively over the interval JK, Figure 4.4. The rate, R11.JK, flow into level, L1, with the rate, R12.JK, flowing out of level, L1. The new value of L1 at time, K, can now be calculated since it depends only on its own old value and on rates in the JK interval, Figure 4.5.

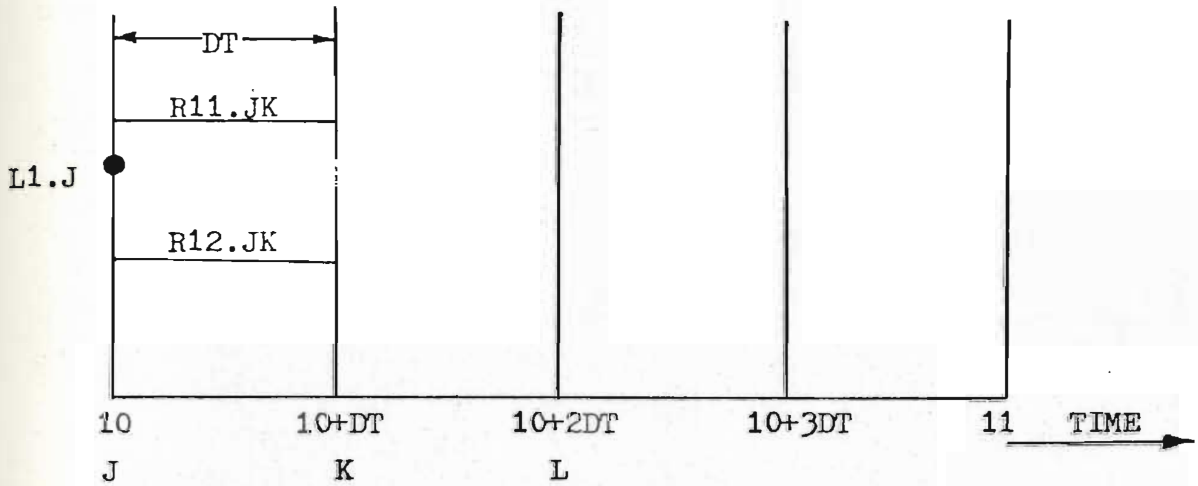


Figure 4.4 Start of new computation sequence.

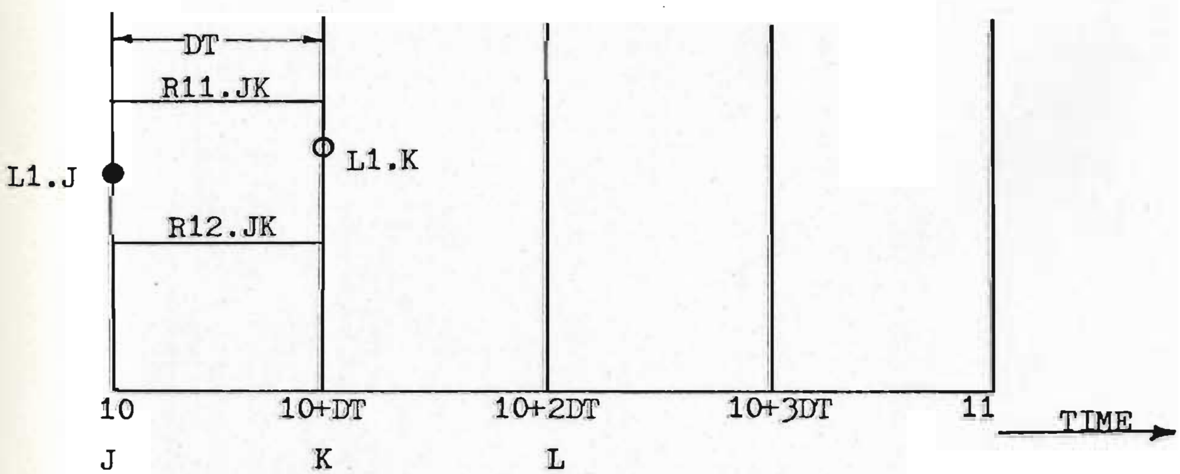


Figure 4.5 After computation of level.

The rate equations are evaluated at the present time K, after the level equations have been evaluated, therefore the rate equations have available as inputs the present values of levels at K, Figure 4.6. The values determined by the rate equation determine the rates that represent the actions that will be taken over the forthcoming intervals, KL. The solutions intervals are taken short enough that the step-wise discontinuities in rates are of no significance.

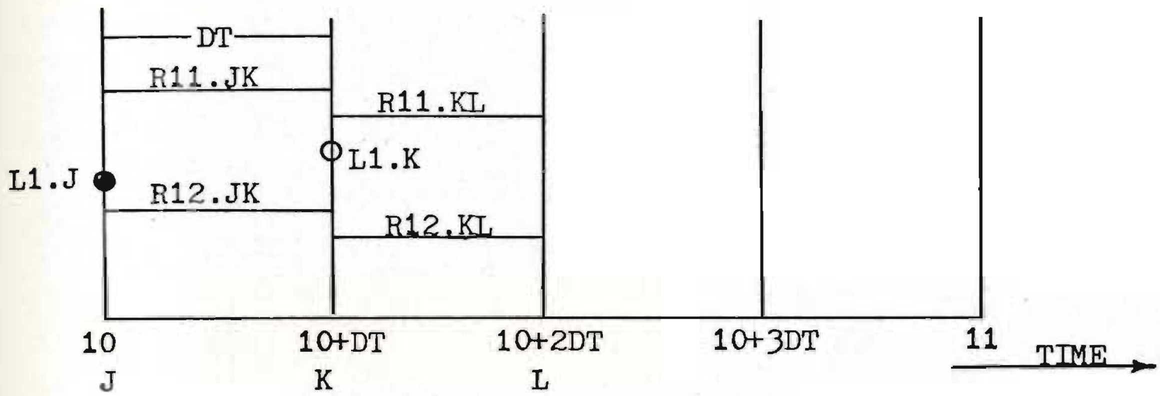


Figure 4.6 After computation of rates

The entire process is now repeated for the next point in time, L, however the first step is to advance the time designators J, K and L by one solution interval, Figure 4.7. With this, the K levels become J levels and the KL rates become JK rates thus new values of levels can now be computed.

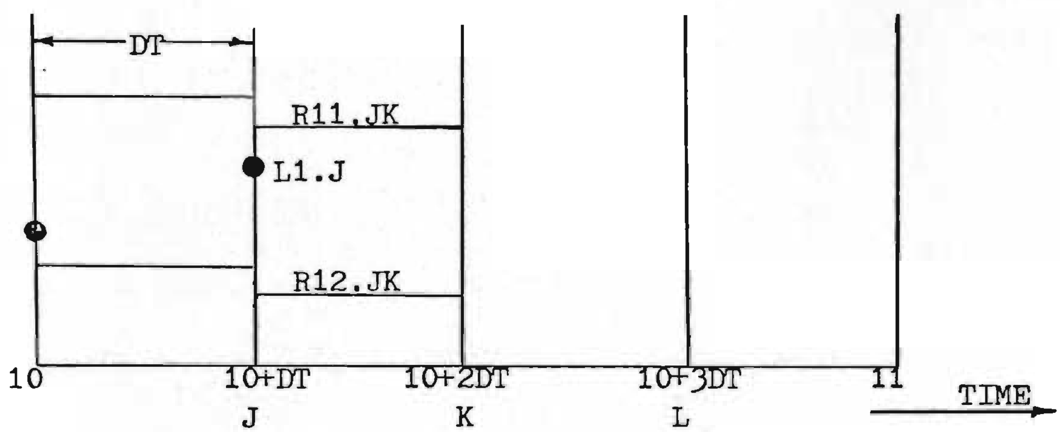


Figure 4.7 Time designators advanced to next solution interval

4.3.2 Symbols In Equations

The standard symbol to represent a constant or variable consists of a group ofsix identities or less, the first must be alphabetical. In addition, all variables shall use a symbol with their proper time postscript separated by a period, however, a constant shall use no time postscripts.

Standard symbols for levels could include:

A.J
A.K
A22222.J
A22222.K
A2ZZZ.J
A2ZZZ.K

Standard symbols for rates could include:

B.JK
B.KL
B22222.JK
B22222.KL
B2ZZZ.JK
B2ZZZ.KL

Standard symbols for a constant could include:

C
C22222
C2ZZZ

4.3.3 Classes of Equations

There are seven equation types. In this section all seven equation types will be discussed in detail.

4.3.3.1 Level Equations

Levels, equation type identified by "L", are the varying contents of the reservoirs of the system. They relate a quantity at the current time to its value at the previous time that calculations were made and to its rates of change during the interval between calculations. The following is a standard format for a level equation.

L   L.K = L.J + (DT) (RI.JK - RO.JK)

where:

L - designates the level equation for use in the computer program

L.K - New value of level being computed at time K (units)

L.J - Value of level from previous time J (units)

DT - The length of the solution interval between time J and K (time measure)

RI.JK - The value of the inflowing rates added during the JK time interval (units/time measure)

RO.JK - The value of the outflowing rates subtracted during the JK time interval (units/time measure)

Any number of rates can be inflowing or outflowing from a level, Figure 4.8.

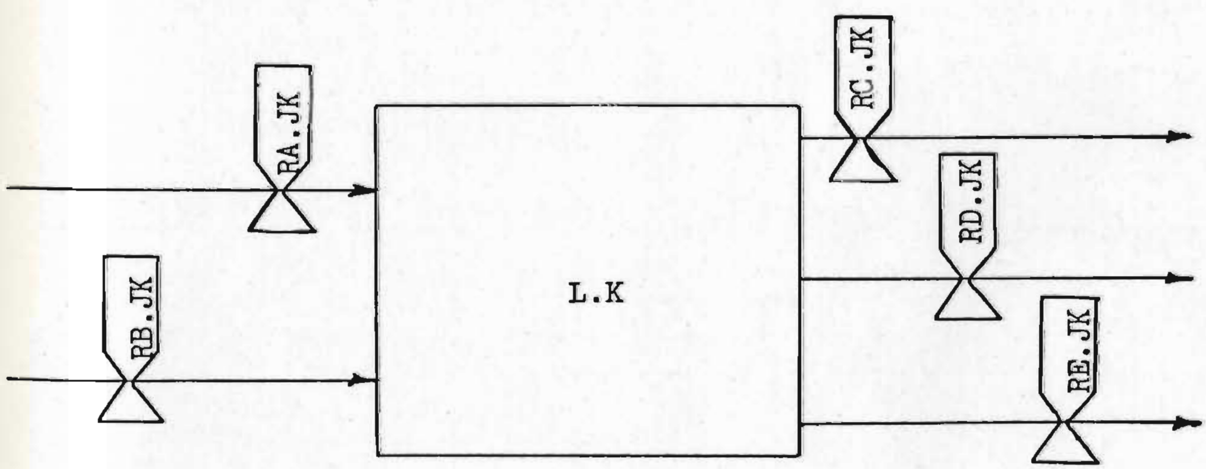


Figure 4.8 A level in a system with more than one inflowing and outflowing rates

Level equation for Figure 4.8 is as follows:

L L.K = L.J + (DT) ((RA.JK + RB.JK) - (RC.JK + RD.JK + RE.JK))

or L L.K = L.J + (DT) (RI.JK - RO.JK)

where:

RA.JK + RB.JK = RI.JK, representing inflowing rates

RC.JK + RD.JK + RE.JK = RO.JK, representing outflowing rates

This is the only flexibility permissible in the standard level equation for use with the Dynamo Simulation Computer Program. The right hand side of the equation must always contain the previous value of the level and the solution interval, DT, as a multiplier of the difference between inflowing and outflowing rates. Notice, that the"dimensions" of each time in the equations are "units", i.e.

L.K = L.J + (DT) (RI.JK - RO.JK)

units = units + (Time measure) (units/time measure - units/time measure)

units = units + units = units

As seen, it is the solution interval, DT, when multiplied by the rates that creates the correct units of measure for adding to the value of the level. The solution interval normally should not appear in any equation other than a level equation.

The level equation is an "integrating" equation that accumulates the net result of past rates of change in the level. In the notation of calculus and differential equations the level equation would be written as follows:

$$L = L_o + \int_o^t (RI - RO)\, dt$$

L - the value of the level at any time t (units)

L_o - the initial value of the level at t = 0

$\int_o^t$ - the operator indicating integration or accumulation for time = 0 until time = t of the difference in inflowing and outflowing rates (RI - RO)

RI - the inflowing rate being added

RO - the outflowing rate being subtracted

dt - the differential operator representing the infinitesimally small difference in time that multiples the flow rates.

4.3.3.2 Rate Equations

The rate equation (denoted by R) state how the flows within the system are controlled. The inputs to a rate equation are system levels, constants, tables, auxiliaries, or other rates. The outflow of a rate equation controls a flow to, from, or between levels.

The following is the standard format for a rate equation.

R   R.KL = f (Levels, constants, tables, auxiliaries or other rates).

Where: the right hand side implies any function or relationship of variables or constants included in the above brackets that describe the policy controlling the rate.

4.3.3.3 Auxiliary Equations

Very often, the clarification and meaning of a rate equation can be enhanced by dividing it into parts that are written as separate equations. These parts are called auxiliary equations. For example, suppose that the input to a bank savings account is a variable that depends on money deposited by an individual plus interest accumulated on such deposits. The rate equation and accompanying auxiliary equations (denoted by A) could be:

R INPUT.KL = INPUTI.K + INPUTB.K

where: INPUTI & INPUTB are auxiliaries

A INPUTI.K = INCOME.K/RATEI

where: INCOME is a level & RATEI is a constant

A INPUTB.K = AMOUNT.K/RATEB

where: AMOUNT is a level and RATEB is a constant

Note, that equation for INPUTI and INPUTB can be substituted into the rate equation INPUT and give the resulting equation:

$$\text{R} \quad \text{INPUT.KL} = \frac{\text{INCOME.K}}{\text{RATEI}} + \frac{\text{INPUTB.K}}{\text{RATEB}}$$

The auxiliary equations have disappeared leaving the rate, INPUT, dependent only on levels and constants. As seen, auxiliary equations are evaluated at time K but after the level equations for time K, since they may use outputs from level equations. The auxiliary equations must, however, be evaluated before the rate equations because their values are substituted into rate equations.

4.3.3.4 Constants Equations

Constant equations are used to give numerical values. They carry the type designation of C. There is no time postscript in a constant equation, since it does not change through time.

A XYZ.K = (RST) (A.K)

C RST = 10

4.3.3.5 Initial-Value Equations

Initial-value equations are used to define initial values of all levels (and some rates) that must be given before the first cycle of model equation computation can begin. These equations are only evaluated prior to each model run. From these initial values for levels the rates of flow immediately following time zero can be computed which are then used to compute new values of the levels.

An initial value equation is customarily written immediately following the corresponding level equation.

L L.K = L.J + (DT) (RI.JK - RO.JK)

N L = 10

As seen the initial value uses no time postscript and is designated by N.

4.3.3.6 Supplementary Equations

Supplementary equations are used to define variables which are not actually part of the model structure but may be of some interest about the model behavior. These equations are not used in any of the decision processes of the model and are denoted by "S".

S T.K = A.K + B.K + C.K

where: T is only the sum total of A, B & C.

4.3.3.7 Table Equations

Table equations are used to express variables which have arbitrary relationships to other variables. This simply is a method of converting linear or non-linear graphs into a form which can be adapted to a computer program. Table equations are notated by T and are discussed in detail in Appendix "A"

4.4 Model Building

To illustrate the technique of formulating the basic structure of a dynamic system model and its associated equations into a useful dynamic model, the following simple examples will be presented. These examples will show how the different components and their associated equations are interconnected with each other.

Figure 4.9 shows a simple model with a source, sink, level, constant parameter, table, two auxiliaries, two rates and two flows. Let us assume that water is flowing from a pond into a reservoir and out into individual homes. In this crude model we are only concerned with water flowing into and out of the reservoir, the size of the pond and the number of homes serviced are of no importance in this model.

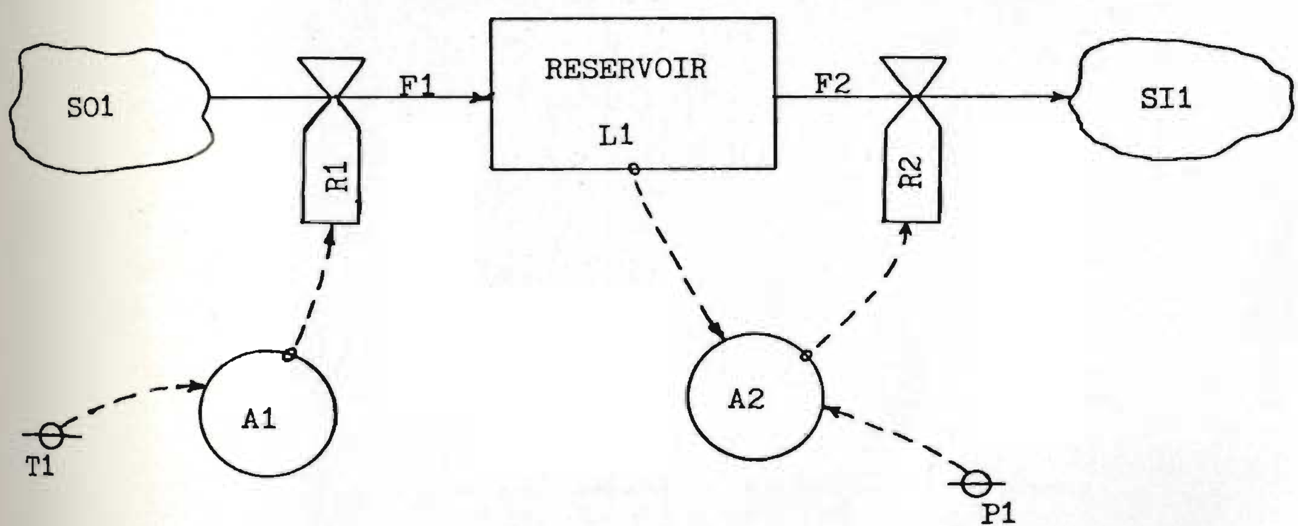


Figure 4.9 A simple model of a reservoir with water flowing in and out

SO1 represents a source (the pond) and SI1 represents a sink (the individual homes) which are outside the boundaries of the model. Water flows, F1, from the pond into the reservoir level, L1, at a rate defined by, R1. The rate, R1 is controlled by an auxiliary, A1, which is defined by, a table. The water flows out of the reservoir at a rate of, R2, which is controlled by the auxiliary, A2. The value of auxiliary, A2, is obtained from the constant parameter, P1, and an information takeoff from the level, L1. The flow, F2, flow directly into the sink, SI1. The equations for this model could be as follows:

```
R    R1.KL = A1.K
A    A1.K = Table (T1, Time.K, O, 10)
T    T1 = 150,000, 125,000, 200,000, 175,000, 150,000,
          125,000, 175,000, 200,000, 150,000, 125,000, 200,000
L    L1.K = L1.J + DT (R1.JK - R2.JK)
N    L1 = 100,000
R    R2.KL = A2.K
A    A2,K = (L1.K)(P1)
C    P1 = 0.80
```

The auxiliary, A1.K, represents the following graph, Figure 4.10

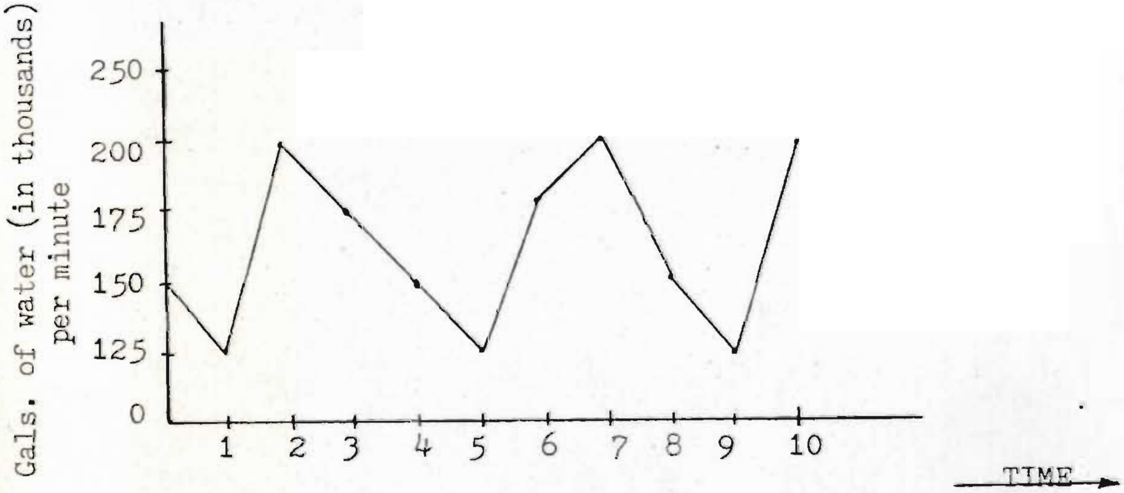


Figure 4.10 A graph showing flow patterns of water entering a reservoir

The initial value of the reservoir is 100,000 gals. of water.
The output rate from the reservoir is always eighty percent (80%) of the water in the reservoir. The units for the inflowing and outflowing water rates are gals. of water/minute and the reservoir is in units of of gallons.

As discussed earlier the level equation is simply an integrating equation that accumulates the net result of past rates of changes in the level. To illustrate that this is so, the level, L1, in Figure 4.9, will be solved by the use of first-order linear differential equations. To make the solutions to the differential equations simple and thus easy to understand, the inflowing rate will be held constant at 75,000 gals/minute, all other variables will remain the same. In this case, the system equations would be written as follows:

R R1.KL = 75,000
L L1.K = L1.J + DT(R1.JK - R2.JK)
N L1 = 100,000
R R2.KL = A2.K
A A2,K = (L1.K)(P1)
C P1 = 0.80

The first order linear differential equation is given as:

$$y^1 + P(x)y = Q(x)$$

with

$$f\ (a) = b$$

and

P, the outflowing rate, and Q, the inflowing rate

This function is given by the formula:

$$f(x) = be^{-A(x)} + e^{-A(x)} \int_a^x Q(t)\ e^{A(t)}\ dt$$

where:

$$A(x) = \int_a^x P(t)\ dt$$

Applying this formula to Figure 4.9 we obtain:

$$L^1 + 0.80L = 75,000$$

or

$$L^1 = 75{,}000 - 0.80L$$

Since L = 100,000 when t = 0, the unique solution is given by the formula:

$$L = 100{,}000\ e^{-.8t} + e^{-.8t} \int_o^t 75{,}000\ e^{.8u}\, du$$

$$L = 100{,}000\ e^{-.8t} + e^{-.8t} \left[\frac{75{,}000}{.8}\ e^{.8u} \right]_o^t$$

$$= 100{,}000\ e^{-.8t} + \frac{75{,}000}{.8}\ e^{-.8t} \left[e^{.8t} - 1 \right]$$

$$= 100{,}000\ e^{-.8t} + 93750 - 93750\ e^{-.8t}$$

$$= 6250\ e^{-.8t} + 93750 \text{ for all } t$$

The following are the calculated solutions for the level, L, at times 0 to 15 inclusive:

	at t = 0,	L = 100,000
	at t = 1,	L = 96558.30603
	at t = 2,	L = 95011.85324
	at t = 3,	L = 94316.98732
	at t = 4,	L = 94004.76377
	at t = 5,	L = 93864.47274
	at t = 6,	L = 93801.43592
	at t = 7,	L = 93773.11165
	at t = 8,	L = 93760.38473
	at t = 9,	L = 93754.66616
	at t = 10,	L = 93752.09664
	at t = 11,	L = 93750.94208
	at t = 12,	L = 93750.42333
	at t = 13,	L = 93750.19020
	at t = 14,	L = 93750.08546
and	at t = 15,	L = 93750.03840

Comparing these solutions for L at different time intervals to the Dynamo computer output (in Appendix "E"), we see that they are exactly the same.

To illustrate how the information link form the connecting tissue in a system between two subsystems, Figure 4.11 will be discussed.

In this example only a general layout of the model has been presented since the main purpose is to demonstrate how two submodels are connected. This example is a production model with two submodels, a labor employment submodel and the other a material submodel.

The labor employment submodel consists of three levels, (labor pool, production workers and workers in training) and three rates (layoff rate, training rate and hiring rate). The only level which will be used directly in the explanation of this example is the production worker level, PWL.

The material submodel consists of two levels (raw material inventory and finished goods inventory), three rates (rate of supply of raw material, production rate and shipping rate), a source and a sink. Here again only the production rate, PR, will be discussed in detail. In the material submodel, only inventories move from one level to another, where as in the labor employment submodel only workers move from level to level, there is no movement between submodels. The only method by which these two submodels can be connected is by means of an information link.

In this example, information concerning the number of production workers employed, PWL, coupled with their productivity rate, C, is used to control the flow of goods from the raw material inventory level to the

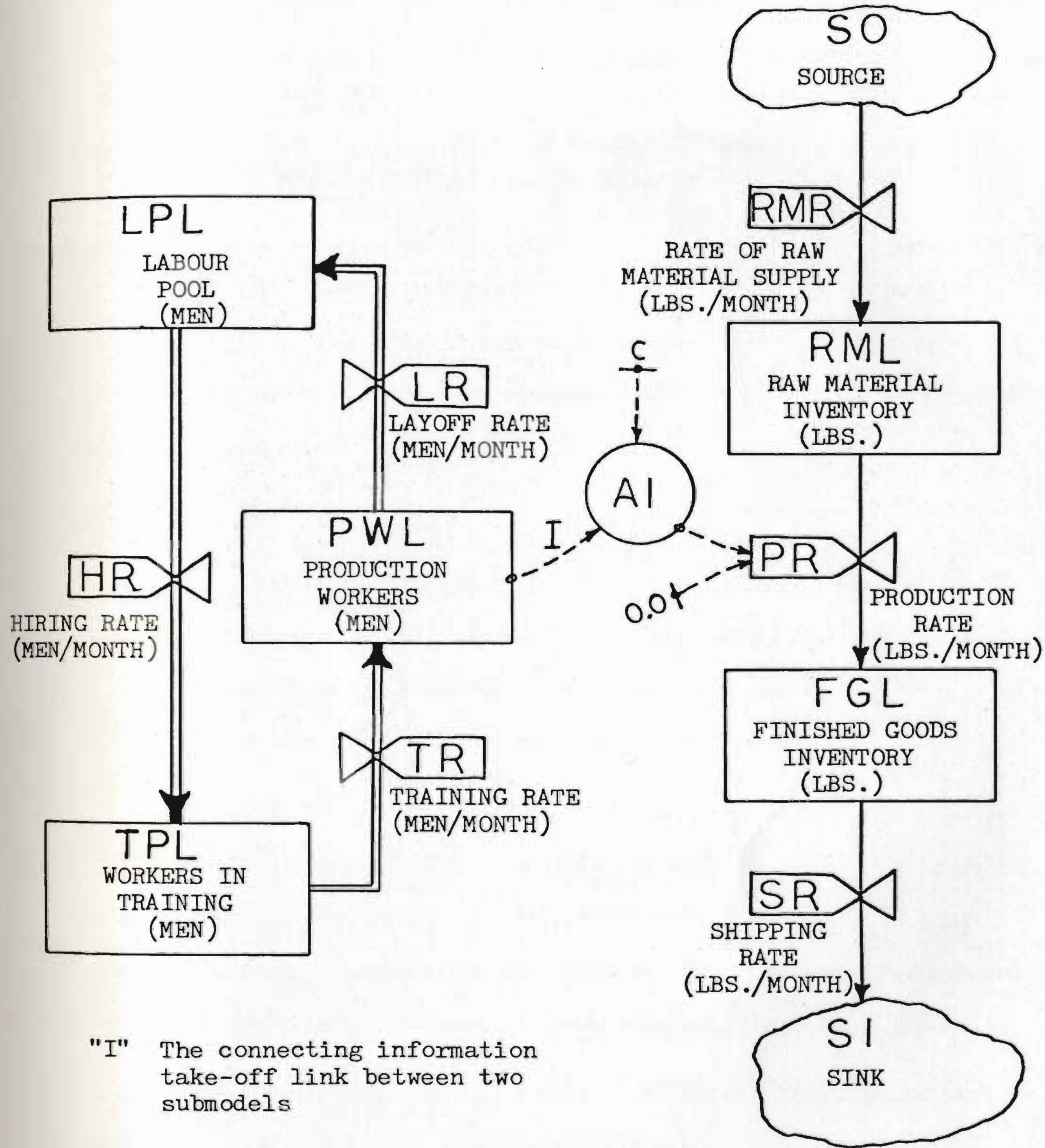


Figure 4.11 A production model showing information link between two submodels

finished goods inventory level.

The following equations are used to establish the production rate,PR.

R PR.KL = CLIP (0.0, A1.K, 0.0, A1.K)

A A1.K = (PWL.K)(C)

C C = 15,000 Productivity rate

L PWL.K = PWL.J + DT(LR.JK - TR.JK)

N PWL = 50

The clip in the equation for the production rate, PR, simply means that the production rate cannot go negative. For further explanation of the use of clips see extracts from "Dynamo II Users Manual" by Alexander L. Plugh III in Appendix "A".

4.5 Model Validity

The validity (or significance) of a model should be judged on how well it represents the actual system. If it does not give a true picture it is meaningless, thus what may be an excellent model for one purpose may be useless for another purpose.

The purpose of system dynamic models is to aid management in improving industrial and economic systems. In order to achieve this, clear and concise objectives of the system must be understood. With concise objectives and the necessary system detail adequately described and properly interrelated, the model system must behave as it should.

The system dynamic model is built on the same information and evidence used in the manager's usual mental model of the management process. The power of system dynamic models is not from more information than a manager has, but the ability to use more of this same information and to portray more usefully its application.

Since the similarity of the model to the actual format of the system is necessary we must know what to look for and what are the tests between the two systems.

The following are tests that can be done between the two systems:

- That the dynamic systems model behavior is not obviously implausible
- Attempt to precipitate additional obvious inadequacies by testing the model over an unusually wide environmental range which are however within the system's boundary.
- Investigate the similarity of problem symptoms between model and real behavior. An example of this would be fluctuating behavior where the time intervals between peak values of the variables could be compared with the actual system.
- Investigate the time-phase relationships between variables, such as the peaking of inventories after the sale and production often indicate how similar the model is to the actual system.
- The data and plots obtained from the model computer output can be examined to see if the decision streams are compatible with the actual system.
- Examine the abruptness with which the values of system variables change. The model of a system should show the same transition characteristics as the system.
- Check the behavior characteristics that can be quantitatively measured.

In summary, serious model defects will usually expose themselves through some failure of the model to perform as would be expected of the actual system, however, a vast number of things could be done to any model to change its behavior characteristic but change must be based on knowledge about the working details of the actual system.

4.6 Dynamo Compiler

The Dynamo Compiler is a computer program which accepts the equations for a model of a dynamic feedback system and produces the requested simulation results as numerical tables and graphical plots.

Dynamo has been specially designed to accept the structure and the equation convention previously discussed in this chapter.[1] The Dynamo language includes time subscripts that easily enables anyone to comprehend how the calculations are made. Dynamo is designed for the person who is problem-orientated rather than computer-orientated. The Dynamo compiler is widely available and adapted to many computer languages including Fortran.

Detail extracts from "Dynamo II User's Manual" by Alexander L. Plugh III explaining its different components are given in Appendix "A."

1 Dynamo has been designed by the Industrial Dynamics group at The Sloan School of Management Massachusetts Institute of Technology. For a more complete description see Dynamo II User's Manual by Alexander L. Plugh III.

CHAPTER 5

A SYSTEMS DYNAMIC MODEL OF A NEWFOUNDLAND INSHORE FISH PROCESSING PLANT

5.1 Introduction

The model of a Newfoundland inshore fish processing plant presented here consists of two main sectors, the processing sector and its associated economic sector (Figure 5.1).

The processing sector considered in this model is limited to the processing of six species; cod, flounder, herring, mackerel, squid and blueberries;[1] a fish meal plant and the associated labour employment sector. These six species will be mainly manually processed in the following manner:

- Cod and flounder will be filleted in a manner as described in Figure 1.1 and packed in $16\frac{1}{2}$ lb. blocks and 5 lb. sello-wrap respectively.
- Herring will be processed into butter-fly fillets by using filleting machines and manually packed in $16\frac{1}{2}$ lb. blocks.
- Squid and mackerel will be processed round in a manner as described in Figure 1.3 with each packed in 40 lb. boxes.
- Blueberries will be processed by placing blueberries on conveyors where thay are sent through a wind tunnel (to remove leaves), washed and inspected prior to packing in 40 lb. boxes.

All species once packed will be frozen and stored in cold storage.

The economic sector consists of total sales revenue, total raw material cost, total labour cost, total packaging material cost, inventory value, long term loan, short term financing, depreciation,

1 Blueberries in the model will be classified as a speciesso as to simplify the explaining of the system logic.

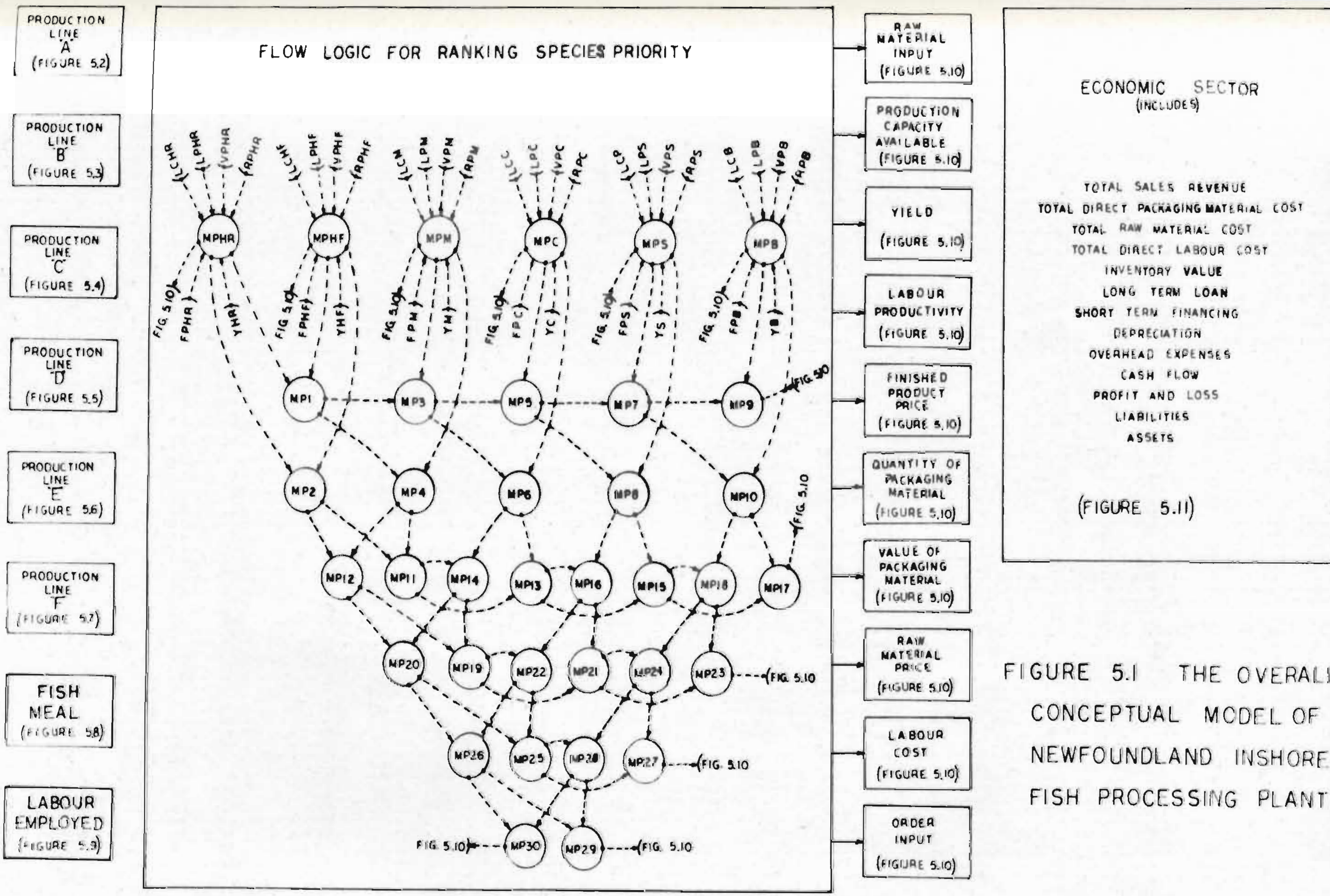


FIGURE 5.1 THE OVERALL CONCEPTUAL MODEL OF A NEWFOUNDLAND INSHORE FISH PROCESSING PLANT

total overhead expense accrued from head office, total production expense, total selling expense, total administration expense, cash flow, profit and loss, liabilities and assets for the processing plant.

The time interval (DT) between each iteration for the model was selected as one day for a total time duration of 300 working days, representing one year.

A complete listing of all model equations and their associated key are given in Appendix "B" and Appendix "C" respectively. These equations will be referred to while explaining the processing model.

5.2 The Processing Sector

Before describing the model for the processing sector, a conceptual frame-work for a multi-species processing sector will be presented.

The processing sector is divided into six production lines, products "A", "B", "C", "D", "E", and "F". These six production lines are set up with product "A" first, product "B" second, "C" third, "D" fourth, "E" fifth and "F" sixth, since fish plant managers have to make daily decisions on species priority when he has more raw material available for production than he can process at any one time. In the model, species priority is made on profit margins per pound with the highest profit margin corresponding with production line "A", the second highest corresponding to "B", the third highest corresponding to "C", etc.

The by-product from these production lines is used to produce fish meal. The labour employment model determines the total number of employees required for working on the production lines.

The equations for the processing sector will be explained under the following general areas, namely:

- production line "A" to "F" (Figures 5.2, 3, 4, 5, 6, 7)
- fish meal (Figure 5.8)
- direct production labour employed (Figure 5.9)
- profit margin per species (Figure 5.1)
- Ranking ofspecies by profit margin (Figure 5.1)
- SpeciesInput variables (Figure 5.10)

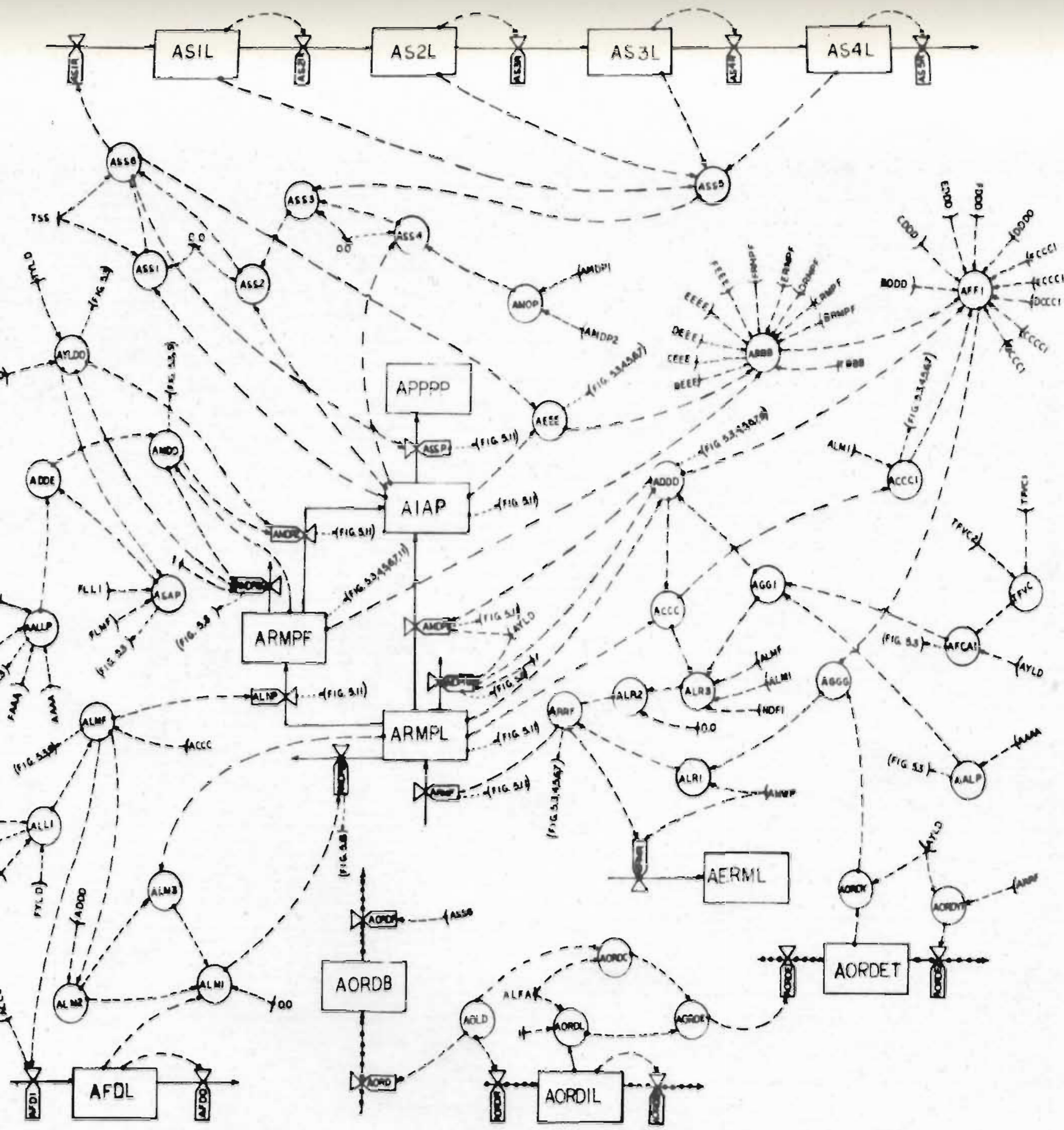
The above mentioned areas will be discussed with special attention to the main variables of interest related to the processing operation.

5.2.1 Production Lines "A" to "F" (Figures 5.2, 3, 4, 5, 6, 7)

Due to the similarity of logic between the different production lines, explanation of production line equations will be made with direct reference to production line "A". The other production lines will be discussed only where they differ in logic from "A". The diagram flow logic for the production lines are given in Figures 5.2, 3, 4, 5, 6, 7 with the associated equations given in Appendix "B", numbers 10 to 5320.

The main rate equations in production line "A" are:

- Raw material buying rate (ARMF)
- Fresh raw material processing rate (AMDP1)
- Raw material freezing rate (AFNP)
- Frozen raw material processing rate (AMDP2)
- Finished inventory shipping rate (ASSP)



THE MAIN RATES IN PRODUCTION LINE "A"

ARMF - RAW MATERIAL BUYING RATE

AMDP1 - FRESH RAW MATERIAL PROCESSING RATE

AFMP - RAW MATERIAL FREEZING RATE

AMDP2 - FROZEN RAW MATERIAL PROCESSING RATE

ASSP - FINISHED INVENTORY SHIPPING RATE

THE MAIN LEVELS IN PRODUCTION LINE "A"

ARMPL - FRESH RAW MATERIAL INVENTORY LEVEL

ARMPF - FROZEN RAW MATERIAL INVENTORY LEVEL

AIAP - FINISHED INVENTORY LEVEL

APPPP - FINISHED GOODS SOLD TO DATE

THE MAIN AUXILIARIES IN PRODUCTION LINE "A"

AORDY - FINISHED PRODUCT ORDER BALANCE

AFF1 - COLD STORAGE SPACE AVAILABLE

ARMP - RAW MATERIAL AVAILABLE

AALP - PRODUCTION CAPACITY AVAILABLE FOR PROCESSING FRESH RAW MATERIAL

AFCA1 - FREEZING CAPACITY AVAILABLE FOR PROCESSING FRESH RAW MATERIAL

ALL1 - FREEZING CAPACITY AVAILABLE FOR FREEZING ROUND RAW MATERIAL

AALLP - PRODUCTION CAPACITY AVAILABLE FOR PROCESSING FROZEN RAW MATERIAL

ASAP - FREEZING CAPACITY AVAILABLE FOR PROCESSING FROZEN RAW MATERIAL

FIGURE 52 PRODUCTION LINE "A"

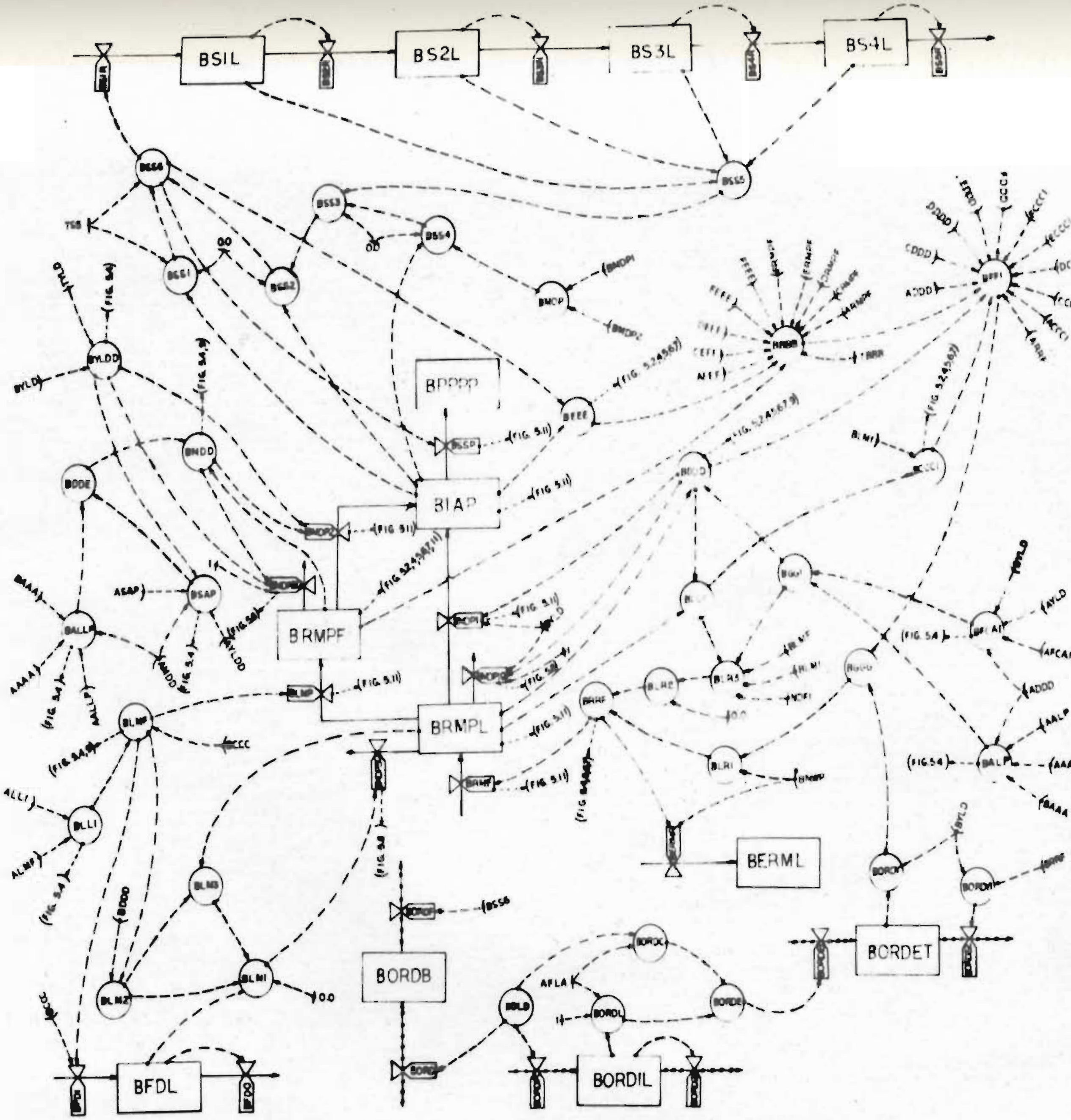


FIGURE 5.3 PRODUCTION LINE 'B'

THE MAIN RATES IN PRODUCTION LINE "B"

BRMF - RAW MATERIAL BUYING RATE

BMDP1 - FRESH RAW MATERIAL PROCESSING RATE

BFMP - RAW MATERIAL FREEZING RATE

BMDP2 - FROZEN RAW MATERIAL PROCESSING RATE

BSSP - FINISHED INVENTORY SHIPPING RATE

THE MAIN LEVELS IN PRODUCTION LINE "B"

BRMPL - FRESH RAW MATERIAL INVENTORY LEVEL

BRMPF - FROZEN RAW MATERIAL INVENTORY LEVEL

BIAP - FINISHED INVENTORY LEVEL

BPPPP - FINISHED GOODS SOLD TO DATE

THE MAIN AUXILARIES IN PRODUCTION LINE "B"

BORDY - FINISHED PRODUCT ORDER BALANCE

BFFI - COLD STORAGE SPACE AVAILABLE

BMAP - RAW MATERIAL AVAILABLE

BALP - PRODUCTION CAPACITY AVAILABLE FOR PROCESSING FRESH RAW MATERIAL

BFCAI - FREEZING CAPACITY AVAILABLE FOR PROCESSING FRESH RAW MATERIAL

BLLI - FREEZING CAPACITY AVAILABLE FOR FREEZING ROUND RAW MATERIAL

BALLP - PRODUCTION CAPACITY AVAILABLE FOR PROCESSING FROZEN RAW MATERIAL

BSAP - FREEZING CAPACITY AVAILABLE FOR PROCESSING FROZEN RAW MATERIAL

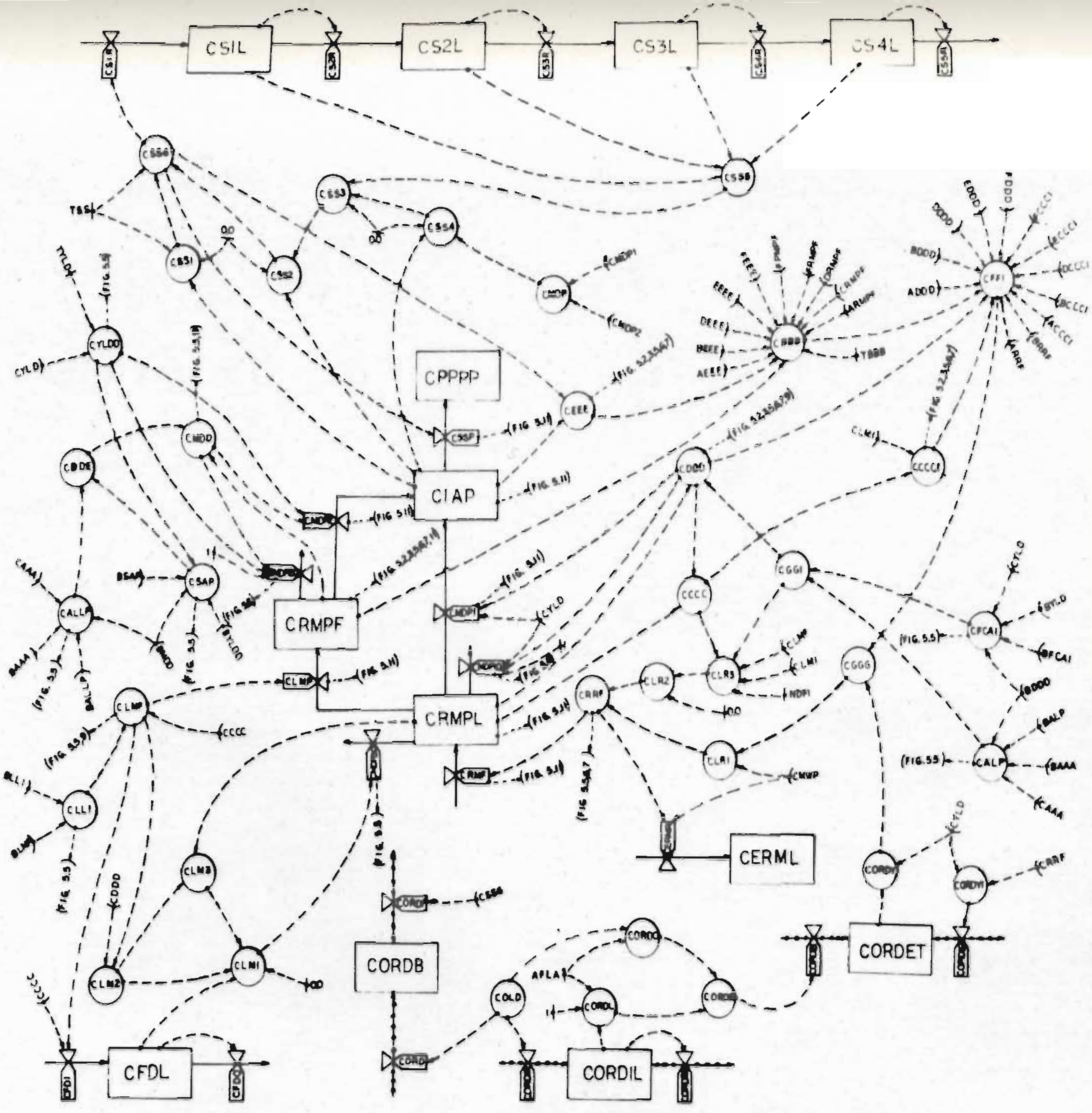


FIGURE 5.4 PRODUCTION LINE 'C'

THE MAIN RATES IN PRODUCTION LINE "C"

CRMF - RAW MATERIAL BUYING RATE

CMDP1 - FRESH RAW MATERIAL PROCESSING RATE

CFMP - RAW MATERIAL FREEZING RATE

CMDP2 - FROZEN RAW MATERIAL PROCESSING RATE

CSSP - FINISHED INVENTORY SHIPPING RATE

THE MAIN LEVELS IN PRODUCTION LINE "C"

CRMPL - FRESH RAW MATERIAL INVENTORY LEVEL

CRMPF - FROZEN RAW MATERIAL INVENTORY LEVEL

CIAP - FINISHED INVENTORY LEVEL

CPPPP - FINISHED GOODS SOLD TO DATE

THE MAIN AUXILIARIES IN PRODUCTION LINE "C"

CORDY - FINISHED PRODUCT ORDER BALANCE

CFFI - COLD STORAGE SPACE AVAILABLE

CRMP - RAW MATERIAL AVAILABLE

CALP - PRODUCTION CAPACITY AVAILABLE FOR PROCESSING FRESH RAW MATERIAL

CFCAI - FREEZING CAPACITY AVAILABLE FOR PROCESSING FRESH RAW MATERIAL

CLLI - FREEZING CAPACITY AVAILABLE FOR FREEZING ROUND RAW MATERIAL

CALLP - PRODUCTION CAPACITY AVAILABLE FOR PROCESSING FROZEN RAW MATERIAL

CSAP - FREEZING CAPACITY AVAILABLE FOR PROCESSING FROZEN RAW MATERIAL

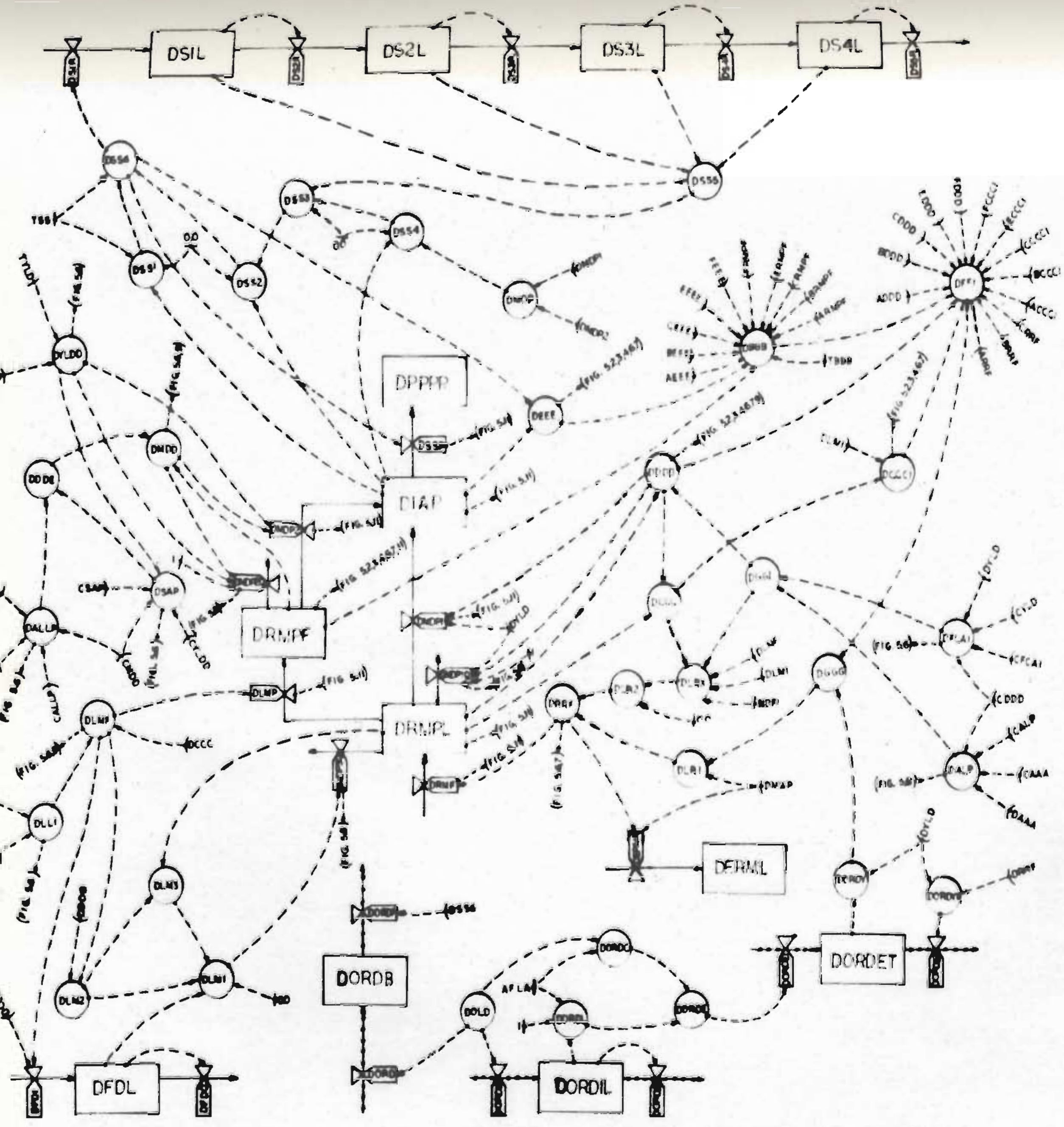


FIGURE 5.6 PRODUCTION LINE 'D'

THE MAIN RATES IN PRODUCTION LINE "D"

- DRMB - RAW MATERIAL BUYING RATE
- DROP1 - FRESH RAW MATERIAL PROCESSING RATE
- DFRP - RAW MATERIAL FREEZING RATE
- DROP2 - FROZEN RAW MATERIAL PROCESSING RATE
- DSSP - FINISHED INVENTORY SHIPPING RATE

THE MAIN LEVELS IN PRODUCTION LINE "D"

- DRMPL - FRESH RAW MATERIAL INVENTORY LEVEL
- DRMPF - FROZEN RAW MATERIAL INVENTORY LEVEL
- DIAP - FINISHED INVENTORY LEVEL
- DPPPP - FINISHED GOODS SOLD TO DATE

THE MAIN AUXILIARIES IN PRODUCTION LINE "D"

- DORDY - FINISHED PRODUCT ORDER BALANCE
- SPS1 - COLD STORAGE SPACE AVAILABLE
- DRMP - RAW MATERIAL AVAILABLE
- DALP - PRODUCTION CAPACITY AVAILABLE FOR PROCESSING FRESH RAW MATERIAL
- DFCA1 - FREEZING CAPACITY AVAILABLE FOR PROCESSING FRESH RAW MATERIAL
- DLL1 - FREEZING CAPACITY AVAILABLE FOR FREEZING ROUND RAW MATERIAL
- DALLP - PRODUCTION CAPACITY AVAILABLE FOR PROCESSING FROZEN RAW MATERIAL
- DSAP - FREEZING CAPACITY AVAILABLE FOR PROCESSING FROZEN RAW MATERIAL

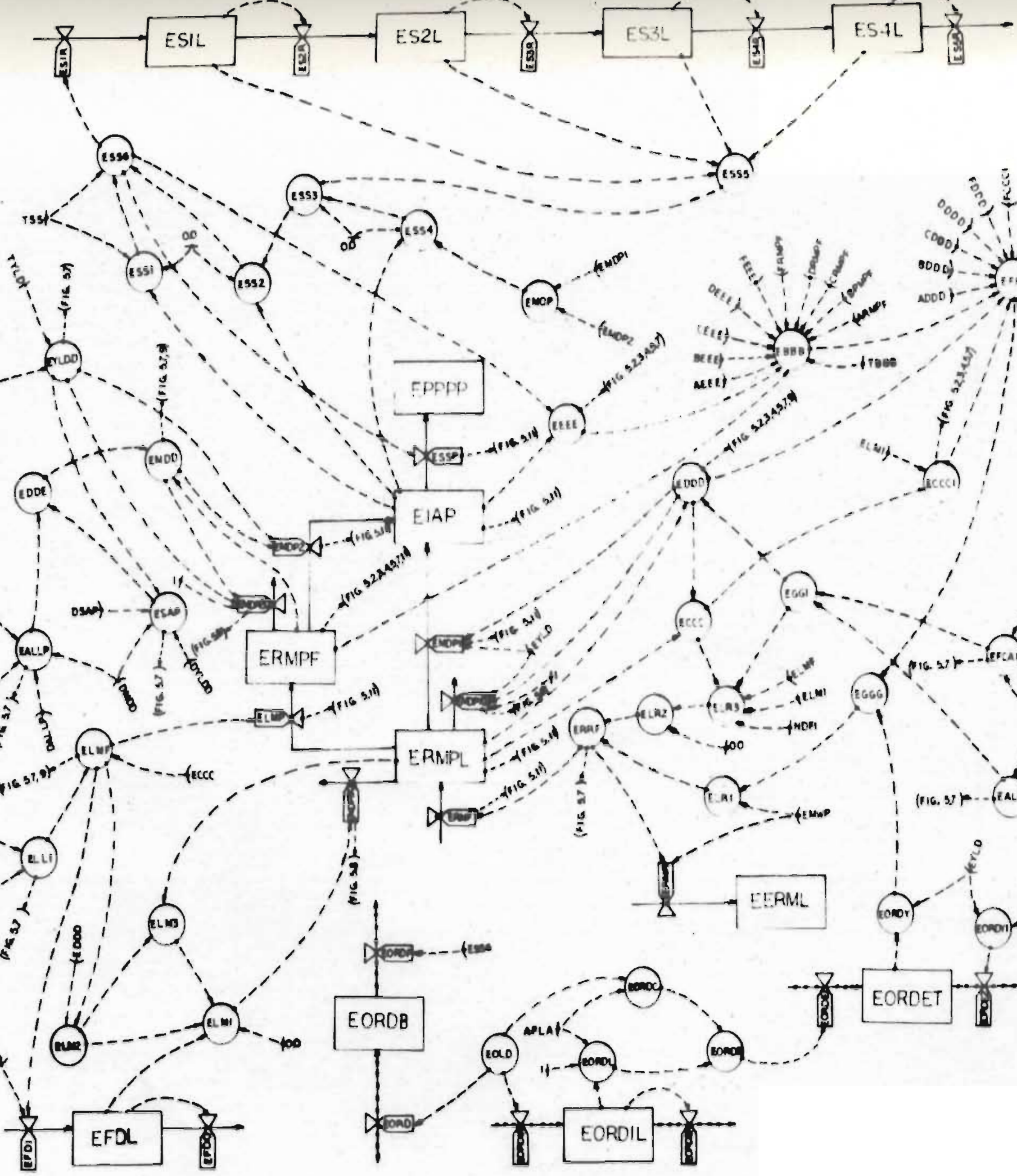


FIGURE 5.6 PRODUCTION LINE 'E'

THE MAIN RATES IN PRODUCTION LINE "E"

ERMW - RAW MATERIAL BUYING RATE

EMDP1 - FRESH RAW MATERIAL PROCESSING RATE

EFMP - RAW MATERIAL FREEZING RATE

EMDP2 - FROZEN RAW MATERIAL PROCESSING RATE

ESSP - FINISHED INVENTORY SHIPPING RATE

THE MAIN LEVELS IN PRODUCTION LINE "E"

ERMPL - FRESH RAW MATERIAL INVENTORY LEVEL

ERMPF - FROZEN RAW MATERIAL INVENTORY LEVEL

EIAP - FINISHED INVENTORY LEVEL

EPPPP - FINISHED GOODS SOLD TO DATE

THE MAIN AUXILARIES IN PRODUCTION LINE "E"

EORDY - FINISHED PRODUCT ORDER BALANCE

EFFI - COLD STORAGE SPACE AVAILABLE

ERMP - RAW MATERIAL AVAILABLE

EALP - PRODUCTION CAPACITY AVAILABLE FOR PROCESSING FRESH RAW MATERIAL

EFCAI - FREEZING CAPACITY AVAILABLE FOR PROCESSING FRESH RAW MATERIAL

ELLI - FREEZING CAPACITY AVAILABLE FOR FREEZING ROUND RAW MATERIAL

EALLP - PRODUCTION CAPACITY AVAILABLE FOR PROCESSING FROZEN RAW MATERIAL

ESAP - FREEZING CAPACITY AVAILABLE FOR PROCESSING FROZEN RAW MATERIAL

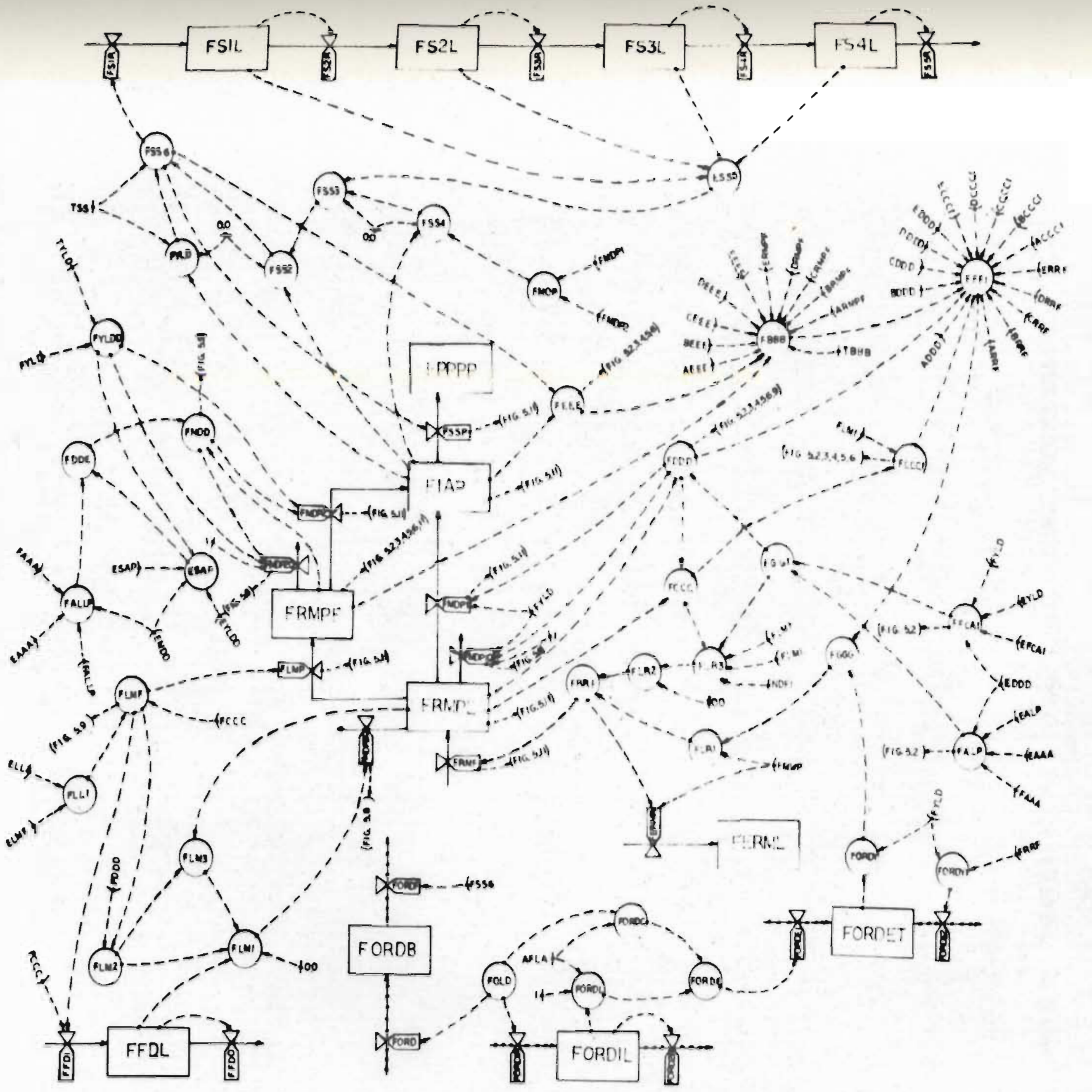


FIGURE 5.7 PRODUCTION LINE 'F'

THE MAIN RATES IN PRODUCTION LINE "F"

FRRF - RAW MATERIAL BUYING RATE

FRDP1 - FRESH RAW MATERIAL PROCESSING RATE

FFRP - RAW MATERIAL FREEZING RATE

FRDP2 - FROZEN RAW MATERIAL PROCESSING RATE

FSSP - FINISHED INVENTORY SHIPPING RATE

THE MAIN LEVELS IN PRODUCTION LINE "F"

FRMPL - FRESH RAW MATERIAL INVENTORY LEVEL

FRMPF - FROZEN RAW MATERIAL INVENTORY LEVEL

FIAP - FINISHED INVENTORY LEVEL

FPPPP - FINISHED GOODS SOLD TO DATE

THE MAIN AUXILARIES IN PRODUCTION LINE "F"

FORDY - FINISHED PRODUCT ORDER BALANCE

FFF1 - COLD SOTRAGE SPACE AVAILABLE

FRMP - RAW MATERIAL AVAILABLE

FALP - PRODUCTION CAPACITY AVAILABLE FOR PROCESSING FRESH RAW MATERIAL

FFCA1 - FREEZING CAPACITY AVAILABLE FOR PROCESSING FRESH RAW MATERIAL

FLL1 - FREEZING CAPACITY AVAILABLE FOR FREEZING ROUND RAW MATERIAL

FALLP - PRODUCTION CAPACITY AVAILABLE FOR PROCESSING FROZEN RAW MATERIAL

FSAP - FREEZING CAPACITY AVAILABLE FOR PROCESSING FROZEN RAW MATERIAL

The main level equations in production line "A" are:

- Fresh raw material inventory level (ARMPL)
- Frozen raw material inventory level (ARMPF)
- Finished inventory level (AIAP)

5.2.1.1 Raw Material Buying Rate (ARMF)

As was discussed earlier, the quantity of raw material bought daily is an important controlling factor in a processing plant. Since fish is perishable, when a fish plant manager overbuys his production capacity of raw material he is faced with spoilage while if he underbuys he is faced with not operating his plant at full capacity.

In the model, the equation for the quantity of raw material bought (ARMF) depends on the following assumptions:

- Cold storage space available (AFF1)
- Finished product order balance (AORDY)
- Raw material available (AMWP)
- Multiplier factor of the minimum of freezer and production capacities plus freezer capacity available for raw material freezing minus one day old raw material held in inventory (ALR3).

The minimum value of the above variables is the quantity selected for the amount of raw material to buy (ARMF).

The cold storage space available for the buying of raw material is represented by AFF1. Equation AFF1 consists of the total cold storage capacity of the plant (TBBB) minus all materials now held in cold storage. This includes all finished goods, raw material frozen in inventory plus today's quantities of fresh raw material being processed or frozen round. The cold storage space available equation for production line "B" (BFF1) differs from AFF1 in that the quantity of raw material bought for production line "A" (ARRF which equals ARMF) must be subtracted from AFF1 to give BFF1. Subsequently the cold storage space available equation for production line "C" (CFF1) is equal to BFF1 - BRRF. The other production lines follow a similar pattern.

The finished product order balance (AORDY) logic which is standard for all production lines is given in equations 730 to 890. Daily orders (AOLD) are continuously coming for production line "A" from which a forecasted order quantity (AORDE) is calculated for production scheduling. The forecasted technique incorporated uses an exponentially weighted average of the past data (further details on the exponentially weighted forecasting technique are given in Appendix "D").

The forecasted order quantity is calculated by multipling AOLD by a factor ALFA giving AORDC and multipling the most previous order quantity for AOLD by 1 - ALFA giving AORDL. AORDC and AORDL are added to give the forecasted daily order quantity (AORDE). These daily forecasted order quantities accumulate in a level (AORDET) which when divided by AYLD (the production line "A" yield) give the forecasted order quantity for the buying of raw material. This forecasted order quantity level (AORDET) is reduced by ARRF/AYLD when raw material is bought.

The raw material available for buying (AMWP) is the daily quantity of raw material for production line "A" that the fishermen bring to the plant.

As stated previously, ALR3 is a factor multiplier of the minimum of freezer and production capacities plus freezer capacity available for raw material freezing minus one day old raw material held in inventory, i.e.:

ALR3.K = NDFI * (AGG1.K + ALMF.K) - (ACCC.K - ALMFK -ALM1.K)

where:

NDFI = multiplying factor

AGG1.K = minimum of freezer and production capacities

ALMF.K = freezer capacity available from raw material freezing

ACCC.K - ALMF.K - ALM1.K = one day old raw material held in inventory.

Of the four assumptions made on the buying of raw material, ALR3 is the most critical and difficult to identify since it decides the rate of spoilage when there is an abundance of raw material available. This equation was selected since it takes a multiplier of the present production through-put of fresh raw material and subtracts from it the day old raw material held in inventory.

5.2.1.2 <u>Fresh Raw Material Processing Rate (AMDP1)</u>

The equation for the fresh raw material processing Rate (AMDP1) is dependant on:

- Plant production capacity (AALP)
- Plant freezer capacity (AFCA1)
- Fresh raw material inventory level (ARMPL)

The minimum of the above criteria is the quantity of raw material to be processed (ADDD) in any day. ADDD when multiplied by the processing yield (AYLD) gives the processing rate (AMDP1) in terms of finished product quantities.

The production planned for each production line is calculated in the following manner: If the total plant was allocated to any one production line, than the total maximum daily through-put for production line "A" (AALP) would be AAAA, the total maximum daily through-put for production line "B" (BALP) would be BAAA, etc. However, since, there are normally more than one production line working at the same time the fresh raw material is allocated by production line priority. To clarify how production capacity is distributed between the different lines, the individual production planned equations for the production lines will be discussed.

The production planned equation for production line "A" (AALP) is given as:

$$AALP.K = AAAA.K$$

The production planned equation for production line "B" (BALP) is given as:

$$BALP.K = \frac{(AALP.K - ADDD.K)}{AAAA.K} \quad (BAAA.K)$$

The production planned equation for production line "C" (CALP) is given as:

$$CALP.K = \frac{(BALP.K - BDDD.K)}{BAAA.K} \quad (CAAA.K)$$

The remaining production planned equations follow a similar pattern with the basic assumption being that once a higher priority production line has selected the quantity of raw material to be processed in any day, the next highest priority production line has access to the balance production capacity.

The plant freezer capacity is set up in a slightly different manner to production capacity. The total daily plant freezing capacity (TFVC) is allocated to each production line in the priority sequence until the freezing capacity has been exhausted.

The freezer capacity equation for production line "A" (AFCA1) is given as:

$$AFCA1.K = TFVC.K/AYLD.K$$

The freezer capacity equation for production line "B" (BFCA1) is given as:

BFCA1.K = (AFCA1.K - ADDD.K)*(AYLD.K)/BYLD.K

The freezer capacity equation for production line "C" (CFCA1) is given as:

CFCA1.K = (BFCA1.K - BDDD.K)*(BYLD.K)/CYLD.K

The remaining production lines follow a similar pattern.

The division by the applicable production line yield is necessary to maintain equation in the same units.

5.2.1.3 Raw Material Freezing Rate (AFNP)

As discussed previously, raw material is frozen only when there isn't sufficient processing capacity (AMDP1) for the fresh raw material held in inventory.

The freezing capacity available for the freezing of raw material follow the same logic as was presented in the discussion of the freezing of processed raw material. The production lines with the highest priority have first chance at the balance of freezing capacity.

5.2.1.4 Frozen Raw Material Processing Rate (AMDP2)

Frozen raw material is processed when there is a surplus in production capacity from fresh raw material processing and a surplus in freezing capacity from the freezing of raw material. The minimum of the production capacity available (AALLP.K) and the freezing capacity available (ASAP.K) is the processing capacity available for the processing of frozen raw material. The allocation of this processing capacity follow the same priority rules as discussed previously.

5.2.1.5 Finished Inventory Shipping Rate (ASSP)

The shipping rate of finished product from each production line is normally equal to TSS however if no processed goods have entered level AIAP for five (5) days than the balance of AIAP is shipped. The equations for deciding the shipping rate for production line "A" are given from numbers 530 to 720.

5.2.1.6 Fresh Raw Material Inventory Level (ARMPL)

The fresh raw material inventory level (ARMPL) is expressed by the following equation:

ARMPL.K = ARMPL.J + (DT)(ARMF.JK-(AMDP1.JK+AMDP1Q.JK+AFNP.JK+AMDP3Q.JK))

where:

ARMF represents raw material bought
AMDP1 represents fresh raw material processed
AMDP1Q represents waste raw material being sent to fish meal plant
AFNP represents raw material frozen
AMDP3Q represents spoiled raw material being sent to fish meal plant

This level does not hold raw material longer than two (2) days due to deterioration and reduction in quality. Within two days after raw material is bought, the raw material is either processed, frozen or sent to fish meal plant.

5.2.1.7 Frozen Raw Material Inventory Level (ARMPF)

The frozen raw material inventory level (ARMPF) gives the new frozen raw material inventory level in terms of its old value and the frozen raw material which have come in (AFNP) and the frozen raw material processed (AMDP2). This is expressed by the following equation:

ARMPF.K = ARMPF.J + (DT)(AFNP.JK-(AMDP2.JK + AMDP2Q.JK))

where:

AMDP2Q represent waste raw material being sent to fish meal plant

5.2.1.8 Finished Inventory Level (AIAP)

The finished inventory level (AIAP) is represented by the following equation:

AIAP.K = AIAP.J + (DT)((AMDP1.JK + AMDP2.JK) - ASSP.JK)

where:

AMDP1 represents fresh raw material processing rate.
AMDP2 represents frozen raw material processing rate
ASSP represents finished inventory shipping rate

5.2.1.9 Other Significant Levels

In comparing different model runs with different management policies, it will be helpful to know the outputs from the following levels;

AERML.K = AERML.J + (DT) (AERMR.JK - 0)

where:

AERML represents total raw material available to the processing plant for production line "A" during the year but was not bought because of processing restrictions.

APPPP.K = APPPP.J + (DT) (ASSP.JK - 0)

where:

APPPP represents total finished goods from production line "A" sold during the year.

5.2.2 Fish Meal Submodel (Figure 5.8)

The main rates and levels in the fish meal submodel (equations

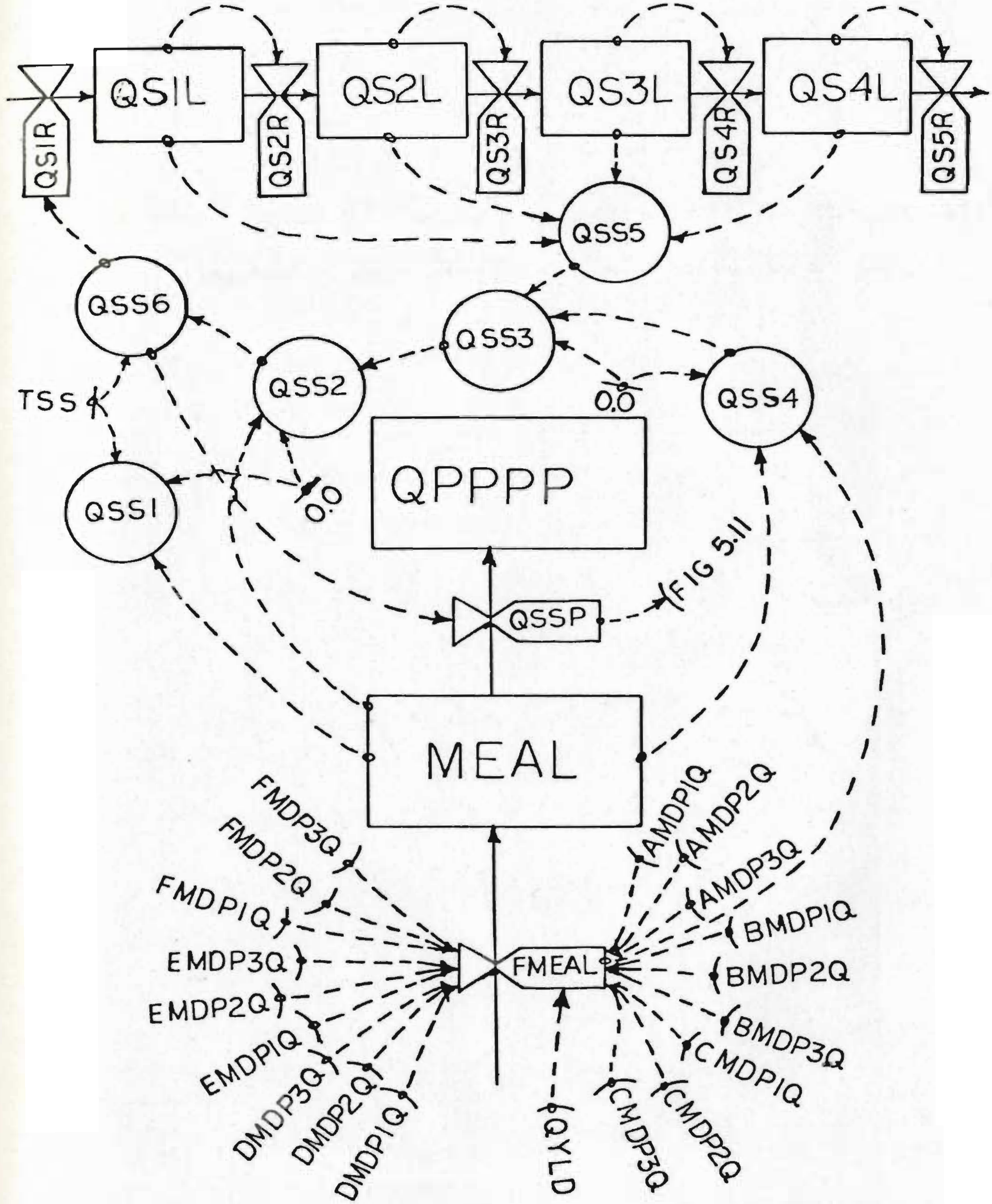


Figure 5.8 Fish Meal Submodel

5330 to 5600, Appendix "B") are:

- The processing rate of fish meal (FMEAL)
- The shipping rate for fish meal (QSSP)
- Fish meal inventory (MEAL)
- Total fish meal sold during the year (QPPPP)

The processing rate of fish meal depends totally on the quantity of waste raw material coming from the production lines. Since the processing of fish meal is done mechanically using very little labour, it is assumed that the fish meal plant is sufficiently large to handle all waste raw material without production delays.

The shipping rate for fish meal (QSSP) follows the same procedure as outlined earlier for finished inventory shipping rate (ASSP).

The fish meal inventory level (MEAL) gives the new fish meal inventory level in terms of its old value and the processed fish meal which have come in (FMEAL) and the fish meal shipped to the consumer (QSSP). This is expressed by the following equation

MEAL.K = MEAL.J + (DT) (FMEAL.JK - QSSP.JK)

The total fish meal sold during the year (QPPPP) is represented by the following equation

QPPPP.K = QPPPP.J + (DT) (QSSP.JK - 0)

5.2.3 Labour Employment Submodel (Figure 5.9)

The labour employment submodel (equations 5610 to 5760, Appendix "B") schedules the number of direct production line workers required daily. The basic assumptions are as follows:

- There is an endless supply of skilled labour available to the

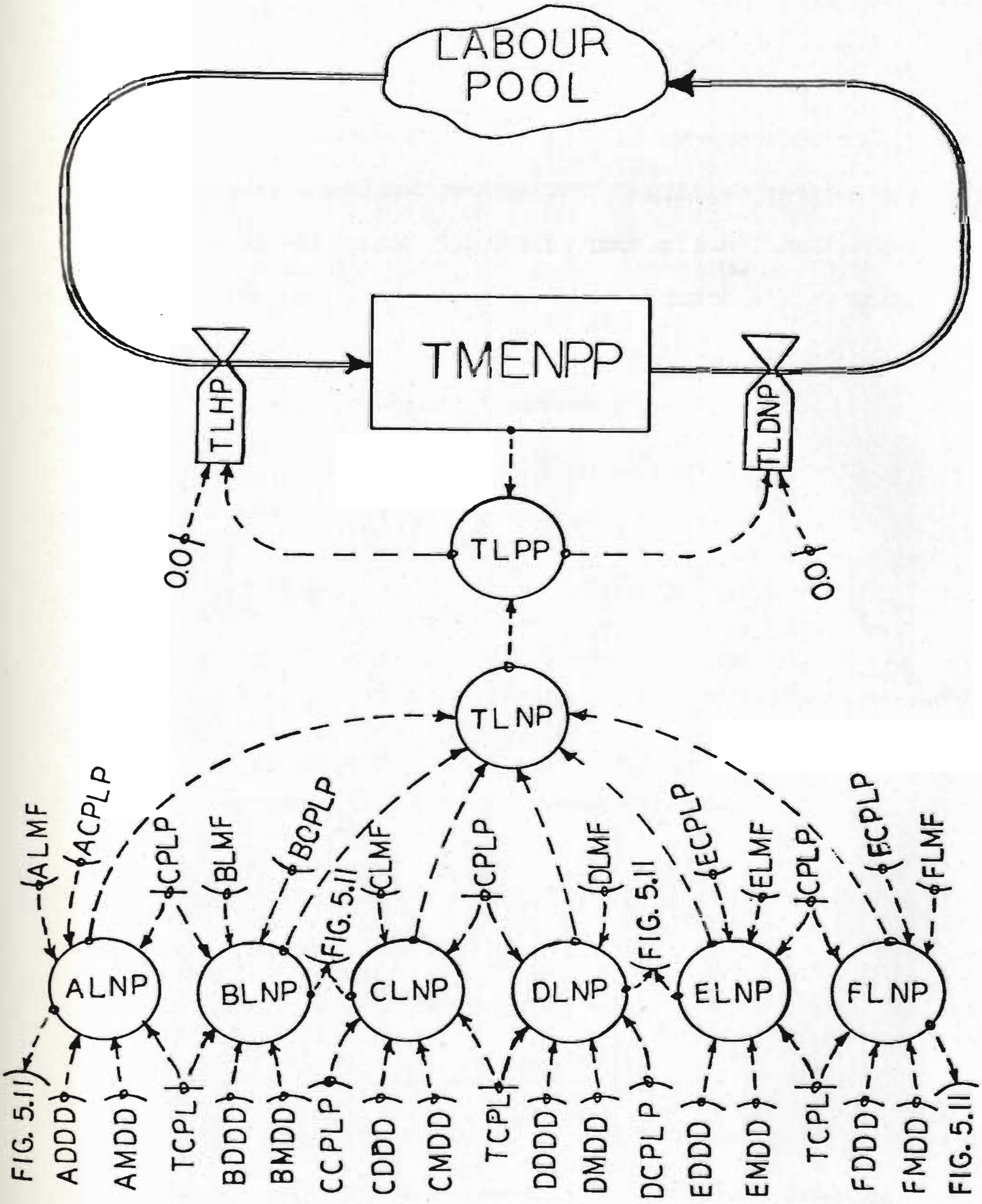


Figure 5.9 Labour Employment Submodel

processing plant.

- No advance dismissal or hiring notices required to be given to workers.
- Plant workers may change from one production line to another and still perform the degree of productivity required.

The number of direct production line workers required daily is determined by the scheduled production quantities and their associated labour productivity constants. For each production line the number of workers required is calculated individually. Since all production lines follow a similar logic, the labour required equation for production line "A" (ALNP) will be presented as an example.

ALNP.K = (AMDP1.JK/ACPLP.K)+(AMDP2.JK/(TCPL*ACPLP.K))+(AFNP.JK/CPLP.K)

where:

AMDP1	represents the fresh raw material processing rate
ACPLP	represents the labour productivity rate for fresh raw material processing
AMDP2	represents the frozen raw material processing rate
TCPL	represents the percentage of ACPLP for the processing of frozen raw material
AFNP	represents the raw material freezing rate
CPLP	represents the labour productivity rate for freezing raw material

The number of workers required for each production line are then accumulated and compared with the previous number of workers employed (TMENPP) to decide if additional workers have to be hired or dismissed.

5.2.4 Profit Margin per Species (Figure 5.1)

The profit margin per species is obtained by subtracting the unit direct cost of raw material, labour and packaging material from the unit selling price. The following is the profit margin equation for flounder:

MPHR.K = FPHR.K - ((RPHR.K/YHR.K)+(LCHR.K/LPHR.K)+VPHR.K)

where:

MPHR represents the unit profit margin for flounder, \$/LB
FPHR represents the unit finished product value, \$/LB
RPHR represents the unit raw material cost, \$/LB
YHR represents the unit finished product yield, %
LCHR represents the unit labour cost, \$/DAY
LPHR represents the unit labour productivity, LBS/DAYS
VPHR represents the unit packaging cost, \$/DAY

The equations for profit margin per species are from 5780 to 5840, Appendix "B".

5.2.5 Ranking of Profit Margin per Species (Figure 5.1)

The ranking of profit margins per species (equations 5850 to 6150, Appendix "B") is obtained by taking the maximum and minimum of the marginal profit of the species until the order priority has been obtained.

5.2.6 Species Input Variables (Figure 5.10)

As was discussed previously, there are six production lines. Each of these production lines may have different species inputs variables, namely:

- Raw material price, \$/LB
- Production capacity available, LBS/DAY
- Yield of finished product from raw material, %
- Labour productivity, LBS/MAN-DAY
- Finished product price, \$/LB
- Quantity of packaging material, LBS
- Cost of packaging material, \$/LB
- Raw material input, LBS
- Labour cost, \$/MAN-DAY
- Order input, LBS

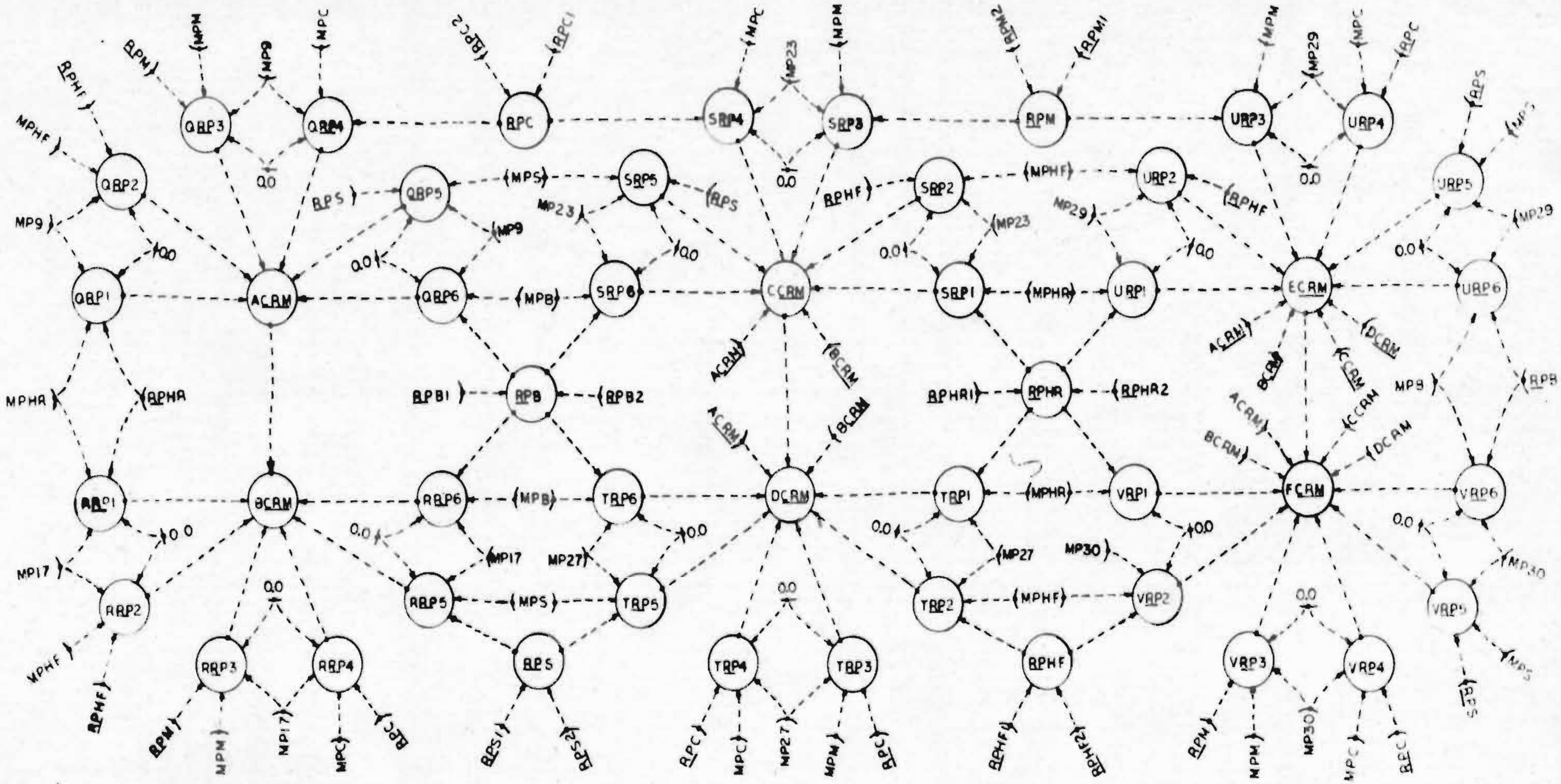


FIGURE 5.10 ALLOCATION OF RAW MATERIAL PRICE TO THE APPROPRIATE PRODUCTION LINE

To allocate the species input variables to the appropriate production line, equations 6160 to 11800, Appendix "B" were developed. The following equations present the logic for the allocation of the raw material price per pound to production line "A".

QRP1.K = CLIP(RPHR.K, 0, MPHR.K, MP9.K)
QRP2.K = CLIP(RPHF.K, 0, MPHF.K, MP9.K)
QRP3.K = CLIP(RPM.K, 0, MPM.K, MP9.K)
QRP4.K = CLIP(RPC.K, 0, MPC.K, MP9.K)
QRP5.K = CLIP(RPS.K, 0, MPS.K, MP9.K)
QRP6.K = CLIP(RPB.K, 0, MPB.K, MP9.K)

ACRM.K = QRP1.K + QRP2.K + QRP3.K + QRP4.K + QRP5.K = QRP6.K

where:

MP9 represents the species with the highest marginal profit

MPHR to MPB represents the marginal profit for each species

RPHR to RPB represents the raw material price per pound for each species

QRP1 equals RPHR if MPHR ≥ MP9 or equal 0 if MPHR < MP9

ACRM represents the raw material price per pound which will be allocated to production line "A"

Figure 5.10 which gives the flow logic for the allocation of Raw Material Price to the appropriate production line can be used to represent the following input variables by:

Replacing	RP	With	P & CRM	With	AAA	For	Production Capacity
"	RP	"	Y & CRM	"	YLD	"	Yield
"	RP	"	LP & CRM	"	CPLP	"	Labour Productivity
"	RP	"	FP & CRM	"	CFG	"	Finished Product Price
"	RP	"	QP & CRM	"	PGQC	"	Quantity of Packaging Material
"	RP	"	VP & CRM	"	CPG	"	Cost of Packaging Material
"	RP	"	TAB & CRM	"	MWP	"	Raw Material Input
"	RP	"	LC & CRM	"	CWR	"	Labour Cost
"	RP	"	O & CRM	"	OLD	"	Order Input

5.3 Economic Sector

The equations for the economic sector will be explained under the following areas:

- Total sales revenue
- Total direct packaging material cost
- Total raw material cost
- Total direct labour cost
- Inventory value
- Long term loan
- Short term financing
- Depreciation
- Overhead expenses
- Cash flow
- Profit and loss
- Liabilities
- Assets
- Economic & management performance ratios

5.3.1 Total Sales Revenue (Figure 5.11)

Sales revenue is the quantity of sales multiplied by the appropriate sales value per pound, equation 11820 to 12040, Appendix "B".

The total sales revenue equation is:

TRSP.K = AFGRP.K + BFGRP.K + CFGRP.K + DFGRP.K + EFGRP.K +
FFGRP.K + QFGRP.K

where:

AFGRP	represents	the	sales	revenue	from	production	line	"A"
BFGRP	"	"	"	"	"	"	"	"B"
CFGRP	"	"	"	"	"	"	"	"C"
DFGRP	"	"	"	"	"	"	"	"D"
EFGRP	"	"	"	"	"	"	"	"E"
FFGRP	"	"	"	"	"	"	"	"F"
QFGRP	"	"	"	"	"	fish meal		

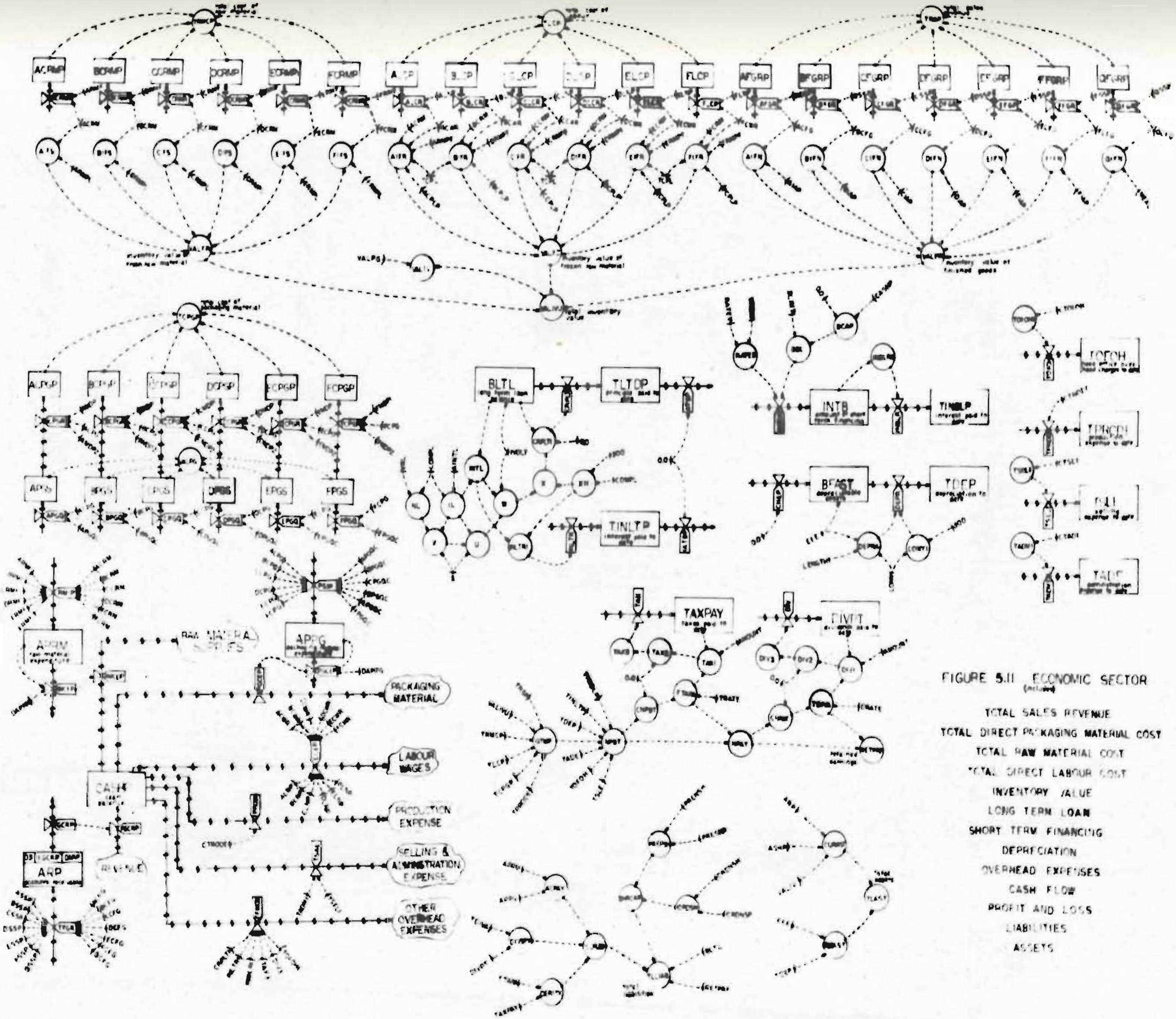


FIGURE 5.11 ECONOMIC SECTOR (included)

TOTAL SALES REVENUE
TOTAL DIRECT PACKAGING MATERIAL COST
TOTAL RAW MATERIAL COST
TOTAL DIRECT LABOUR COST
INVENTORY VALUE
LONG TERM LOAN
SHORT TERM FINANCING
DEPRECIATION
OVERHEAD EXPENSES
CASH FLOW
PROFIT AND LOSS
LIABILITIES
ASSETS

5.3.2 Total Direct Packaging Material Cost (Figure 5.11)

Packaging material cost is the daily finished product processing rate multiplied by the appropriate unit packaging material cost, equations 12050 to 12420, Appendix "B".

The total packaging material cost equation is:

TCPGP.K = ACPGP.K + BCPGP.K + CCPGP.K + DCPGP.K + ECPGP.K + FCPGP.K

where:

ACPGP	represents	the	packaging	material	cost	of	production	line	"A".
BCPGP	"	"	"	"	"	"	"	"	"B"
CCPGP	"	"	"	"	"	"	"	"	"C"
DCPGP	"	"	"	"	"	"	"	"	"D"
ECPGP	"	"	"	"	"	"	"	"	"E"
FCPGP	"	"	"	"	"	"	"	"	"F"

5.3.3 Total Direct Raw Material Cost (Figure 5.11)

Raw material cost is the quantity of raw material bought multiplied by the appropriate buying cost per pound, equations 12430 to 12620, Appendix "B".

The total raw material cost equation is:

TRMCP.K = ACRMP.K + BCRMP.K + CCRMP.K + DCRMP.K + ECRMP.K + FCRMP.K

where:

ACRMP	represents	the	total	raw	material	cost	for	production	line "A"
BCRMP	"	"	"	"	"	"	"	"	"B"
CCRMP	"	"	"	"	"	"	"	"	"C"
DCRMP	"	"	"	"	"	"	"	"	"D"
ECRMP	"	"	"	"	"	"	"	"	"E"
FCRMP	"	"	"	"	"	"	"	"	"F"

5.3.4 Total Direct Labour Cost (Figure 5.11)

Labour cost is the number of production workers employed daily multiplied by the appropriate labour cost per day, equations

12630 to 12820, Appendix "B".

The total labour cost equation is:

TLCP.K = ALCP.K + BLCP.K + CLCP.K + DLCP.K + ELCP.K + FLCP.K

where:

ALCP	represents	the	total	production	labour	cost	of	production	line	"A"
BLCP	"	"	"	"	"	"	"	"	"	"B"
CLCP	"	"	"	"	"	"	"	"	"	"C"
DLCP	"	"	"	"	"	"	"	"	"	"D"
ELCP	"	"	"	"	"	"	"	"	"	"E"
FLCP	"	"	"	"	"	"	"	"	"	"F"

5.3.5 Inventory Value (Figure 5.11)

The inventory value is the quantity of finished product, frozen raw material, fresh raw material and packaging material in stock multiplied by their appropriate unit value, equations 12830 to 13080, Appendix "B".

The inventory value equation is

VALIV.K = VALFIN.K + VALFZ.K + VALFR.K + VALPG.K

where:

VALFIN	represents	the	value	of	finished	product		inventory
VALFZ	"	"	"	"	frozen	raw	material	"
VALFR	"	"	"	"	fresh	"	"	"
VALPG	"	"	"	"	packaging		"	"

5.3.6 Long Term Loan (Figure 5.11)

The long term loan is set up with an initial loan of IVOLT which will be repaid over YRL years at a yearly interest rate of AINTL. The loan will be repaid in NL equal payments. The balance of the long term loan (BLTL), principle (TLTDP) and interest (TINLTP) paid on the bank loan to date are calculated daily. The long term loan equations are 13090 to 13290, Appendix "B".

5.3.7 Short Term Financing (Figure 5.11)

Short term financing is set up with a banking firm where the bank agrees to make plant operating payments up to BLIMIT, beyond BLIMIT the processing plant has to obtain other sources of funding. The bank charges the processing plant a daily interest rate of RATED on the borrowed amount (BCAP). The equations for this section are 13300 to 13400, Appendix "B".

5.3.8 Depreciation (Figure 5.11)

The total fixed assets EEE is depreciated over a life of LENGTT years at a fixed depreciating rate of DEPRA every COMY1 days, equations 13410 to 13490, Appendix "B". DEPRA is obtained from the following equation:

DEPRA.K = EEE / (LENGTT*COMY)

where:

EEE represents the total initial fixed assets value

LENGTT represents the number of years the fixed assets are to be depreciated

COMPY represents the number of time fixed assets are to be depreciated in a year

5.3.9 Overhead Expenses (Figure 5.11)

The overhead expenses are subdivided into four main areas, namely:

- Total overhead accrued from head office, equations 13500 to 13540, Appendix "B".
- Total production expense, equations 13550 to 13580, Appendix "B"
- Total selling expense, equations 13590 to 13630, Appendix "B"
- Total administration expense, equations 13640 to 13680, Appendix "B"

The overhead expense accrued from head office is the average monthly expense charged to the processing operation for the operation of a head office.

The production expense includes the average monthly expense of unemployment insurance; Canada Pension Plan, Workman's Compensation; light, heat and power; miscellaneous and collection expenses; indirect and unabsorbed labour; machinery, equipment and building repairs and maintenance; general trucking; municipal and water taxes; fire insurance; miscellaneous plant supplies; equipment hire; motor vehicle expense; engine room expense; cleaning expense; forklift expense; fish meal plant expense, wages, packaging, light, heat, power, etc.

The selling expense includes the average monthly expense from foreign exchange and commissions; outward freight, labour, duty etc.

The administrative expense includes the average monthly expense of staff salaries and wages; telephone and telegrams; printing, stationery and office supplies; travelling; legal fees; audit and accounting.

5.3.10 Cash Flow (Figure 5.11)

The equations for the cash flow section are 13690 to 13940, Appendix "B".

The important cash balance level (CASHP) is represented by the following equation:

$$\text{CASHP.K} = \text{CASHP.J} + (\text{DT})(\text{FGCRP.JK} - \text{RMCEP.JK} - \text{LCEP.JK} - \text{TPRDER.JK} - \text{TFIXOH.JK} - \text{PGCEP.JK} - \text{TSAE.JK})$$

where:

CASHP	represents cash balance
FGCRP	represents finished goods cash receipt rate
RMCEP	represents raw-material cash expenditure
LCEP	represents labour cash expenditure
TPRDER	represents production O/H cash expenditure
TSAE	represents selling and admin. O/H cash expenditure
PGCEP	represents packaging material cash expenditure
TFIXOH	represents other fixed O/H cash expenditure

TFIXOH includes:

CRPLT1	- principal on long term loan cash expenditures
INLTR1	- interest on long term loan cash expenditures
INBLR1	- interest on short term financing cash expenditures
TAX	- tax cash expenditure
DIV	- dividend cash expenditure
TOFOHI	- accrued overhead from head office expenditure

5.3.11 Profit and Loss (Figure 5.11)

Profit and loss gives the gross trading marginal profit, net profit before taxes, taxes, net profit after taxes, dividends and retained earnings, equations 13950 to 14170, Appendix "B".

The trading marginal profit equation is given as:

$$GTMP.K = TRSP.K + VALIVU - (TRMCP.K + TLCP.K + TCPGP.K + TPRODE.K)$$

where:

GTMP	represents the gross trading profit
TRSP	represents the total sales revenue
VALIVU	represents inventory value excluding packaging material
TRMCP	represents the total direct raw material cost
TLCP	represents the total direct labour cost
TCPGP	represents the total packaging material cost
TPRODE	represents the total production expense

The net profit before taxes equation is:

NPBT.K = GTMP.K - (TINBLP.K + TDEP.K +TOFOH.K + TADE.K + TINLTP.K + TSLE.K)

where:

NPBT	represents the net profit before taxes
GTMP	represents the gross trading profit
TINBLP	represents the total interest paid on short term financing
TDEP	represents the total depreciated value
TOFOH	represents the total overhead accrued from head office expense
TADE	represents the total administration expense
TINLTP	represents the total interest paid on long term loan
TSLE	represents the total selling expense

The year end taxes to be paid on the net profit before taxes are at a rate of TRATE. Since taxes are to be paid monthly on a fluctuating net profit before taxes, only a percentage (AMOUNT) of the actual tax rate (TRATE) is paid monthly with the appropriate tax adjustment (DERITX) made at the end of the year.

Dividends are paid quarterly on the net profit after taxes in the same manner that taxes are paid with the appropriate dividend adjustment (DIVSPY) made at the end of the year.

Subtracting dividends (TDIVA) from the net profit after taxes gives the retained earnings.

5.3.12 Liabilities (Figure 5.11)

The total liabilities include current liabilities, long term loan value outstanding, value of common and preference shares and retained earnings, equation 14180 to 14240, Appendix "B".

The current liabilities include accounts payable (raw material (APRM) and packaging material (APPG)) plus taxes and dividends not paid.

The equation for total liabilities is given as:

TLLIAB.K = CURLIB.K + BLTL.K + SHRCAP.K + RETPRF.K

where:

TLLIAB represents the total liabilities
CURLIB represents the current liabilities
BLTL represents the value of long term loan outstanding
SHRCAP represents the value of common and preference shares
RETPRF represents the value of retained earnings.

5.3.13 Assets (Figure 5.11)

The total assets include current assets and fixed assets, equations 14250 to 14280, Appendix "B".

The current assets is given by the following equation:

CURAST.K = ARP.K + CASHP.K + VALIV.K

where:

CURAST represents the value of current assets
ARP represents cash receivables
CASHP represents cash on hand or in bank
VALIV represents inventory value in stock.

The fixed assets are represented by BFAST.

5.3.14 Economic & Management Performance Ratios

The economic and management performance ratios are given in equations 15880 to 16040, Appendix "B", namely:

- the gross profit ratio (GPR)
- the operating ratio (OPR)
- the expense ratio (EXR)
- the net profit ratio (NPBTR)
- the return on capital ratio (ROCER)
- the return on total assets (ROTASR)

CHAPTER 6

INITIAL INPUT DATA, TESTING, EXECUTING AND ANALYSIS OF FISH PROCESSING MODEL

6.1 Model Input Data

The following input conditions of a typical Newfoundland in-shore fish processing plant as described in Chapter 5 is considered for computer modeling.

Table 6.1 contains data related to plant's processing capacities, labour productivity, yield, labour cost, raw material cost, packaged material cost and selling price. These parameters described are assumed to remain constant throughout a simulation run, however, they could be made stochastic if required.

- Plant cold storage capacity:	1,000,000 LBS.
- Plant freezer capacity:	100,000 LBS./DAY
- Daily labour productivity for freezing raw material using existing equipment (plate freezers):	10,000 LBS./MAN
- Labour productivity percentage when processing thawed raw material:	90%
- Additional yield drop when processing thawed raw material:	10%
- Normal finished product shipping rate:	20,000 LBS./DAY
- Monthly production expense:	$22,000
= Monthly head office expense:	$ 4,750
- Monthly selling expense:	$15,000
- Monthly administration expense:	$ 7,300
- Yearly corporation income tax rate on net profit before taxes:	49%
- Yearly dividend rate on net profit after taxes:	10%
- Yearly interest rate on long term loan:	10%
- Number of payments per year on long term loan:	2/YR.
- Life of long term loan:	35 YRS.
- Daily interest rate on short term financing:	10 3/4%
- Bank limit on short term financing:	$250,000

TABLE 6.1

INPUT DATA FOR COMPUTER MODEL

SPECIES	PACK TYPE	Plant Processing Capacity[1] (lbs/day)	Labour Productivity[2] (lb/man-day)	Yield[3] (%)	Labour Cost ($/day)	Raw Material Cost($/lb)	Package Material Cost($/lb)	Selling Price ($/lb)
FLOUNDER	Fillets 5 lb. Sello Wrap	40,000	410	22	32.00	0.12	0.06	0.96
HERRING	Butter-fly Fillets 16½ lb. Blocks	60,000	1300	45	32.00	0.06	0.05	0.41
MACKEREL	Round 40 lb. Boxes	80,000	1600	100	32.00	0.05	0.02	0.15
COD	Fillets 16½ lb. Blocks	60,000	640	33	32.00	0.135	0.05	1.00
SQUID	Round 40 lb. Boxes	80,000	1600	100	32.00	0.05	0.03	0.27
BLUEBERRIES	40 lb. Boxes	100,000	250	90	32.00	0.35	0.04	0.72
FISH MEAL				75				0.0025

1 Plant processing capacity is the plant's space allocated for the processing of each particular species pack type. The processing methods for each species were explained in Chapter 5.

2 Labour productivity is the average through-put of each species pack type per man per day, based on layout, methods used and the type of equipment.

3 Yield is the overall percentage of finished product obtained from each particular raw material supply.

4 Plant processing capacity, labour productivity and yield are average values which are assumed to remain constant, but could be varied in the model if required.

- Depreciable life of fixed assets: 15 YEARS
- Number of times fixed assets are depreciated in a year: 12

Raw material is supplied to the inshore plant according to the season and local environmental conditions. The daily raw material input for each species supplied to the model plant from January 1 to December 31 is given in equations 6620 to 7050, Appendix "B".

The daily market orders for finished goods inputed into the computer model are given in equations 11660 to 11800, Appendix "B".

The packaging material quantities inputed into the model which are dependent on the anticipated production quantities for each species are given in equations 9580 to 9630, Appendix "B".

The initial values of assets and liabilities at the beginning of the year are given in Table 6.2.

All of the above input data related to the operation of a Newfoundland inshore fish processing plant has been obtained from trade journals, newspapers, fish plant operators and sources affiliated with the fish processing industry.

6.2. Testing and Debugging of the Computer Model

The first test when any set of model equations is run on the Dynamo II_F computer program is actually done by the Dynamo compiler. It checks the equations for the kinds of logical errors that represent inconsistencies within the equation set itself, improper details in equation structure, and card-punching errors that represent impossible situations. These logical errors are printed out by the computer as error messages which normally are self-explanatory. Nevertheless, there

TABLE 6.2

INITIAL VALUE OF ASSETS AND LIABILITIES

AT THE BEGINNING OF THE YEAR

ASSETS

Value of fixed assets	$1,100,000
Cash	$150,000
Accounts receivable	-
Value of inventory	-
TOTAL ASSETS	$1,250,000

LIABILITIES

Share capital issued:		
500 preference shares	150.00/share = $ 75,000	
2500 ordinary shares	70.00/share = $175,000	$250,000
Long term loan		$1,000,000
Accounts payable		-
Retained earnings from previous year		-
Tax deferred		-
Dividends deferred		-
TOTAL LIABILITIES		$1,250,000

Note: - assumed to be zero in order to maintain the anonymity of the data source.

are occasions when the error that caused the message is an unusual one and the message is obscure.

Some typical logical error messages are as follows:

- DEFINED PREVIOUSLY: Two or more L, A, R or S equations exist for this quantity; only one such equation is permitted.
- NOT DEFINED: Self-explanatory. Message is followed by one or more lines explaining where the quantity appeared in the model. Quantity is made a constant with the value 0.
- NOT USED: Quantity was defined but never appeared on the right of any equation or any PRINT or PLOT card.
- PREVIOUSLY DEFINED: Quantity identified was previously defined. Balance of card ignored.
- TOO FEW: Self-explanatory; a right parenthesis was added where indicated, at a comma that doesn't appear to be related to a function. DYNAMO will add a right parenthesis in hope of matching the comma to a function.
- TOO MANY: Self-explanatory. The one identified was ignored.

Errors may or may not be fatal, when the model will not continue to be executed on the compiler. Errors such as mentioned above cause no difficulty; they are simply noted and the model continues to execute. Some examples of fatal errors are as follows:

- NAME EXPECTED: Equation cards should start with a quantity name.
- NOT OUTPUT SPECIFIED: No print or plot cards have been processed.
- FUNCTION ON LEFT OF =: Function name may appear only on right of equal sign.

A more complete listing of logical and fatal Dynamo error messages are given in "Dynamo II Users Manual" by Alexander L. Plugh III.

The second and most important test may be classified as "model behavior". Model behavior is testing the system dynamic model to see that it represents the actual system.

Further discussion on model behavior was presented earlier in Model Validity, Chapter 4.

The system dyanmic model of a Newfoundland inshore fish processing plant as presented in Chapter 5 was obtained by continuous testing and debugging of the model logic and behavior. To present all computer outputs related to the testing procedure would take countless numbers of pages, however, it would be appropriate to discuss descriptively some of the more important tests that were done.

The first tests were related to logical errors which were simple to correct. Once these logical errors were corrected, attention was focused on model behavior. Since the processing sector includes multi-feedback control loops, this of course was where most attention was placed.

The main feedback control loops were for buying and processing of the raw material. The approach for testing the model behavior in these two main feedback loops was to run the model for a relatively short time with the appropriate variables printed every DT. A number of short runs would be made having only one dominating variable in any computer run, with all other affecting variables sufficiently large so they would not be controlling factors in a particular run, however, still remaining within the model boundaries. To further clarify this methodology a simple example will be presented.

Let us assume that the model equations as presented in Appendix "B", were executed on the computer in their present form with the only change being in equation 15540 where the plant's freezer capacity TFVC1 is reduced from 100,000 to 5,000 LBS/DAY. Original with TFVC1 = 100,000 LBS./DAY, we noticed that the plant's freezer capacity was sufficiently large that it never became a controlling variable for the amount of fish processed on any particular day, however once it was changed to 5,000 LBS./DAY it became a controlling variable. If the model was run with this change for every DT the following should be observed.

- The sum total of all species processed on any given day will not be greater than 5,000 lbs.
- There will be no processing of lower priority species when the supply of higher priority species is greater than 5,000 lbs.
- The daily value of rates for the quantity of raw material bought, fresh raw material processed, frozen raw material processed and finished goods shipped for each species will never be negative.
- The value of inventory levels for each species will never be negative.
- The quantity of raw material spoiled because it was held as fresh raw material for longer than 2 days will be zero.
- The restrictions on the buying and processing of raw material for product "A" were met before any excess freezer capacity was allocated to subsequent products.
- A particular quantity of raw material follows the pattern of first being bought, then processed and later sold.
- The total assets equal the total liabilities for each DT.

As can be seen from the above example, by making one variable a controlling variable for one complete computer run, the inadequacies in the model can more readily be identified. Once this approach has been used for testing model reaction to different variables which are made controlling variables, then the model may be tested for varying controlling parameters. This is to say that at time 5, raw material may be a controlling variable.

Another method that is often very useful when building a complex feedback computer model is to build the model in stages with each particular stage tested prior to being connected to other stages.

6.3 Execution of the Model on Dynamo II_F

6.3.1 Model Spec, Print and Plot Cards

There are four quantities that specify the essential parameters of a simulation run:

- DT the interval of TIME between TIME J and TIME K
- LENGTH the value of TIME when the run is to be terminated
- PRTPER the interval of TIME between each print-out of the the results
- PLTPER the interval of TIME between each plot output of the results

The card that specifies these parameters is the SPEC card. The SPEC card for the Newfoundland fish processing model, equation 16050, Appendix "B", is given as:

SPEC DT = 1/LENGTH = 300/PRTPER = 6/PLTPER = 10

where TIME = 0 represents January 1st. and TIME = 300 represents December 31st. The units of TIME are days.

The print cards are given in equations 16060 to 16190, Appendix "B". The first print card specifies that in the first column the variable AFGRP will be printed. The number previous to the closed parenthesis specifies the column this particular variable is to be printed in the print-out of the results, in this particular case AFGRP is to be printed out in column 1. The remainder of equation 19060 and 19190 are likewise specified, with the initial X in equation 19061 identifying it as a continuation of the preceding card.

The plot cards, equations 16200 to 16210, Appendix "B", indicates several graphs of variables versus time. The maximum of 10 variables are permitted on any one plot. The name of the variable is specified and the symbol which is to be used for indicating that variable. When the plotting scales are not indicated, DYNAMO II_F will automatically scale to ensure that the width of the page is effectively used and that the full range of the variable falls on the plotted page.

6.3.2 Computer Outputs

Tables 6.3 and 6.4 give the DYNAMO II_F print-out and plot output for the Newfoundland fish processing model equations, as presented in Appendix "B". The model was simulated on IBM - 370/158 computer.

Table 6.3 presents the model from an economic viewpoint while Table 6.4 presents the model from its production viewpoint. The computer results for each case are given every 6 days to reduce the number of pages.

TABLE 6.3

COMPUTER PRINT-OUT FOR THE ECONOMIC VIEWPOINT OF THE NEWFOUNDLAND INSHORE

FISH PROCESSING MODEL AS PRESENTED IN APPENIDIX "B"

RUN-BASIC FISH PROCESSI MODEL OF A NFLD INSHORE FREEZER PLANT

TIME	AFGRP	ACRMP	ALCP	ACPGP	TRSP	GTMP	NPBT	SHRCAP	EEE	MPHR	GPR
	BFGRP	BCRMP	BLCP	BCPGP	VALIVU	TINBLP	TTAXA	BLTL	TDEP	MPHF	OPR
	CFGRP	CCRMP	CLCP	CCPGP	TRMCP	TDEP	TDIVA	RETPRF	DFAST	MPM	EXR
	DFGRP	DCRMP	DLCP	DCPGP	TLCP	TOFOH	RETPRF	ACPAY	CASHP	MPC	NPBTR
	EFGRP	ECRMP	ELCP	ECPGP	TCPGP	TADE		DERITX	ARP	MPS	ROCER
	FFGRP	FCRMP	FLCP	FCPGP	TPRODE	TINLTP		DIVSPY	VALIV	MPB	ROTASR
	QFGRP	TRMCP	TLCP	TCPGP	GTMP	TSLE		CURLIB	CURAST		
	TRSP					NPBT		TLLIAB	TLAST		
- - - - - - - - -											
E+00	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+00	E+03	E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E-03	E+00
	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03		E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03		E+00	E+03	E+00	E+00
	E+00	E+03	E+03	E+03	E+03	E+03		E+03	E+03		
	E+03					E+03		E+03	E+03		
- - - - - - - - -											

TABLE 6.3 Continued

.0	.00	.00	.000	.000	.0	.00	.00	250.00	1100.0	.27650	.0000
	.00	.00	.000	.000	.00	.0	.00	1000.0	.000	.20205	.0000
	.00	.00	.000	.000	.00	.000	.000	.00	1100.0	60.000	.0000
	.00	.000	.000	.000	.00	.000	.00	.000	150.00	.49091	.000
	.00	.00	.000	.000	.00	.000		.000	.00	.17000	.0000
	.00	.000	.000	.000	.00	.000		.0	.00	.16311	.00000
	.0	.00	.00	.00	.00	.00		.000	150.00		
	.0					.00		1250.0	1250.0		
- - - - - - - - -											
6.	.00	.00	.000	.000	.0	.00	.00	250.00	1100.0	.27650	.0000
	.00	.00	.000	.000	.00	.0	.00	1000.0	.000	.20205	.0000
	.00	.00	.000	.000	.00	.000	.000	.00	1100.0	60.000	.0000
	.00	.000	.000	.000	.00	.000	.00	.000	150.00	.49091	.000
	.00	.00	.000	.000	.00	.000		.000	.00	.17000	.0000
	.00	.000	.000	.000	.00	.000		.0	.00	.16311	.00000
	.0	.00	.00	.00	.00	.00		.000	150.00		
	.0					.00		1250.0	1250.0		
- - - - - - - - -											
12.	.00	.00	.000	.000	.0	.00	.00	250.00	1100.0	.27650	.0000
	.00	.00	.000	.000	.00	.0	.00	1000.0	.000	.20205	.0000
	.00	.00	.000	.000	.00	.000	.000	.00	1100.0	60.000	.0000
	.00	.000	.000	.000	.00	.000	.00	.000	150.00	.49091	.000
	.00	.00	.000	.000	.00	.000		.000	.00	.17000	.0000
	.00	.000	.000	.000	.00	.000		.0	.00	.16311	.00000
	.0	.00	.00	.00	.00	.00		.000	150.00		
	.0					.00		1250.0	1250.0		
- - - - - - - - -											

TABLE 6.3 Continued

18.	.00	.00	.000	.000	.0	.00	.00	250.00	1100.0	.27650	.0000
	.00	.00	.000	.000	.00	.0	.00	1000.0	.000	.20205	.0000
	.00	.00	.000	.000	.00	.000	.000	.00	1100.0	60.000	.0000
	.00	.000	.000	.000	.00	.000	.00	.000	150.00	.49091	.000
	.00	.00	.000	.000	.00	.000		.000	.00	.17000	.0000
	.00	.000	.000	.000	.00	.000		.0	.00	.16311	.00000
	.0	.00	.00	.00	.00	.00		.000	150.00		
	.0					.00		1250.0	1250.0		
- - - - - - - -											
24.	.00	.00	.000	.000	.0	-22.00	-55.16	250.00	1100.0	.27650	-.0002
	.00	.00	.000	.000	.00	.0	.00	1000.0	6.111	.20205	.0002
	.00	.00	.000	.000	.00	6.111	.000	-55.16	1093.9	60.000	.0003
	.00	.000	.000	.000	.00	4.750	-55.16	.000	100.95	.49091	-.001
	.00	.00	.000	.000	.00	7.300		.000	.00	.17000	-.5464
	.00	.000	.000	.000	22.00	.000		.0	.00	.16311	-.04617
	.0	.00	.00	.00	-22.00	15.00		.000	100.95		
	.0					-55.16		1194.8	1194.8		
- - - - - - - -											
30.	.00	.00	.000	.000	.0	-22.00	-55.16	250.00	1100.0	.27650	-.0002
	.00	.00	.000	.000	.00	.0	.00	1000.0	6.111	.20205	.0002
	.00	.00	.000	.000	.00	6.111	.000	-55.16	1093.9	60.000	.0003
	.00	.000	.000	.000	.00	4.750	-55.16	.000	100.95	.49091	-.001
	.00	.00	.000	.000	.00	7.300		.000	.00	.17000	-.5464
	.00	.000	.000	.000	22.00	.000		.0	.00	.16311	-.04617
	.0	.00	.00	.00	-22.00	15.00		.000	100.95		
	.0					-55.16		1194.8	1194.8		
- - - - - - - -											

TABLE 6.3 Continued

36.	.00	.00	.000	.000	.0	-22.00	-55.16	250.00	1100.0	.27650	-.0002
	.00	.00	.000	.000	.00	.0	.00	1000.0	6.111	.20205	.0002
	.00	.00	.000	.000	.00	6.111	.000	-55.16	1093.9	60.000	.0003
	.00	.000	.000	.000	.00	4.750	-55.16	.000	100.95	.49091	-.001
	.00	.00	.000	.000	.00	7.300		.000	.00	.17000	-.5464
	.00	.000	.000	.000	22.00	.000		.0	.00	.16311	-.04617
	.0	.00	.00	.00	-22.00	15.00		.000	100.95		
	.0					-55.16		1194.8	1194.8		
- - - - - - - - -											
42.	.00	.00	.000	.000	.0	-22.00	-55.16	250.00	1100.0	.27650	-.0002
	.00	.00	.000	.000	.00	.0	.00	1000.0	6.111	.20205	.0002
	.00	.00	.000	.000	.00	6.111	.000	-55.16	1093.9	60.000	.0003
	.00	.000	.000	.000	.00	4.750	-55.16	.000	100.95	.49091	-.001
	.00	.00	.000	.000	.00	7.300		.000	.00	.17000	-.5464
	.00	.000	.000	.000	22.00	.000		.0	.00	.16311	-.04617
	.0	.00	.00	.00	-22.00	15.00		.000	100.95		
	.0					-55.16		1194.8	1194.8		
- - - - - - - - -											
48.	.00	.00	.000	.000	.0	-22.00	-55.16	250.00	1100.0	.27650	-.0002
	.00	.00	.000	.000	.00	.0	.00	1000.0	6.111	.20205	.0002
	.00	.00	.000	.000	.00	6.111	.000	-55.16	1093.9	60.000	.0003
	.00	.000	.000	.000	.00	4.750	-55.16	.000	79.70	.49091	-.001
	.00	.00	.000	.000	.00	7.300		.000	.00	.17000	-.5464
	.00	.000	.000	.000	22.00	.000		.0	21.25	.16311	-.04617
	.0	.00	.00	.00	-22.00	15.00		.000	100.95		
	.0					-55.16		1194.8	1194.8		
- - - - - - - - -											

TABLE 6.3 Continued

54.	.00	.00	.000	.000	.0	-43.58	-109.91	250.00	1100.0	.27650	-.0005
	.00	.00	.000	.000	.67	.0	.00	1000.0	12.222	.20205	.0005
	.00	.16	.067	.020	.16	12.222	.000	-109.91	1087.8	60.000	.0006
	.00	.000	.000	.000	.07	9.500	-109.91	.109	30.53	.49091	-.001
	.00	.00	.000	.000	.02	14.600		.000	.00	.17000	-2.0964
	.00	.000	.000	.000	44.00	.000		.0	21.90	.16311	-.09639
	.0	.16	.07	.02	-43.58	30.00		.109	52.43		
	.0					-109.91		1140.2	1140.2		
60.	.00	.00	.000	.000	.0	-40.79	-107.11	250.00	1100.0	.27650	-.0005
	.00	.00	.000	.000	6.55	.0	.00	1000.0	12.222	.20205	.0005
	.00	1.96	.806	.573	1.96	12.222	.000	-107.11	1087.8	60.000	.0006
	.00	.000	.000	.000	.81	9.500	-107.11	.436	28.32	.49091	-.001
	.00	.00	.000	.000	.57	14.600		.000	.00	.17000	-1.9282
	.00	.000	.000	.000	44.00	.000		.0	27.23	.16311	-.09368
	.0	1.96	.81	.57	-40.79	30.00		.436	55.55		
	.0					-107.11		1143.3	1143.3		
66.	.00	.00	.000	.000	8.2	-35.42	-101.75	250.00	1100.0	.27650	-4.2939
	.00	.00	.000	.000	10.26	.0	.00	1000.0	12.222	.20205	5.2939
	8.20	5.73	2.349	1.861	5.73	12.222	.000	-101.75	1087.8	60.000	6.5576
	.00	.000	.000	.000	2.35	9.500	-101.75	.764	23.34	.49091	-12.333
	.00	.00	.000	.000	1.86	14.600		.000	8.25	.17000	-1.6615
	.00	.000	.000	.000	44.00	.000		.0	29.65	.16311	-.08855
	50.0	5.73	2.35	1.86	-35.42	30.00		.764	61.24		
	8.2					-101.75		1149.0	1149.0		

TABLE 6.3 Continued

72.	.00	.00	.000	.000	24.7	-27.60	-93.92	250.00	1100.0	.27650	-1.1174
	.00	.00	.000	.000	11.74	.0	.00	1000.0	12.222	.20205	2.1174
	24.60	11.45	4.699	3.886	11.45	12.222	.000	-93.92	1087.8	60.000	2.1903
	.00	.000	.000	.000	4.70	9.500	-93.92	1.091	-31.35	.49091	-3.803
	.00	.00	.000	.000	3.89	14.600		.000	21.64	.17000	-1.3535
	.00	.000	.000	.000	44.00	.000		.0	79.10	.16311	-.08117
	100.0	11.45	4.70	3.89	-27.60	30.00		1.091	69.39		
	24.7					-93.92		1157.2	1157.2		
- - - - - - - - -											
78.	.00	.10	.038	.000	41.2	-48.78	-148.29	250.00	1100.0	.27650	-1.1825
	.00	.05	.030	.000	7.91	22.6	.00	1000.0	18.333	.20205	2.1825
	41.00	18.00	7.384	6.340	18.15	18.333	.000	-148.29	1081.7	60.000	1.9678
	.00	.000	.000	.000	7.45	14.250	-148.29	1.241	-80.53	.49091	-3.595
	.00	.00	.000	.000	6.34	21.900		.000	29.00	.17000	-6.9656
	.00	.000	.000	.000	66.00	.000		.0	72.82	.16311	-.13444
	250.0	18.15	7.45	6.34	-48.78	45.00		1.241	21.29		
	41.2					-148.29		1103.0	1103.0		
- - - - - - - - -											
84.	.00	2.91	1.077	.266	65.9	-28.37	-127.88	250.00	1100.0	.27650	-.4302
	.00	1.29	.841	.107	21.58	22.6	.00	1000.0	18.333	.20205	1.4302
	65.60	24.54	10.069	8.795	28.74	18.333	.000	-127.88	1081.7	60.000	1.2308
	.00	.000	.000	.000	11.99	14.250	-127.88	2.141	-79.87	.49091	-1.939
	.00	.00	.000	.000	9.17	21.900		.000	38.81	.17000	-3.0019
	.00	.000	.000	.000	66.00	.000		.0	83.66	.16311	-.11374
	350.0	28.74	11.99	9.17	-28.37	45.00		2.141	42.60		
	65.9					-127.88		1124.3	1124.3		
- - - - - - - - -											

TABLE 6.3 Continued

90.	.00	9.45	3.499	.990	82.5	-20.65	-120.15	250.00	1100.0	.27650	-.2501
	.00	4.20	2.734	.396	39.16	22.6	.00	1000.0	18.333	.20205	1.2501
	82.00	31.09	12.754	11.249	44.74	18.333	.000	-120.15	1081.7	60.000	.9833
	.00	.000	.000	.000	18.99	14.250	-120.15	3.041	-83.86	.49091	-1.456
	.00	.00	.000	.000	12.63	21.900		.000	37.31	.17000	-2.3458
	.00	.000	.000	.000	66.00	.000		.0	97.78	.16311	-.10606
	550.0	44.74	18.99	12.63	-20.65	45.00		3.041	51.22		
	82.5					-120.15		1132.9	1132.9		
- - - - - - - - -											
96.	20.00	19.72	7.305	2.170	127.3	-13.01	-112.52	250.00	1100.0	.27650	-.1022
	.00	8.78	5.709	.869	36.97	22.6	.00	1000.0	18.333	.20205	1.1022
	106.60	37.63	15.439	13.703	66.14	18.333	.000	-112.52	1081.7	60.000	.6374
	.00	.000	.000	.000	28.45	14.250	-112.52	3.941	-92.76	.49091	-.884
	.00	.00	.000	.000	16.74	21.900		.000	61.04	.17000	-1.8831
	.00	.000	.000	.000	66.00	.000		.0	91.47	.16311	-.09858
	750.0	66.14	28.45	16.74	-13.01	45.00		3.941	59.75		
	127.3					-112.52		1141.4	1141.4		
- - - - - - - - -											
102.	60.00	32.18	11.919	3.680	203.2	-2.61	-136.02	250.00	1100.0	.27650	-.0128
	19.20	14.32	9.315	1.474	33.50	773.9	.00	1000.0	24.444	.20205	1.0128
	123.00	44.18	18.124	16.157	90.68	24.444	.000	-136.02	1075.6	60.000	.5362
	.00	.000	.000	.000	39.36	19.000	-136.02	4.091	-147.02	.49091	-.669
	.00	.00	.000	.000	21.31	29.200		.000	106.09	.17000	-3.1997
	.00	.000	.000	.000	88.00	.000		.0	83.43	.16311	-.12166
	1050.0	90.68	39.36	21.31	-2.61	60.00		4.091	42.51		
	203.2					-136.02		1118.1	1118.1		
- - - - - - - - -											

Table 6.3 Continued

108.	80.00	44.64	16.533	5.202	248.1	5.99	-127.43	250.00	1100.0	.27650	.0241
	19.20	19.87	12.921	2.084	37.15	773.9	.00	1000.0	24.444	.20205	.9759
	147.60	50.67	20.787	18.612	115.17	24.444	.000	-127.43	1075.6	60.000	.4391
	.00	.000	.000	.000	50.24	19.000	-127.43	4.037	-137.11	.49091	-.514
	.00	.00	.000	.000	25.90	29.200		.000	105.66	.17000	-2.4962
	.00	.000	.000	.000	88.00	.000		.0	82.50	.16311	-.11311
	1350.0	115.17	50.24	25.90	5.99	60.00		4.037	51.05		
	248.1					-127.43		1126.6	1126.6		
- - - - - - - - -											
114.	120.00	57.10	21.147	6.725	324.0	44.21	-89.21	250.00	1100.0	.27650	.1364
	38.40	25.41	16.527	2.693	37.01	773.9	.00	1000.0	24.444	.20205	.8636
	164.00	55.74	22.867	20.636	138.25	24.444	.000	-89.21	1075.6	60.000	.3363
	.00	.000	.000	.000	60.54	19.000	-89.21	3.709	-115.60	.49091	-.275
	.00	.00	.000	.000	30.05	29.200		.000	126.35	.17000	-1.0029
	.00	.000	.000	.000	88.00	.000		.0	78.20	.16311	-.07661
	1650.0	138.25	60.54	30.05	44.21	60.00		3.709	88.95		
	324.0					-89.21		1164.5	1164.5		
- - - - - - - - -											
120.	140.00	69.56	25.761	8.248	352.5	39.87	-93.55	250.00	1100.0	.27650	.1131
	38.40	30.95	20.133	3.303	38.24	773.9	.00	1000.0	24.444	.20205	.8869
	172.20	58.85	24.143	21.925	159.36	24.444	.000	-93.55	1075.6	60.000	.3091
	.00	.000	.000	.000	70.04	19.000	-93.55	3.382	-88.72	.49091	-.265
	.00	.00	.000	.000	33.48	29.200		.000	96.98	.17000	-1.1100
	.00	.000	.000	.000	88.00	.000		.0	76.01	.16311	-.08066
	1900.0	159.36	70.04	33.48	39.87	60.00		3.382	84.28		
	352.5					-93.55		1159.8	1159.8		
- - - - - - - - -											

126.	180.00	82.01	30.375	9.770	420.1	50.96	-116.71	250.00	1100.0	.27650	.1213
	57.60	36.50	23.738	3.913	34.25	1860.8	.00	1000.0	30.556	.20205	.8787
	180.40	59.99	24.613	22.477	178.51	30.556	.000	-116.71	1069.4	60.000	.3264
	.00	.000	.000	.000	78.73	23.750	-116.71	3.055	-111.37	.49091	-.278
	.00	.00	.000	.000	36.16	36.500		.000	108.93	.17000	-1.7443
	.00	.000	.000	.000	110.00	.000		.0	69.34	.16311	-.10270
	2100.0	178.51	78.73	36.16	50.96	75.00		3.055	66.90		
	420.1					-116.71		1136.3	1136.3		
- - - - - - - - -											
132.	220.00	94.47	34.989	11.293	464.4	62.98	-104.69	250.00	1100.0	.27650	.1356
	57.60	42.04	27.344	4.523	30.37	1860.8	.00	1000.0	30.556	.20205	.8644
	184.48	59.99	24.613	22.498	196.51	30.556	.000	-104.69	1069.4	60.000	.2953
	.00	.000	.000	.000	86.95	23.750	-104.69	3.000	-82.98	.49091	-.225
	.00	.00	.000	.000	38.31	36.500		.000	98.55	.17000	-1.3273
	.00	.000	.000	.000	110.00	.000		.0	63.30	.16311	-.09116
	2300.0	196.51	86.95	38.31	62.98	75.00		3.000	78.87		
	464.4					-104.69		1148.3	1148.3		
- - - - - - - - -											
138.	240.00	106.93	39.603	12.815	503.8	75.07	-92.60	250.00	1100.0	.27650	.1490
	76.80	47.59	30.950	5.133	31.41	1860.8	.00	1000.0	30.556	.20205	.8510
	184.48	59.99	24.613	22.498	214.51	30.556	.000	-92.60	1069.4	60.000	.2722
	.00	.000	.000	.000	95.17	23.750	-92.60	3.000	-61.09	.49091	-.184
	.00	.00	.000	.000	40.45	36.500		.000	89.84	.17000	-1.0180
	.00	.000	.000	.000	110.00	.000		.0	62.21	.16311	-.07980
	2500.0	214.51	95.17	40.45	75.07	75.00		3.000	90.96		
	503.8					-92.60		1160.4	1160.4		
- - - - - - - - -											

144.	280.00	119.39	44.217	14.338	543.9	87.06	-80.61	250.00	1100.0	.27650	.1601
	76.80	53.13	34.556	5.743	31.60	1860.8	.00	1000.0	30.556	.20205	.8399
	184.48	59.99	24.613	22.498	232.51	30.556	.000	-80.61	1069.4	60.000	.2521
	.00	.000	.000	.000	103.39	23.750	-80.61	3.000	-42.41	.49091	-.148
	.00	.00	.000	.000	42.58	36.500		.000	85.08	.17000	-.7830
	.00	.000	.000	.000	110.00	.000		.0	60.27	.16311	-.06875
	2650.0	232.51	103.39	42.58	87.06	75.00		3.000	102.95		
	543.9					-80.61		1172.4	1172.4		
- - - - - - - - -											
150.	300.00	131.84	48.831	15.861	583.3	77.10	-124.43	250.00	1100.0	.27650	.1322
	96.00	58.67	38.162	6.352	32.60	2559.9	.00	1000.0	36.667	.20205	.8678
	184.48	59.99	24.613	22.498	250.51	36.667	.000	-124.43	1063.3	60.000	.2826
	.00	.000	.000	.000	111.61	28.500	-124.43	3.000	-165.60	.49091	-.213
	.00	.00	.000	.000	44.71	43.800		.000	83.71	.17000	-1.9073
	.00	.000	.000	.000	132.00	.000		.0	147.14	.16311	-.11025
	2850.0	250.51	111.61	44.71	77.10	90.00		3.000	65.24		
	583.3					-124.43		1128.6	1128.6		
- - - - - - - - -											
156.	340.00	144.30	53.445	17.383	623.5	90.17	-161.36	250.00	1100.0	.27650	.1446
	96.00	64.22	41.768	6.962	34.68	2559.9	.00	998.3	36.667	.20205	.8554
	184.48	59.99	24.613	22.498	269.04	36.667	.000	-161.36	1063.3	60.000	.3446
	.00	.000	.000	.000	120.04	28.500	-161.36	3.210	-203.10	.49091	-.259
	.00	.00	.000	.000	46.97	43.800		.000	82.96	.17000	-6.0177
	.00	.525	.210	.126	132.00	50.000		.0	146.96	.16311	-.14802
	3050.0	269.04	120.04	46.97	90.17	90.00		3.210	26.81		
	623.5					-161.36		1090.1	1090.1		
- - - - - - - - -											

<u>TABLE 6.3</u> Continued

162.	360.00	156.76	58.059	18.906	665.9	106.05	-145.47	250.00	1100.0	.27650	.1593
	115.20	69.76	45.373	7.572	42.11	2559.9	.00	998.3	36.667	.20205	.8407
	184.48	59.99	24.613	22.498	290.19	36.667	.000	-145.47	1063.3	60.000	.3227
	.00	.787	.315	.315	129.52	28.500	-145.47	3.788	-193.89	.49091	-.218
	.00	.00	.000	.000	50.24	43.800		.000	86.04	.17000	-3.3612
	3.00	2.887	1.155	.945	132.00	50.000		.0	151.13	.16311	-.13146
	3200.0	290.19	129.52	50.24	106.05	90.00		3.788	43.28		
	665.9					-145.47		1106.6	1106.6		
- - - - - - - - -											
168.	400.00	169.22	62.673	20.428	731.9	135.47	-116.06	250.00	1100.0	.27650	.1851
	115.20	75.31	48.979	8.182	50.18	2559.9	.00	998.3	36.667	.20205	.8149
	184.48	59.99	24.613	22.498	317.17	36.667	.000	-116.06	1063.3	60.000	.2936
	10.80	3.465	1.386	1.732	141.33	28.500	-116.06	4.628	-189.96	.49091	-.159
	.00	.00	.000	.000	56.10	43.800		.000	110.16	.17000	-1.5782
	18.00	9.187	3.675	3.255	132.00	50.000		.0	153.33	.16311	-.10208
	3400.0	317.17	141.33	56.10	135.47	90.00		4.628	73.54		
	731.9					-116.06		1136.9	1136.9		
- - - - - - - - -											
174.	420.00	181.67	67.287	21.951	810.9	143.75	-140.93	250.00	1100.0	.27650	.1773
	134.40	80.85	52.585	8.792	50.10	2559.9	.00	998.3	42.778	.20205	.8227
	184.48	59.99	24.613	22.498	346.04	42.778	.000	-140.93	1057.2	60.000	.2983
	32.40	8.032	3.213	4.284	153.89	33.250	-140.93	4.943	-231.27	.49091	-.174
	.00	.00	.000	.000	63.30	51.100		.000	140.30	.17000	-2.5585
	36.00	15.487	6.195	5.775	154.00	50.000		.0	146.05	.16311	-.12670
	3600.0	346.04	153.89	63.30	143.75	105.00		4.943	55.08		
	810.9					-140.93		1112.3	1112.3		
- - - - - - - - -											

<u>TABLE 6.3</u> Continued

180.	460.00	194.13	71.901	23.474	896.0	184.39	-102.04	250.00	1100.0	.27650	.2058
	134.40	86.39	56.191	9.402	57.47	4298.7	.00	998.3	42.778	.20205	.7942
	184.48	59.99	24.613	22.498	376.48	42.778	.000	-102.04	1057.2	60.000	.2719
	59.40	14.175	5.670	7.875	167.09	33.250	-102.04	5.100	-211.50	.49091	-.114
	.00	.00	.000	.000	71.54	51.100		.000	160.46	.17000	-1.0839
	54.00	21.787	8.715	8.295	154.00	50.000		.0	145.18	.16311	-.08862
	3750.0	376.48	167.09	71.54	184.39	105.00		5.100	94.14		
	896.0					-102.04		1151.4	1151.4		
- - - - - - - - -											
186.	480.00	206.59	76.515	24.996	985.8	225.41	-61.02	250.00	1100.0	.27650	.2286
	153.60	91.94	59.797	10.011	60.98	4298.7	.00	998.3	42.778	.20205	.7714
	184.48	59.99	24.613	22.498	407.08	42.778	.000	-61.02	1057.2	60.000	.2472
	91.80	20.475	8.190	11.655	180.35	33.250	-61.02	5.100	-179.51	.49091	-.062
	.00	.00	.000	.000	79.98	51.100		.000	174.40	.17000	-.4515
	72.00	28.087	11.235	10.815	154.00	50.000		.0	140.26	.16311	-.05117
	3950.0	407.08	180.35	79.98	225.41	105.00		5.100	135.15		
	985.8					-61.02		1192.4	1192.4		
- - - - - - - - -											
192.	520.00	219.05	81.129	26.519	1076.4	266.48	-19.95	250.00	1100.0	.27650	.2476
	153.60	97.48	63.403	10.621	63.75	4298.7	.00	998.3	42.778	.20205	.7524
	184.48	59.99	24.613	22.498	437.68	42.778	.000	-19.95	1057.2	60.000	.2263
	124.20	26.775	10.710	15.435	193.61	33.250	-19.95	5.100	-137.48	.49091	-.019
	.00	.00	.000	.000	88.41	51.100		.000	179.11	.17000	-.1132
	90.00	34.387	13.755	13.335	154.00	50.000		.0	134.59	.16311	-.01618
	4150.0	437.68	193.61	88.41	266.48	105.00		5.100	176.22		
	1076.4					-19.95		1233.4	1233.4		
- - - - - - - - -											

TABLE 6.3 Continued

198.	540.00	231.50	85.743	28.042	1166.2	287.44	1.02	250.00	1100.0	.27650	.2465
	172.80	103.02	67.008	11.231	47.26	4298.7	.50	998.3	42.778	.20205	.7535
	184.48	59.99	24.613	22.498	468.28	42.778	.052	.47	1057.2	60.000	.2089
	156.60	33.075	13.230	19.215	206.87	33.250	.47	5.100	-132.12	.49091	.001
	.00	.00	.000	.000	96.84	51.100		.498	179.99	.17000	.0052
	108.00	40.687	16.275	15.855	154.00	50.000		51.9	149.32	.16311	.00037
	4300.0	468.28	206.87	96.84	287.44	105.00		5.650	197.19		
	1166.2					1.02		1254.4	1254.4		
- - - - - - - - -											
204.	580.00	243.96	90.357	29.564	1256.8	337.20	16.04	250.00	1100.0	.27650	.2683
	172.80	108.57	70.614	11.841	98.08	5876.5	7.86	998.3	48.889	.20205	.7317
	184.48	60.16	24.680	22.518	511.65	48.889	.818	7.36	1051.1	60.000	.2166
	189.00	39.375	15.750	22.995	224.33	38.000	7.36	11.509	-144.32	.49091	.013
	.00	12.60	4.608	.648	105.67	58.400		7.858	177.75	.17000	.0714
	126.00	46.987	18.320	18.104	176.00	50.000		817.9	191.30	.16311	.00577
	4499.9	511.65	224.33	105.67	337.20	120.00		20.186	224.73		
	1256.8					16.04		1275.8	1275.8		
- - - - - - - - -											
210.	600.00	255.80	94.741	31.049	1398.2	358.60	37.43	250.00	1100.0	.27650	.2565
	192.00	113.83	74.039	12.435	83.85	5876.5	18.34	998.3	48.889	.20205	.7435
	184.48	61.96	25.418	23.070	580.95	48.889	1.909	17.18	1051.1	60.000	.1947
	221.40	45.675	18.270	26.775	250.01	38.000	17.18	11.387	-148.85	.49091	.027
	57.60	50.40	18.432	4.536	116.47	58.400		18.343	228.57	.17000	.1522
	138.00	53.287	19.109	18.601	176.00	50.000		1909.1	166.28	.16311	.01325
	4699.9	580.95	250.01	116.47	358.60	120.00		31.638	246.01		
	1398.2					37.43		1297.1	1297.1		
- - - - - - - - -											

TABLE 6.3 Continued

216.	640.00	264.20	97.855	32.153	1554.0	428.05	106.88	250.00	1100.0	.27650	.2754
	192.00	117.58	76.473	12.877	99.45	5876.5	52.37	998.3	48.889	.20205	.7246
	192.68	65.72	26.962	24.359	647.26	48.889	5.451	49.06	1051.1	60.000	.1752
	253.80	51.975	20.790	30.555	274.50	38.000	49.06	10.814	-128.03	.49091	.069
	129.60	88.20	32.256	8.424	127.67	58.400		52.373	272.23	.17000	.3394
	141.00	59.587	20.160	19.302	176.00	50.000		5451.1	170.68	.16311	.03592
	4949.9	647.26	274.50	127.67	428.05	120.00		68.638	314.88		
	1554.0					106.88		1366.0	1366.0		
- - - - - - - - -											
222.	640.00	268.88	99.585	32.800	1684.0	479.70	158.53	250.00	1100.0	.27650	.2849
	192.00	119.65	77.825	13.137	118.04	5876.5	77.68	998.3	48.889	.20205	.7151
	209.08	71.45	29.312	26.384	709.35	48.889	8.085	72.77	1051.1	60.000	.1617
	286.20	58.275	23.310	34.335	297.62	38.000	72.77	9.978	-82.56	.49091	.094
	201.60	126.00	46.080	12.312	139.39	58.400		77.681	270.70	.17000	.4335
	150.00	65.100	21.513	20.423	176.00	50.000		8085.1	177.55	.16311	.05136
	5149.9	709.35	297.62	139.39	479.70	120.00		95.744	365.69		
	1684.0					158.53		1416.8	1416.8		
- - - - - - - - -											
228.	640.00	269.91	99.969	32.990	1836.2	489.55	134.02	250.00	1100.0	.27650	.2666
	211.20	120.12	78.126	13.213	78.90	7076.0	65.67	998.3	55.000	.20205	.7334
	225.48	77.99	31.997	28.838	758.34	55.000	6.835	61.52	1045.0	60.000	.1637
	318.60	64.575	25.830	38.115	317.54	42.750	61.52	2.141	-121.48	.49091	.073
	273.60	157.50	57.600	16.200	151.64	65.700		21.517	286.03	.17000	.4610
	162.00	68.250	24.017	22.283	198.00	50.000		2239.6	126.16	.16311	.04605
	5299.9	758.34	317.54	151.64	489.55	135.00		25.898	290.71		
	1836.2					134.02		1335.7	1335.7		
- - - - - - - - -											

TABLE 6.3 Continued

234.	659.80	269.91	99.969	32.990	1949.3	546.86	191.34	250.00	1100.0	.27650	.2805
	211.41	120.12	78.126	13.213	55.72	7076.0	93.76	998.3	55.000	.20205	.7195
	250.08	84.54	34.682	31.292	771.19	55.000	9.758	87.82	1045.0	60.000	.1542
	351.00	70.874	28.350	41.895	327.38	42.750	87.82	2.141	-3.49	.49091	.098
	291.60	157.50	57.600	16.200	161.63	65.700		49.603	258.52	.17000	.5498
	180.00	68.250	28.652	26.037	198.00	50.000		5162.7	93.00	.16311	.06305
	5449.9	771.19	327.38	161.63	546.86	135.00		56.906	348.02		
	1949.3					191.34		1393.0	1393.0		
- - - - - - - - -											
240.	659.80	269.91	99.969	32.990	2016.3	571.19	215.66	250.00	1100.0	.27650	.2833
	211.41	120.12	78.126	13.213	38.22	7076.0	105.68	998.3	55.000	.20205	.7167
	266.48	91.08	37.367	33.746	784.03	55.000	10.999	98.99	1045.0	60.000	.1490
	383.40	77.174	30.870	45.675	332.70	42.750	98.99	2.141	113.52	.49091	.107
	291.60	157.50	57.600	16.200	168.58	65.700		61.522	190.29	.17000	.5792
	198.00	68.250	28.769	26.758	198.00	50.000		6403.3	68.54	.16311	.06984
	5599.9	784.03	332.70	168.58	571.19	135.00		70.066	372.35		
	2016.3					215.66		1417.4	1417.3		
- - - - - - - - -											
246.	659.80	269.91	99.969	32.990	2076.1	609.31	253.79	250.00	1100.0	.27650	.2935
	211.41	120.12	78.126	13.213	40.85	7076.0	124.36	998.3	55.000	.20205	.7065
	291.08	97.62	40.052	36.201	796.88	55.000	12.943	116.49	1045.0	60.000	.1448
	415.80	83.474	33.390	49.455	337.91	42.750	116.49	2.141	199.80	.49091	.122
	291.60	157.50	57.600	16.200	174.82	65.700		80.203	145.75	.17000	.6183
	200.68	68.250	28.769	26.758	198.00	50.000		8347.7	64.93	.16311	.08004
	5699.9	796.88	337.91	174.82	609.31	135.00		90.691	410.47		
	2076.1					253.79		1455.5	1455.5		
- - - - - - - - -											

TABLE 6.3 Continued

252.	659.80	269.91	99.969	32.990	2125.0	609.03	219.99	250.00	1100.0	.27650	.2866
	211.41	120.12	78.126	13.213	37.95	7429.5	107.80	998.3	61.111	.20205	.7134
	307.48	104.17	42.737	38.655	809.72	61.111	11.220	100.98	1038.9	60.000	.1543
	448.20	89.773	35.910	53.235	343.11	47.500	100.98	2.141	175.44	.49091	.104
	291.60	157.50	57.600	16.200	181.05	73.000		29.294	117.20	.17000	.6314
	200.68	68.250	28.769	26.758	220.00	50.000		6624.1	55.80	.16311	.07279
	5799.8	809.72	343.11	181.05	609.03	150.00		38.059	348.44		
	2125.0					219.99		1387.3	1387.3		
- - - - - - - - -											
258.	659.80	269.91	99.969	32.990	2182.1	642.81	253.77	250.00	1100.0	.27650	.2946
	211.41	120.12	78.126	13.213	36.76	7429.5	124.35	998.3	61.111	.20205	.7054
	332.08	110.66	45.399	41.109	821.41	61.111	12.942	116.48	1038.9	60.000	.1503
	480.60	94.970	37.989	56.542	347.85	47.500	116.48	1.771	220.79	.49091	.116
	291.60	157.50	57.600	16.200	186.81	73.000		45.843	112.21	.17000	.6646
	200.68	68.250	28.769	26.758	220.00	50.000		8346.5	48.85	.16311	.08198
	5949.8	821.41	347.85	186.81	642.81	150.00		55.961	381.84		
	2182.1					253.77		1420.7	1420.7		
- - - - - - - - -											
264.	659.80	269.91	99.969	32.990	2231.0	659.73	270.69	250.00	1100.0	.27650	.2957
	211.41	120.12	78.126	13.213	20.77	7429.5	132.64	998.3	61.111	.20205	.7043
	348.48	115.73	47.480	43.134	829.79	61.111	13.805	124.25	1038.9	60.000	.1470
	512.99	98.278	39.312	58.716	351.26	47.500	124.25	1.129	264.10	.49091	.121
	291.60	157.50	57.600	16.200	191.01	73.000		54.136	105.36	.17000	.6799
	200.68	68.250	28.769	26.758	220.00	50.000		9209.7	28.66	.16311	.08646
	6049.8	829.79	351.26	191.01	659.73	150.00		64.475	398.12		
	2231.0					270.69		1437.0	1437.0		
- - - - - - - - -											

270.	659.80	269.91	99.969	32.990	2260.9	673.07	284.02	250.00	1100.0	.27650	.2977
	211.41	120.12	78.126	13.213	12.95	7429.5	139.17	998.3	61.111	.20205	.7023
	356.68	118.84	48.756	44.422	834.31	61.111	14.485	130.37	1038.9	60.000	.1450
	534.59	99.695	39.879	59.755	353.10	47.500	130.37	.487	310.23	.49091	.126
	291.60	157.50	57.600	16.200	193.34	73.000		60.670	82.08	.17000	.6914
	200.68	68.250	28.769	26.758	220.00	50.000		9889.7	18.51	.16311	.08993
	6099.8	834.31	353.10	193.34	673.07	150.00		71.046	410.82		
	2260.9					284.02		1449.7	1449.7		
- - - - - - - - -											
276.	659.80	269.91	99.969	32.990	2273.2	652.18	229.98	250.00	1100.0	.27650	.2869
	211.41	120.12	78.126	13.213	4.10	7429.5	112.69	998.3	67.222	.20205	.7131
	364.88	119.99	49.225	44.975	835.51	67.222	11.729	105.56	1032.8	60.000	.1562
	538.64	99.747	39.900	59.850	353.59	52.250	105.56	.055	299.61	.49091	.101
	291.60	157.50	57.600	16.200	193.98	80.300		29.685	49.32	.17000	.6425
	200.68	68.250	28.769	26.758	242.00	50.000		7133.5	9.02	.16311	.07590
	6149.8	835.51	353.59	193.98	652.18	165.00		36.873	357.95		
	2273.2					229.98		1390.7	1390.7		
- - - - - - - - -											
282.	659.80	269.91	99.969	32.990	2277.3	652.16	229.96	250.00	1100.0	.27650	.2864
	211.41	120.12	78.126	13.213	.00	7429.5	112.68	998.3	67.222	.20205	.7136
	368.96	119.99	49.225	44.995	835.51	67.222	11.728	105.55	1032.8	60.000	.1559
	538.64	99.747	39.900	59.850	353.59	52.250	105.55	.000	328.37	.49091	.101
	291.60	157.50	57.600	16.200	194.01	80.300		29.676	24.61	.17000	.6426
	200.68	68.250	28.769	26.758	242.00	50.000		7132.6	4.89	.16311	.07590
	6173.0	835.51	353.59	194.01	652.16	165.00		36.808	357.87		
	2277.3					229.96		1390.7	1390.6		
- - - - - - - - -											

TABLE 6.3 Continued

288.	659.80	269.91	99.969	32.990	2277.3	652.16	229.96	250.00	1100.0	.27650	.2864
	211.41	120.12	78.126	13.213	.00	7429.5	112.68	998.3	67.222	.20205	.7136
	368.96	119.99	49.225	44.995	835.51	67.222	11.728	105.55	1032.8	60.000	.1559
	538.64	99.747	39.900	59.850	353.59	52.250	105.55	.000	343.32	.49091	.101
	291.60	157.50	57.600	16.200	194.01	80.300		29.676	9.66	.17000	.6426
	200.68	68.250	28.769	26.758	242.00	50.000		7132.6	4.89	.16311	.07590
	6173.0	835.51	353.59	194.01	652.16	165.00		36.808	357.87		
	2277.3					229.96		1390.7	1390.6		
- - - - - - - - -											
294.	659.80	269.91	99.969	32.990	2277.3	652.16	229.96	250.00	1100.0	.27650	.2864
	211.41	120.12	78.126	13.213	.00	7429.5	112.68	998.3	67.222	.20205	.7136
	368.96	119.99	49.225	44.995	835.51	67.222	11.728	105.55	1032.8	60.000	.1559
	538.64	99.747	39.900	59.850	353.59	52.250	105.55	.000	349.83	.49091	.101
	291.60	157.50	57.600	16.200	194.01	80.300		29.676	3.15	.17000	.6426
	200.68	68.250	28.769	26.758	242.00	50.000		7132.6	4.89	.16311	.07590
	6173.0	835.51	353.59	194.01	652.16	165.00		36.808	357.87		
	2277.3					229.96		1390.7	1390.6		
- - - - - - - - -											
300.	659.80	269.91	99.969	32.990	2277.3	630.16	174.80	250.00	1100.0	.27650	.2767
	211.41	120.12	78.126	13.213	.00	7429.5	85.65	998.3	73.333	.20205	.7233
	368.96	119.99	49.225	44.995	835.51	73.333	8.915	80.23	1026.7	60.000	.1678
	538.64	99.747	39.900	59.850	353.59	57.000	80.23	.000	300.94	.49091	.077
	291.60	157.50	57.600	16.200	194.01	87.600		2.647	.90	.17000	.5699
	200.68	68.250	28.769	26.758	264.00	50.000		2228.7	4.89	.16311	.06017
	6173.0	835.51	353.59	194.01	630.16	180.00		4.875	306.73		
	2277.3					174.80		1333.4	1333.4		
- - - - - - - - -											

TABLE 6.3 Continued

```
TABHR=F,TABHF=H,TABM=M,TABC=C,TABS=S,TABB=B

                .0                     10.T                     20.T                     30.T                     40.T FHMCSB
             .0F - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - FHMCSB
               F                        .                        .                        .                        . FHMCSB
               F                        .                        .                        .                        . FHMCSB
               F                        .                        .                        .                        . FHMCSB
               F                        .                        .                        .                        . FHMCSB
               F                        .                        .                        .                        . FHMCSB
               F                      H .                        .                        .                        . FMCSB
               F                        .                   H    .                        .                        . FMCSB
               M    F    C              .                   H    .                        .                        . MSB
               M             F          .   C               H    .                        .                        . MSB
           100.M - - - - - - - - -F- - - - - - - - - C - - -H- - - - - - - - - - - - - - - - - - - - - - - - - - - - MSB
               M                  F     .        H   C           .                        .                        . MSB
               M          H       F     .            C           .                        .                        . MSB
               H                  F     .            C           .                        .                        . HMSB
               H                  F     .            C           .                        .                        . HMSB
               H                  F     .            C           .                        .                        . HMSB
               H            S     F     .M           C           .                        .                        . HB
               H                  F     .            CS          . M                      .                        . HB
               H                  F     .            C           . M                      .                        . MS,HB
               H                  F     .            C           . M                      .                        . MS,HB
           200.H - - - - - - - - -F- - - - - - - - - C - - - - - - M - - - - - - - - - - - - - - - - - - - - - - - - MS,HB
               .             F        H .   C               B    . M                      .                        . MS
               .    F    C              .             M     H    . S                      .                        . HB
               F                        .                   H    . S                      .                        . FMCB
               F                        .                   H    . S                      .                        . FMCB
               F                        .                   H    . S                      .                        . FMCB
               F                        .S       H               .                        .                        . FMCB
               F          H             .                        .                        .                        . FMCSB
               F                        .                        .                        .                        . FHMCSB
               F                        .                        .                        .                        . FHMCSB
           300.F - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - FHMCSB
```

TABLE 6.3 Continued

CASHP=C

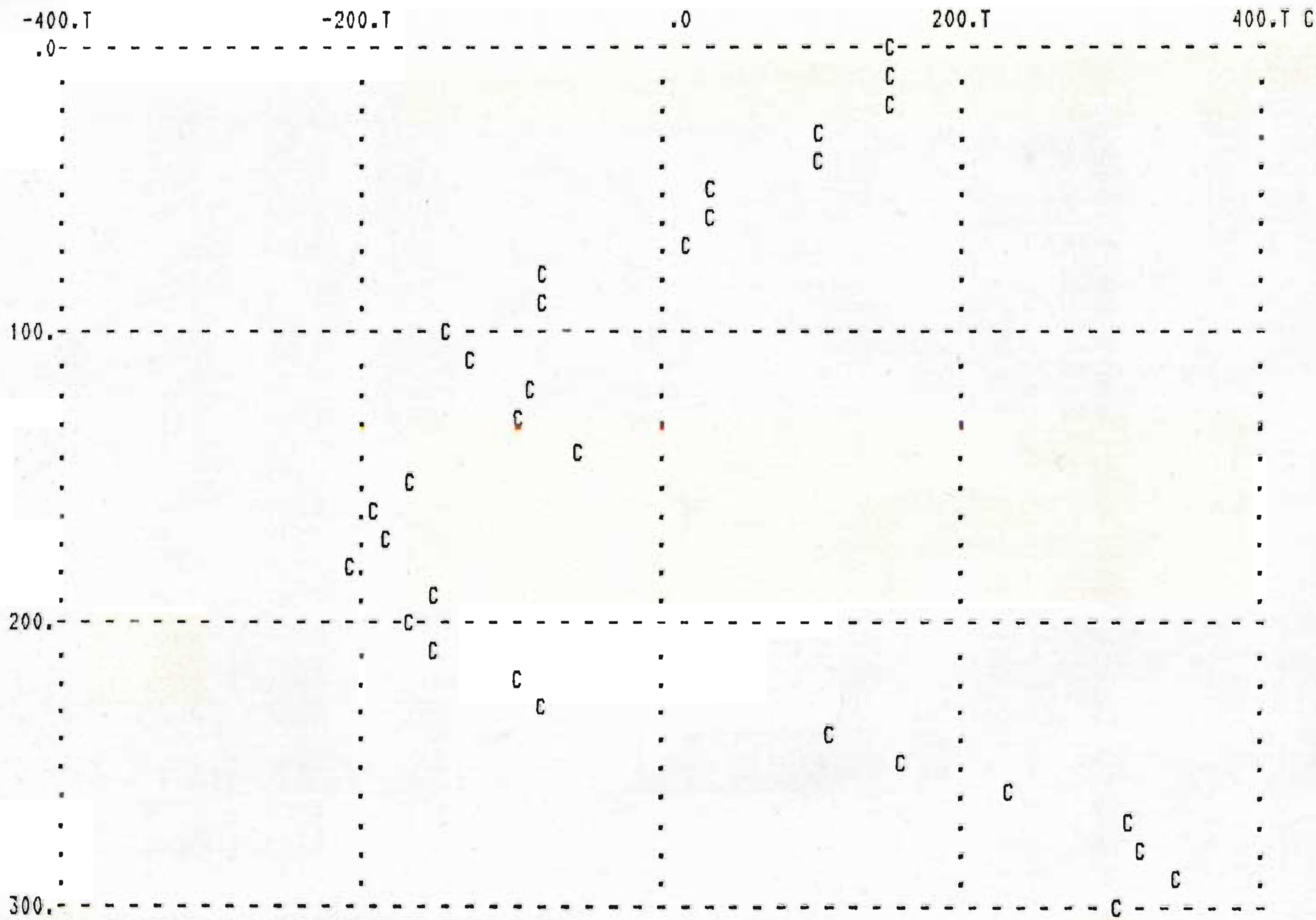


TABLE 6.4

COMPUTER PRINT-OUT FOR THE PRODUCTION VIEWPOINT OF THE NEWFOUNDLAND INSHORE

FISH PROCESSING MODEL AS PRESENTED IN APPENDIX "B"

RUN-BASIC FISH PROCESSI MODEL OF A NFLD INSHORE FREEZER PLANT

TIME	AMWP	ARMF	AMDP1	AFNP	AMDP2	ASSP	ARMPL	ARMPF	AIAP	KPHR
	BMWP	BRMF	BMDP1	BFNP	BMDP2	BSSP	BRMPL	BRMPF	BIAP	KPHF
	CMWP	CRMF	CMDP1	CFNP	CMDP2	CSSP	CRMPL	CRMPF	CIAP	MPA
	DMWP	DRMF	DMDP1	DFNP	DMDP2	DSSP	DRMPL	DRMPF	DIAP	MPC
	EMWP	ERMF	EMDP1	EFNP	EMDP2	ESSP	ERMPL	ERMPF	EIAP	MPS
	FMWP	FRMF	FMDP1	FFNP	FMDP2	FSSP	FRMPL	FRMPF	FIAP	SPF
E+00	E+03	E+03	E+00	E+00	E+00	E+03	E+03	E+00	E+03	E+00
	E+00	E+00	E+00	E+00	E+00	E+00	E+00	E+00	E+03	E+00
	E+03	E+03	E+00	E+00	E+00	E+03	E+03	E+00	E+03	E-03
	E+03	E+03	E+03	E+00	E+00	E+03	E+03	E+00	E+03	E+00
	E+03	E+03	E+03	E+00	E+00	E+03	E+03	E+00	E+03	E+00
	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+00
.0	.000	.000	.0	0.	0.	.000	.000	0.	.000	.27650
	.0	.0	.0	0.	0.	0.	.0	0.	.000	.20205
	.000	.000	.0	0.	0.	.000	.000	0.	.000	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
6.	.000	.000	.0	0.	0.	.000	.000	0.	.000	.27650
	.0	.0	.0	0.	0.	0.	.0	0.	.000	.20205
	.000	.000	.0	0.	0.	.000	.000	0.	.000	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
12.	.000	.000	.0	0.	0.	.000	.000	0.	.000	.27650
	.0	.0	.0	0.	0.	0.	.0	0.	.000	.20205
	.000	.000	.0	0.	0.	.000	.000	0.	.000	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311

<u>TABLE 6.4</u> Continued

18.	.000	.000	.0	0.	0.	.000	.000	0.	.000	.27650
	.0	.0	.0	0.	0.	0.	.0	0.	.000	.20205
	.000	.000	.0	0.	0.	.000	.000	0.	.000	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
24.	.000	.000	.0	0.	0.	.000	.000	0.	.000	.27650
	.0	.0	.0	0.	0.	0.	.0	0.	.000	.20205
	.000	.000	.0	0.	0.	.000	.000	0.	.000	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
30.	.000	.000	.0	0.	0.	.000	.000	0.	.000	.27650
	.0	.0	.0	0.	0.	0.	.0	0.	.000	.20205
	.000	.000	.0	0.	0.	.000	.000	0.	.000	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
36.	.000	.000	.0	0.	0.	.000	.000	0.	.000	.27650
	.0	.0	.0	0.	0.	0.	.0	0.	.000	.20205
	.000	.000	.0	0.	0.	.000	.000	0.	.000	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
42.	.000	.000	.0	0.	0.	.000	.000	0.	.000	.27650
	.0	.0	.0	0.	0.	0.	.0	0.	.000	.20205
	.000	.000	.0	0.	0.	.000	.000	0.	.000	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
48.	.000	.000	.0	0.	0.	.000	.000	0.	.000	.27650
	.0	.0	.0	0.	0.	0.	.0	0.	.000	.20205
	.000	.000	.0	0.	0.	.000	.000	0.	.000	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311

TABLE 6.4 Continued

54.	.000	.000	.0	0.	0.	.000	.000	0.	.000	.27650
	.0	.0	.0	0.	0.	0.	.0	0.	.000	.20205
	3.636	3.636	1227.1	0.	0.	.000	2.727	0.	1.227	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
60.	.000	.000	.0	0.	0.	.000	.000	0.	.000	.27650
	.0	.0	.0	0.	0.	0.	.0	0.	.000	.20205
	9.090	9.090	3681.5	0.	0.	.000	8.181	0.	14.726	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
66.	.000	.000	.0	0.	0.	.000	.000	0.	.000	.27650
	.0	.0	.0	0.	0.	0.	.0	0.	.000	.20205
	14.544	14.544	6135.8	0.	0.	20.000	13.635	0.	22.950	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
72.	.000	.000	.0	0.	0.	.000	.000	0.	.000	.27650
	.0	.0	.0	0.	0.	0.	.0	0.	.000	.20205
	18.180	18.180	8181.0	0.	0.	20.000	18.180	0.	25.900	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
78.	2.307	2.307	507.5	0.	0.	.000	1.538	0.	.254	.27650
	1155.0	1155.0	169.4	0.	0.	0.	770.0	0.	.085	.20205
	18.180	18.180	8181.0	0.	0.	.000	18.180	0.	14.986	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
84.	6.921	6.921	2030.2	0.	0.	.000	6.152	0.	7.106	.27650
	3465.0	3465.0	677.6	0.	0.	0.	3080.0	0.	2.372	.20205
	18.180	18.180	8181.0	0.	0.	20.000	18.180	0.	24.072	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311

TABLE 6.4 Continued

90.	11.535	11.535	3552.8	0.	0.	20.000	10.766	0.	23.093	.27650
	5775.0	5775.0	1185.8	0.	0.	0.	5390.0	0.	7.708	.20205
	18.180	18.180	8181.0	0.	0.	.000	18.180	0.	13.158	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
96.	15.380	15.380	5075.4	0.	0.	.000	15.380	0.	8.216	.27650
	7700.0	7700.0	1694.0	0.	0.	0.	7700.0	0.	16.093	.20205
	18.180	18.180	8181.0	0.	0.	20.000	18.180	0.	22.244	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
102.	15.380	15.380	5075.4	0.	0.	.000	15.380	0.	18.669	.27650
	7700.0	7700.0	1694.0	0.	0.	0.	7700.0	0.	6.257	.20205
	18.180	18.180	8181.0	0.	0.	.000	18.180	0.	11.330	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
108.	15.380	15.380	5075.4	0.	0.	.000	15.380	0.	9.121	.27650
	7700.0	7700.0	1694.0	0.	0.	0.	7700.0	0.	16.421	.20205
	15.453	15.453	7362.9	0.	0.	20.000	16.362	0.	20.007	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
114.	15.380	15.380	5075.4	0.	0.	.000	15.380	0.	19.573	.27650
	7700.0	7700.0	1694.0	0.	0.	0.	7700.0	0.	6.585	.20205
	9.999	9.999	4908.6	0.	0.	.000	10.908	0.	18.049	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
120.	15.380	15.380	5075.4	0.	0.	.000	15.380	0.	10.026	.27650
	7700.0	7700.0	1694.0	0.	0.	0.	7700.0	0.	16.749	.20205
	4.545	4.545	2454.3	0.	0.	20.000	5.454	0.	21.365	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311

TABLE 6.4 Continued

126.	15.380	15.380	5075.4	0.	0.	20.000	15.380	0.	20.478	.27650
	7700.0	7700.0	1694.0	0.	0.	0.	7700.0	0.	6.913	.20205
	.000	.000	.0	0.	0.	.000	.000	0.	9.955	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
132.	15.380	15.380	5075.4	0.	0.	.000	15.380	0.	19.931	.27650
	7700.0	7700.0	1694.0	0.	0.	0.	7700.0	0.	17.077	.20205
	.000	.000	.0	0.	0.	.000	.000	0.	.000	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
138.	15.380	15.380	5075.4	0.	0.	20.000	15.380	0.	21.383	.27650
	7700.0	7700.0	1694.0	0.	0.	0.	7700.0	0.	7.241	.20205
	.000	.000	.0	0.	0.	.000	.000	0.	.000	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
144.	15.380	15.380	5075.4	0.	0.	.000	15.380	0.	11.835	.27650
	7700.0	7700.0	1694.0	0.	0.	0.	7700.0	0.	17.405	.20205
	.000	.000	.0	0.	0.	.000	.000	0.	.000	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
150.	15.380	15.380	5075.4	0.	0.	20.000	15.380	0.	22.288	.27650
	7700.0	7700.0	1694.0	0.	0.	0.	7700.0	0.	7.569	.20205
	.000	.000	.0	0.	0.	.000	.000	0.	.000	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
156.	15.380	15.380	5075.4	0.	0.	.000	15.380	0.	12.740	.27650
	7700.0	7700.0	1694.0	0.	0.	0.	7700.0	0.	17.733	.20205
	.000	.000	.0	0.	0.	.000	.000	0.	.000	60.000
	1.050	1.050	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	6.300	6.300	5.250	.000	.000	.000	5.250	.00	10.50	.16311

TABLE 6.4 Continued

162.	15.380	15.380	5075.4	0.	0.	20.000	15.380	0.	23.193	.27650
	7700.0	7700.0	1694.0	0.	0.	0.	7700.0	0.	7.897	.20205
	.000	.000	.0	0.	0.	.000	.000	0.	.000	60.000
	7.350	7.350	6.300	0.	0.	.000	6.300	0.	15.75	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	21.000	21.000	21.000	.000	.000	.000	21.000	.00	17.75	.16311
168.	15.380	15.380	5075.4	0.	0.	.000	15.380	0.	13.645	.27650
	7700.0	7700.0	1694.0	0.	0.	0.	7700.0	0.	18.061	.20205
	.000	.000	.0	0.	0.	.000	.000	0.	.000	60.000
	13.650	13.650	12.600	0.	0.	20.000	12.600	0.	29.30	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	21.000	21.000	21.000	.000	.000	20.000	21.000	.00	43.75	.16311
174.	15.380	15.380	5075.4	0.	0.	20.000	15.380	0.	24.097	.27650
	7700.0	7700.0	1694.0	0.	0.	0.	7700.0	0.	8.225	.20205
	.000	.000	.0	0.	0.	.000	.000	0.	.000	60.000
	19.950	19.950	18.900	0.	0.	20.000	18.900	0.	20.65	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	21.000	21.000	21.000	.000	.000	20.000	21.000	.00	49.75	.16311
180.	15.380	15.380	5075.4	0.	0.	.000	15.380	0.	14.550	.27650
	7700.0	7700.0	1694.0	0.	0.	0.	7700.0	0.	18.389	.20205
	.000	.000	.0	0.	0.	.000	.000	0.	.000	60.000
	21.000	21.000	21.000	0.	0.	20.000	21.000	0.	43.50	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	21.000	21.000	21.000	.000	.000	20.000	21.000	.00	55.75	.16311
186.	15.380	15.380	5075.4	0.	0.	20.000	15.380	0.	25.002	.27650
	7700.0	7700.0	1694.0	0.	0.	0.	7700.0	0.	8.553	.20205
	.000	.000	.0	0.	0.	.000	.000	0.	.000	60.000
	21.000	21.000	21.000	0.	0.	20.000	21.000	0.	49.50	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	21.000	21.000	21.000	.000	.000	20.000	21.000	.00	61.75	.16311
192.	15.380	15.380	5075.4	0.	0.	.000	15.380	0.	15.455	.27650
	7700.0	7700.0	1694.0	0.	0.	0.	7700.0	0.	18.717	.20205
	.000	.000	.0	0.	0.	.000	.000	0.	.000	60.000
	21.000	21.000	21.000	0.	0.	20.000	21.000	0.	55.50	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	21.000	21.000	21.000	.000	.000	20.000	21.000	.00	67.75	.16311

TABLE 6.4 Continued

198.	15.380	15.380	5075.4	0.	0.	.000	15.380	0.	5.907	.27650
	7700.0	7700.0	1694.0	0.	0.	0.	7700.0	0.	8.881	.20205
	.000	.000	.0	0.	0.	.000	.000	0.	.000	60.000
	21.000	21.000	21.000	0.	0.	20.000	21.000	0.	61.50	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	21.000	21.000	21.000	.000	.000	20.000	21.000	.00	73.75	.16311
- - - - - - - - -										
204.	15.380	15.380	5075.4	0.	0.	.000	15.380	0.	16.359	.27650
	7700.0	7700.0	1694.0	0.	0.	0.	7700.0	0.	19.045	.20205
	3.636	3.636	1227.1	0.	0.	.000	2.727	0.	1.227	60.000
	21.000	21.000	21.000	0.	0.	20.000	21.000	0.	67.50	.49091
	18.000	18.000	16.200	0.	0.	20.000	18.000	0.	32.400	.17000
	21.000	21.000	5.057	15.943	.000	20.000	21.000	28.25	51.50	.16311
- - - - - - - - -										
210.	11.535	11.535	4060.3	0.	0.	.000	12.304	0.	5.289	.27650
	5775.0	5775.0	1355.2	0.	0.	0.	6160.0	0.	8.701	.20205
	9.090	9.090	3681.5	0.	0.	.000	8.181	0.	14.726	60.000
	21.000	21.000	21.000	0.	0.	20.000	21.000	0.	73.50	.49091
	18.000	18.000	16.200	0.	0.	20.000	18.000	0.	29.600	.17000
	21.000	21.000	4.967	16.033	.000	.000	21.000	131.31	14.44	.16311
- - - - - - - - -										
216.	6.921	6.921	2537.7	0.	0.	.000	7.690	0.	5.844	.27650
	3465.0	3465.0	847.0	0.	0.	0.	3850.0	0.	15.562	.20205
	14.544	14.544	6135.8	0.	0.	20.000	13.635	0.	22.950	60.000
	21.000	21.000	21.000	0.	0.	20.000	21.000	0.	79.50	.49091
	18.000	18.000	16.200	0.	0.	20.000	18.000	0.	26.800	.17000
	19.950	19.950	8.467	12.533	.000	.000	21.000	218.76	12.99	.16311
- - - - - - - - -										
222.	2.307	2.307	1015.1	0.	0.	.000	3.076	0.	17.264	.27650
	1155.0	1155.0	338.8	0.	0.	0.	1540.0	0.	19.373	.20205
	18.180	18.180	8181.0	0.	0.	20.000	18.180	0.	25.900	60.000
	21.000	21.000	21.000	0.	0.	20.000	21.000	0.	85.50	.49091
	18.000	18.000	16.200	0.	0.	20.000	18.000	0.	24.000	.17000
	13.650	13.650	13.179	1.521	.000	.000	14.700	269.46	12.54	.16311
- - - - - - - - -										
228.	.000	.000	.0	0.	0.	19.802	.000	0.	19.802	.27650
	.0	.0	.0	0.	0.	0.	.0	0.	.220	.20205
	18.180	18.180	8181.0	0.	0.	.000	18.180	0.	14.986	60.000
	21.000	21.000	21.000	0.	0.	20.000	21.000	0.	91.50	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	5.000	.17000
	.000	.000	.000	.000	31.284	20.000	.000	213.86	45.43	.16311
- - - - - - - - -										

TABLE 6.4 Continued

234.	.000	.000	.0	0.	0.	.000	.000	0.	.000	.27650
	.0	.0	.0	0.	0.	0.	.0	0.	.000	.20205
	18.180	18.180	8181.0	0.	0.	20.000	18.180	0.	24.072	60.000
	21.000	21.000	21.000	0.	0.	20.000	21.000	0.	97.50	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	4.768	20.000	.000	5.30	113.13	.16311
240.	.000	.000	.0	0.	0.	.000	.000	0.	.000	.27650
	.0	.0	.0	0.	0.	0.	.0	0.	.000	.20205
	18.180	18.180	8181.0	0.	0.	.000	18.180	0.	13.158	60.000
	21.000	21.000	21.000	0.	0.	20.000	21.000	0.	103.50	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	17.90	.16311
246.	.000	.000	.0	0.	0.	.000	.000	0.	.000	.27650
	.0	.0	.0	0.	0.	0.	.0	0.	.000	.20205
	18.180	18.180	8181.0	0.	0.	20.000	18.180	0.	22.244	60.000
	21.000	21.000	21.000	0.	0.	20.000	21.000	0.	109.50	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
252.	.000	.000	.0	0.	0.	.000	.000	0.	.000	.27650
	.0	.0	.0	0.	0.	0.	.0	0.	.000	.20205
	18.180	18.180	8181.0	0.	0.	.000	18.180	0.	11.330	60.000
	18.900	18.900	19.950	0.	0.	20.000	19.950	0.	115.50	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
258.	.000	.000	.0	0.	0.	.000	.000	0.	.000	.27650
	.0	.0	.0	0.	0.	0.	.0	0.	.000	.20205
	15.453	15.453	7362.9	0.	0.	20.000	16.362	0.	20.007	60.000
	12.600	12.600	13.650	0.	0.	20.000	13.650	0.	99.45	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
264.	.000	.000	.0	0.	0.	.000	.000	0.	.000	.27650
	.0	.0	.0	0.	0.	0.	.0	0.	.000	.20205
	9.999	9.999	4908.6	0.	0.	.000	10.908	0.	18.049	60.000
	6.300	6.300	7.350	0.	0.	20.000	7.350	0.	45.60	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311

TABLE 6.4 Continued

270.	.000	.000	.0	0.	0.	.000	.000	0.	.000	.27650
	.0	.0	.0	0.	0.	0.	.0	0.	.000	.20205
	4.545	4.545	2454.3	0.	0.	20.000	5.454	0.	21.365	60.000
	.000	.000	1.050	0.	0.	.000	1.050	0.	13.95	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
276.	.000	.000	.0	0.	0.	.000	.000	0.	.000	.27650
	.0	.0	.0	0.	0.	0.	.0	0.	.000	.20205
	.000	.000	.0	0.	0.	.000	.000	0.	9.955	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
282.	.000	.000	.0	0.	0.	.000	.000	0.	.000	.27650
	.0	.0	.0	0.	0.	0.	.0	0.	.000	.20205
	.000	.000	.0	0.	0.	.000	.000	0.	.000	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
288.	.000	.000	.0	0.	0.	.000	.000	0.	.000	.27650
	.0	.0	.0	0.	0.	0.	.0	0.	.000	.20205
	.000	.000	.0	0.	0.	.000	.000	0.	.000	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
294.	.000	.000	.0	0.	0.	.000	.000	0.	.000	.27650
	.0	.0	.0	0.	0.	0.	.0	0.	.000	.20205
	.000	.000	.0	0.	0.	.000	.000	0.	.000	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
300.	.000	.000	.0	0.	0.	.000	.000	0.	.000	.27650
	.0	.0	.0	0.	0.	0.	.0	0.	.000	.20205
	.000	.000	.0	0.	0.	.000	.000	0.	.000	60.000
	.000	.000	.000	0.	0.	.000	.000	0.	.00	.49091
	.000	.000	.000	0.	0.	.000	.000	0.	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311

6.3.3 Interpretation of Computer Print-outs

The first block in Table 6.3 on page 118 gives the names of the variables in the arrangement for which values are printed in successive blocks. The second block gives the power of 10 by which the numerical values are to be multiplied. Succeeding blocks give number values at the specified printing interval. For example, the values of CASHP and MPM at TIME = 0 are 150×10^{3} and 60×10^{-3} respectively.

On page 136 is a typical print-out form of a plot. At the beginning of the plot are printed the designations of the variables and the symbols used to represent the variables on the graph. Next come the scales to which the variables are plotted with a scaling factor of T = 1000. In the main body of the plot, time is printed along the bottom. The letter groups on the top margin indicate where curves have crossed on the plot. Within each group the first letter designates the letter that appears on the plot, and the following letters are those that are also represented by the first letter. A comma separates the different groups. To further illustrate this, at TIME = 0, the group of FHMCSB appears on the top with F appearing on the plot with a quantity of 0 lbs. also representing the quantities for the remaining letters, while at TIME = 200, H and B equal 0 lbs. each, F equals approximately 8000 lbs., C equals approximately 15,000 lbs. and M and S equal approximately 21,000 lbs. each. A colored line can be run through each particular letter to make the plot easier to read.

6.4. Analysis of Computer Print-out, Basic Model

While analysing the computer print-out for the basic input data for the Newfoundland inshore fish processing model we shall continuously refer to Tables 6.3 and 6.4.

Table 6.3 giving the economic viewpoint of the model is presented in eleven columns, namely:

- column 1 giving the sales revenue for each species with line 8 giving the total sales revenue
- column 2 giving the raw material expenditure for each species with line 7 giving the total raw material expenditure
- column 3 giving the direct labour expenditure for each species with line 7 giving the total direct labour expenditure
- column 4 giving the packaging material expenditure for each species with line 7 giving the total packaging material expenditure
- column 5 giving the revenue and expenditures which make up the gross trading profit
- column 6 giving the gross trading profit and all other taxable deductions which make up the net profit before taxes
- column 7 giving the net profit before taxes minus taxes and dividends giving the retained earnings
- column 8 giving the liabilities of the particular plant
- column 9 giving the assets of the particular plant
- column 10 giving the profit margins for each individual species
- column 11 giving the management and economic performance ratios

Table 6.4 giving the production viewpoint of the model is presented in ten columns, namely:

- column 1 giving the daily raw material supply available for each species
- column 2 giving the daily raw material bought for each species
- column 3 giving the daily production processing rate of fresh raw material for each species
- column 4 giving the daily freezing rate of round raw material to be processed later for each species
- column 5 giving the daily production processing rate of previously frozen raw material for each species

- column 6 giving the daily shipping rate of finished products for each species
- column 7 giving the quantity of fresh raw material held in inventory for each species
- column 8 giving the quantity of frozen raw material held in inventory for each species
- column 9 giving the quantity of finished product held in inventory for each species
- column 10 giving the management and economic performance ratios

At TIME = 0 the plant isn't operating (Table 6.3) however it does have total assets and liabilities of $1,250,000. From Table 6.4 we see that once the plant does start production, cod which has the highest unit profit margin[1] (MPC = 49¢) of the six species will receive production priority over the other species. Flounder with the second highest profit margin (MPHR) of 27.65¢ will be processed next. The remaining four species will be processed in the order of herring, squid, blueberries and mackerel.

From TIME = 0 to TIME = 48, the plant remains closed from a production viewpoint, however the plant does incur an expenditure of $70,300 thus reducing cash balance (CASHP) from $150,000 to $79,700. Of this expenditure, $49,050 is related to the payment of overhead expenses and loans with the balance of $21,250 being used to buy packaging material. The retained earnings (RETPRF) for this period is - $55,160.

Prior to TIME = 54 the plant begins production of herring, it is the first speciesto become available for processing (Table 6.3). At TIME = 54 the raw material (CMWP) is 3636 lbs. and since there is sufficient

1 Profit margin = Unit selling price - Unit direct production cost

cold storage capacity and market orders the plant buys all 3636 lbs. (CRMF) of herring. This 3636 lbs. of round herring is now held in inventory for processing the following day, however, while the plant is buying this raw material, it is processing 2727 lbs. of round herring that was bought the day before (CRMPF). All 2727 lbs. of round herring is processed into 1227 lbs. of butter-fly fillets (CMDP1) since there are sufficient production and freezing capacity. At the end of day 54, these 1227 lbs. of herring fillets will be stored in inventory waiting shipment to markets (CIAP). No inventory will be shipped until the shipping restriction of 20,000 lbs. has been met. With no cash being received from sales, the plant must continue to use up its cash reserves at an ever increasing rate because in addition to paying overhead expense, loan and packaging material cost it is now paying for raw material (CCRMP) and direct labour cost (CLCP). These cash expenditures have now reduced the cash balance (CASHP) to $30,530 and the retained earnings (RETPRF) to - $109,910.

At TIME = 66, Table 6.2, the plant has sales revenue (TRSP) of $8250 ($8200 from herring fillets and $50 from fish meal) however, no cash has been received from such sales (ARP). This causes the cash balance to continue its downward trend while retained earnings (RETPRF) do show a moderate increase from TIME = 54 due to increased sales revenue (TRSP), unsold inventory (VALIVU) and no overhead expenses and loans due. At TIME = 72 the plant does receive cash from sales however, the amount is greatly exceeded by cash expenditure.

In addition to herring, the plant begins production of cod and flounder at TIME = 78 (Table 6.4). Cod being the highest profit margin speciesis given first priority on the cold storage space available and meeting its market orders. Since the raw material available for cod (AMWP) doesn't exceed these restrictions, the plant buys all 2307 lbs. Flounder, the next highest profit margin speciesalso doesn't exceed these buying restrictions, therefore all 1155 lbs. available (BMWP) are bought. Only after the plant has bought all cod and flounder available in this case, does it consider buying herring, and since it can buy all herring available and still be within buying restrictions, all 18,180 lbs. are bought (CRMF).

The processing of three species at TIME = 78 coupled with overhead expense and interest payments made during this time resulted in a significant drop in retained earnings (RETPRF) from - $93,920 at TIME = 72 to - $148,290 and in cash balance from $31,350 at TIME = 72 to - $80,530, Table 6.2.

From TIME = 78 to TIME = 120 the processing plant continues to buy and process all raw material available since the buying and processing restrictions exceed the quantities of incoming raw material (Table 6.4). During this period, cash balance (CASHP) reaches a low of - $147,020 at TIME = 102 mainly due to overhead expenses and loan payments which are to be paid at this time, however, this situation improves to - $88,720 at TIME = 120. It is significant to note that at TIME = 120 there was accounts receivable balance (ARP) of $96,980 and inventory valued (VALIV) at $76,010 while the accounts payable (ACPAY) were $3382.

At TIME = 126 the plant loses its supply of herring (CMWP), due to end of the season, but continues to process cod and flounder until

TIME = 156 when supplies of squid (DMWP) and mackerel (FMWP) becomes available, Table 6.3 The accumulated quantities of all these species are still within the plant's cold storage and market order limitations thus all available quantities are bought. While these quantities of raw material are being bought the plant is processing the quantities bought the day before. Since the plant's production and freezing capacities exceed these quantities, all fresh raw material are processed on that day. The plant continues to buy and process all available quantities of these species up to TIME = 198.

From TIME = 126 to TIME = 144 the plant's financial statement begins to improve with retained earnings (RETPRF) increasing from - $116,710 to - $80,610 and cash balance (CASHP) increasing from - $111,370 to - $42,410. These improvements are mainly due to a leveling off in quantities of raw material bought and a steady increase in cash receivables. From TIME = 150 to TIME = 156 this trend reverses since with overhead expenses and interest due on short term loan coupled with a long term loan interest payment (TINCTP) of $50,000, the retained earnings decreased to - $161,360 and cash balance to - $203,100.

At TIME = 204 two additional species, herring and blueberries, become available supplies of raw material. Since these species in addition to cod, flounder, squid and mackerel are all within the cold storage and market orders limitations, all available quantities are bought. The quantity of raw material that is held in inventory for processing is made up of 15,380 lbs. of cod, 7700 lbs. of flounder, 2727 lbs. of herring, 21,000 lbs. of squid, 18,000 lbs. of blueberries and 21,000 lbs. of mackerel which is within the daily plant's freezer capacity (TFVC1) of 100,000 lbs., however it exceeds the plant's daily production capacity by 15,943 lbs. of mackerel. Thus 15,943 lbs. of mackerel cannot be processed that day, however, there is sufficient freezer capacity to freeze all 15,943 lbs. of mackerel (FFNP) where it is held in cold storage for later processing. This procedure of freezing excess raw material continues until TIME = 228, when the available supply of raw material drops below the plant's production capacity. With this excess plant production capacity, frozen raw material is thawed and processed until maximum production is reached. The processing of frozen raw material held in cold storage continues until TIME = 240.

From TIME = 156 to TIME = 276 retained earnings (RETPRF) and cash balances (CASHP) generally show an increasing trend. This trend results from a build up in cash receivables which is exceeding cash expenditures on production. At TIME = 198 the plant finally shows a profit (RETPRF) of $470 with cash receivables (ARP) of $179,990 while cash balance is - $132,120. At TIME = 240 the cash balance shows a plus value of $113,520.

At TIME = 276 the plant no longer has a supply of raw material thus the retained earnings remain constant until at TIME = 300 when end of the year overhead expenses have to be accounted. The cash balance shows a steady increase from TIME = 276 since the plant is continuing to receive cash payments from previous sales (ARP).

The production quantities and value of products produced for the year are:

	Finished Product Production (lbs./yr.)	Selling Price ($/lb.)	Value of Finished Product ($/yr.)
COD	659,800	1.00	659,800
FLOUNDER	220,200	0.96	211,410
HERRING	900,000	0.41	368,640
SQUID	1,995,000	0.27	538,640
BLUEBERRIES	405,000	0.72	291,600
MACKEREL	1,338,000	0.15	200,680
FISH MEAL	2,469,200	0.0025	6,173
Total	7,987,200		2,277,300

At TIME = 300, the year end financial statement is as follows:

Total sales revenue for the year (TRSP)	$2,277,300
Total raw material cost (TRMCP)	$ 835,510
Total direct labour cost (TLCP)	$ 353,590
Total packaging material cost (TCPGP)	$ 194,010
Total production expense (TPRODE)	$ 264,000
Total short term financing interest (TINBLP)	$ 7,430
Total depreciation on fixed assets (TDEP)	$ 73,333
Total overhead accrued from head office (TOFOH)	$ 57,000
Total administration expense (TADE)	$ 87,600
Total interest on long term loan (TINLTP)	$ 50,000
Total selling expense (TSLE)	$ 180,000
Total taxes (TTAXA)	$ 85,650
Total dividends (TDIVA)	$ 8,915
Total retained earnings (RETPRF)	$ 80,230

The assets and liabilities for the year obtained from Table 6.3 are given in Table 6.5.

Cash balance is a very important factor in the daily operation of a fish plant. It is presented in a graphical form on page 137 in

TABLE 6.5

ASSETS AND LIABILITIES FOR THE YEAR

ASSETS	Beginning of Year	End of Year
Value of fixed assets (BFAST)	$1,100,000	$1,026,700
Cash (CASHP)	$150,000	$300,940
Accounts receivable (ARP)	-	$900
Value of inventory (VALIV)	-	$4,890
TOTAL ASSETS (TLAST)	$1,250,000	$1,333,400
LIABILITIES		
Share capital (SHRCAP)	$250,000	$250,000
Long term loan (BLTL)	$1,000,000	$998,300
Accounts payable (ACPAY)	-	-
Retained earnings (RETPRF)	-	$80,230
Tax deferred (DERITX)	-	$2,647
Dividends deferred (DIVSPY)	-	$2,228
TOTAL LIABILITIES (TLLIAB)	$1,250,000	$1,333,400

\- nil

Table 6.3. A quick look at the graph shows that the minimum cash balance at any time does not exceed the maximum bank limit (BLIMIT) of $250,000.

CHAPTER 7

SCENERIOS OF AN INSHORE FISH PROCESSING PLANT

7.1 Introduction

A computer simulation model is an extremely useful management tool for showing the effects on the actual system when different data is inputed into the model. Unlike real life, all conditions but one, can be held constant and a particular time-history repeated to see the effect of the condition that was changed. Circumstances can be studied that might seldom be encountered in the real world. Changes that might seem to be too risky to try in practice can be investigated. The manager can now have a laboratory situation in which he can observe various anticipated dynamic behaviors of the system at low cost, that would seldom be obtainable from trial on real organizations.

The approach presented in this report when applied to the system dynamic model of an inshore fish processing plant gives the manager a tool which is useful in formulating various plant operating strategies.

In the following sections, different scenerios will be presented as examples of the applications of the modelling technique.

7.2 Scenerio For 100% Increase in Supply of Raw Material For All Species as Compared to Basic Model Discussed in Section 6.4

7.2.1 Production Viewpoint

Table 7.1 gives the computer print-out for the inshore fish processing model from its production viewpoint when the quantity of raw material available has been doubled in relation to those values as discussed in Chapter 6 with all other variables kept constant. The computer print-out is given every six days.

The plant remains closed from TIME = 0 to TIME = 48 since there isn't a supply of raw material available (Table 7.1). At TIME = 54 the plant has started production and since there is sufficient cold storage capacity and market orders, the plant buys all 3272 lbs. of raw material available (CMWP). There is also sufficient production and freezer capacity to process on day 54 all 5454 lbs. of fresh raw material (CRMPL), held in inventory from the day before, into 2454 lbs. of butter-fly herring fillets. The plant continues to buy and process all raw material available up to TIME 84 since the buying and processing limitations exceed the quantities of incoming raw material.

At TIME = 90 the plant continues to have sufficient cold storage capacity and market orders for buying all available raw material, however, now there isn't sufficient production capacity to process all 21,532 lbs. of cod (ARMPL), 10,780 lbs. of flounder (BRMPL) and 36,360 lbs. of herring (CRMPL). The 21,532 lbs. of cod is processed into 7,106 lbs. of cod fillets (AMDP1) and the 10,780 lbs. of flounder into 2376.6. lbs. of flounder fillets (BMDP1) while herring, being the lowest priority species of the three, has only 22,298 lbs. processed into 10,034 lbs. of butter-fly herring fillets with the remaining 14,062 lbs. frozen round since there is sufficient freezer capacity (TFVC1). This approach of freezing excess herring and holding in cold storage for later processing continues to TIME = 120.

At TIME = 108 only 18,898 lbs. of a possible 30,906 lbs. of herring was bought (CRMF) since there was no market orders for the remaining 12,008 lbs. However at TIME = 120 there are sufficient market orders due to a drop in raw material available (CMWP). At TIME = 126 there is no longer a supply of herring, so the plant begins processing frozen herring with its excess production capacity until TIME = 156.

At TIME = 156 raw material supplies of squid and mackerel in addition to cod and flounder are available to the plant. There is sufficient cold storage capacity to buy all available species, however there has been a drop in market order for flounder, thus only 8,439 lbs. of 15,400 lbs. is bought. This drop in demand for flounder fillets continue until TIME = 216 when the raw material supply decreases. From TIME = 156 to TIME = 168 all quantities of fresh cod, flounder, and squid held in inventory are processed while quantities of mackerel which exceed production capacity are frozen for processing later.

From TIME = 174 to TIME = 264 the plant's cold storage facilities are filled to capacity and the plant only buys new raw material when finished goods have been shipped to their markets. Since there is limited cold storage capacity only the higher priority species are bought. When there isn't sufficient production capacity the appropriate quantities are frozen while if there is excess production capacity, frozen raw material is processed.

At TIME = 276 there is excess cold storage capacity, however, now there is no longer a supply of raw material. The plant continues processing all remaining frozen raw material until they become exhausted on which time the plant closes for the season.

TABLE 7.1

COMPUTER PRINT-OUT FOR 100% INCREASE IN SUPPLY OF RAW MATERIAL FOR ALL SPECIES AS COMPARED TO BASIC MODEL DISCUSSED IN SECTION 6.4, PRODUCTION VIEWPOINT

	ARR111	ARR21	BRR111	BRR21	BRR511	BRR61	CRR111	CRR21	DRR111	DRR21
PRESENT	770.0	15.40T	1818.	36.36T	1818.	36.36T	2100.	42.00T	1538.	30.76T
ORIGINAL	385.0	7700.	909.0	18.18T	909.0	18.18T	1050.	21.00T	769.0	15.38T

	ERR111	ERR21	FRR11	QUAHR	QUAHF	QUAM	QUAC	QUAS	QUAR
PRESENT	2100.	42.00T	36.00T	500.0T	850.0T	2800.T	1400.T	4000.T	920.0T
ORIGINAL	1050.	21.00T	18.00T	250.0T	425.0T	1400.T	700.0T	2000.T	460.0T

TIME	AMWP	ARMF	AMDP1	AFMP	AMDP2	ASSP	ARMPL	ARMPF	AIAP	MPEF
	BMWP	BRMF	BMDP1	BFMP	BMDP2	BSSP	BRMPL	BRMPF	BIAP	PPEF
	CMWP	CRMF	CMDP1	CFMP	CMDP2	CSSP	CRMPL	CRMPF	CIAP	MPE
	DMWP	DRMF	DMDP1	DFMP	DMDP2	DSSP	DRMPL	DRMPF	DIAP	MPC
	EMWP	ERMF	EMDP1	EFMP	EMDP2	ESSP	ERMPL	ERMPF	EIAP	MPS
	FMWP	FRMF	FMDP1	FFMP	FMDP2	FSSP	FRMPL	FRMPF	FIAP	SPF
- - - - - - - - - -										
E+00	E+03	E+03	E+03	E+00	E+00	E+03	E+03	E+00	E+03	E+00
	E+03	E+03	E+00	E+00	E+00	E+03	E+03	E+00	E+03	E+00
	E+03	E+03	E+03	E+03	E+00	E+03	E+03	E+03	E+03	E-03
	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+00
	E+03	E+00	E+00	E+03	E+00	E+00	E+03	E+03	E+03	E+00
	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+00
- - - - - - - - - -										
.0	.000	.000	.000	0.	0.	.000	.000	0.	.000	.27650
	.000	.000	.0	0.	0.	.000	.000	0.	.000	.20205
	.000	.000	.000	.000	.0	.000	.000	.00	.000	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
- - - - - - - - - -										
6.	.000	.000	.000	0.	0.	.000	.000	0.	.000	.27650
	.000	.000	.0	0.	0.	.000	.000	0.	.000	.20205
	.000	.000	.000	.000	.0	.000	.000	.00	.000	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
- - - - - - - - - -										
12.	.000	.000	.000	0.	0.	.000	.000	0.	.000	.27650
	.000	.000	.0	0.	0.	.000	.000	0.	.000	.20205
	.000	.000	.000	.000	.0	.000	.000	.00	.000	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
- - - - - - - - - -										

TABLE 7.1 Continued

18.	.000	.000	.000	0.	0.	.000	.000	0.	.000	.27650
	.000	.000	.0	0.	0.	.000	.000	0.	.000	.20205
	.000	.000	.000	.000	.0	.000	.000	.00	.000	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
24.	.000	.000	.000	0.	0.	.000	.000	0.	.000	.27650
	.000	.000	.0	0.	0.	.000	.000	0.	.000	.20205
	.000	.000	.000	.000	.0	.000	.000	.00	.000	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
30.	.000	.000	.000	0.	0.	.000	.000	0.	.000	.27650
	.000	.000	.0	0.	0.	.000	.000	0.	.000	.20205
	.000	.000	.000	.000	.0	.000	.000	.00	.000	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
36.	.000	.000	.000	0.	0.	.000	.000	0.	.000	.27650
	.000	.000	.0	0.	0.	.000	.000	0.	.000	.20205
	.000	.000	.000	.000	.0	.000	.000	.00	.000	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
42.	.000	.000	.000	0.	0.	.000	.000	0.	.000	.27650
	.000	.000	.0	0.	0.	.000	.000	0.	.000	.20205
	.000	.000	.000	.000	.0	.000	.000	.00	.000	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
48.	.000	.000	.000	0.	0.	.000	.000	0.	.000	.27650
	.000	.000	.0	0.	0.	.000	.000	0.	.000	.20205
	.000	.000	.000	.000	.0	.000	.000	.00	.000	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311

TABLE 7.1 Continued

54.	.000	.000	.000	0.	0.	.000	.000	0.	.000	.27656
	.000	.000	.0	0.	0.	.000	.000	0.	.000	.20205
	7.272	7.272	2.454	.000	.0	.000	5.454	.00	2.454	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
60.	.000	.000	.000	0.	0.	.000	.000	0.	.000	.27656
	.000	.000	.0	0.	0.	.000	.000	0.	.000	.20205
	18.180	18.180	7.363	.000	.0	.000	16.362	.00	9.452	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
66.	.000	.000	.000	0.	0.	.000	.000	0.	.000	.27656
	.000	.000	.0	0.	0.	.000	.000	0.	.000	.20205
	29.088	29.088	12.272	.000	.0	20.000	27.270	.00	25.900	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
72.	.000	.000	.000	0.	0.	.000	.000	0.	.000	.27656
	.000	.000	.0	0.	0.	.000	.000	0.	.000	.20205
	36.360	36.360	16.362	.000	.0	20.000	36.360	.00	31.801	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
78.	4.614	4.614	1.015	0.	0.	.000	3.076	0.	.568	.27656
	2.310	2.310	338.8	0.	0.	.000	1.540	0.	.165	.20205
	36.360	36.360	16.362	.000	.0	20.000	36.360	.00	29.973	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
84.	13.842	13.842	4.060	0.	0.	.000	12.304	0.	14.211	.27656
	6.930	6.930	1355.2	0.	0.	.000	6.160	0.	4.743	.20205
	36.360	36.360	16.362	.000	.0	20.000	36.360	.00	28.145	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311

TABLE 7.1 Continued

90.	23.070	23.070	7.106	0.	0.	20.000	21.532	0.	26.186	.27650
	11.550	11.550	2371.6	0.	0.	.000	10.780	0.	15.415	.20205
	36.360	36.360	10.034	14.062	.0	.000	36.360	29.92	12.855	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
96.	30.760	30.760	10.151	0.	0.	.000	30.760	0.	16.433	.27650
	15.400	15.400	3388.0	0.	0.	.000	15.400	0.	12.166	.20205
	36.360	36.360	2.763	30.220	.0	.000	36.360	154.68	14.882	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
102.	30.760	30.760	10.151	0.	0.	.000	30.760	0.	17.337	.27650
	15.400	15.400	3388.0	0.	0.	.000	15.400	0.	12.514	.20205
	36.360	36.360	2.763	30.220	.0	.000	36.360	336.00	11.460	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
108.	30.760	30.760	10.151	0.	0.	.000	30.760	0.	16.242	.27650
	15.400	15.400	3388.0	0.	0.	.000	15.400	0.	12.842	.20205
	30.906	18.896	2.763	12.936	.0	.000	19.076	501.95	8.038	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
114.	30.760	30.760	10.151	0.	0.	.000	30.760	0.	19.147	.27650
	15.400	15.400	3388.0	0.	0.	.000	15.400	0.	13.170	.20205
	19.998	17.831	2.763	11.869	.0	.000	18.009	576.90	4.616	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
120.	30.760	30.760	10.151	0.	0.	20.000	30.760	0.	20.052	.27650
	15.400	15.400	3388.0	0.	0.	.000	15.400	0.	13.498	.20205
	9.090	9.090	2.763	4.768	.0	20.000	10.908	637.18	21.194	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311

TABLE 7.1 Continued

126.	30.760	30.760	10.151	0.	0.	20.000	30.760	0.	20.956	.27650
	15.400	15.400	3388.0	0.	0.	.000	15.400	0.	13.826	.20205
	.000	.000	.000	.000	2486.7	.000	.000	638.52	17.434	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
132.	30.760	30.760	10.151	0.	0.	20.000	30.760	0.	21.661	.27650
	15.400	15.400	3388.0	0.	0.	.000	15.400	0.	14.154	.20205
	.000	.000	.000	.000	2486.7	.000	.000	601.68	12.354	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
138.	30.760	30.760	10.151	0.	0.	20.000	30.760	0.	22.766	.27650
	15.400	15.400	3388.0	0.	0.	.000	15.400	0.	14.482	.20205
	.000	.000	.000	.000	2486.7	.000	.000	564.84	7.274	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
144.	30.760	30.760	10.151	0.	0.	20.000	30.760	0.	23.671	.27650
	15.400	15.400	3388.0	0.	0.	.000	15.400	0.	14.810	.20205
	.000	.000	.000	.000	2486.7	20.000	.000	528.00	22.194	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
150.	30.760	30.760	10.151	0.	0.	20.000	30.760	0.	24.576	.27650
	15.400	15.400	3388.0	0.	0.	.000	15.400	0.	15.138	.20205
	.000	.000	.000	.000	2486.7	.000	.000	491.16	17.114	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
156.	30.760	30.760	10.151	0.	0.	20.000	30.760	0.	25.480	.27650
	15.400	8.439	3388.0	0.	0.	.000	15.400	0.	15.466	.20205
	.000	.000	.000	.000	.0	.000	.000	469.91	5.720	60.000
	2.100	2.100	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	12.600	12.600	8.187	2.313	.000	20.000	10.500	.21	20.79	.16311

TABLE 7.1 Continued

162.	30.760	30.760	10.151	0.	0.	20.000	30.760	0.	26.385	.27650
	15.400	6.447	1426.4	0.	0.	.000	6.484	0.	6.496	.20205
	.000	.000	.000	.000	.0	5.145	.000	457.21	5.145	60.000
	14.700	14.700	12.600	.000	.000	.000	12.600	.00	11.50	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	42.000	42.000	13.419	28.581	.000	20.000	42.000	9.51	25.99	.16311
168.	30.760	30.760	10.151	0.	0.	20.000	30.760	0.	27.290	.27650
	15.400	6.229	1378.4	0.	0.	.000	6.265	0.	14.935	.20205
	.000	.000	.000	.000	.0	.000	.000	457.21	.000	60.000
	27.300	27.300	25.200	.000	.000	20.000	25.200	.00	38.60	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	42.000	42.000	1.256	40.744	.000	.000	42.000	211.40	16.10	.16311
174.	30.760	30.760	10.151	0.	0.	20.000	30.760	0.	28.195	.27650
	15.400	6.011	1330.4	0.	0.	.000	6.047	0.	3.085	.20205
	.000	.000	.000	.000	3098.4	5.524	.000	443.57	5.524	60.000
	39.900	34.108	16.692	.000	.000	20.000	16.692	17.28	58.98	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	42.000	.000	.000	.000	.000	.000	.000	364.52	.00	.16311
180.	30.760	30.760	10.151	0.	0.	20.000	30.760	0.	29.100	.27650
	15.400	5.909	1300.0	0.	0.	.000	5.909	0.	10.959	.20205
	.000	.000	.000	.000	3979.1	11.075	.000	416.22	11.075	60.000
	42.000	39.625	14.068	.000	.000	20.000	14.069	27.31	64.86	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	42.000	.000	.000	.000	.000	.000	.000	364.52	.00	.16311
186.	30.760	30.760	10.151	0.	0.	20.000	30.760	0.	30.004	.27650
	15.400	5.909	1300.0	0.	0.	.000	5.909	0.	18.759	.20205
	.000	.000	.000	.000	3904.4	11.783	.000	387.12	11.783	60.000
	42.000	40.332	14.314	.000	.000	20.000	14.314	42.53	69.06	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	42.000	.000	.000	.000	.000	.000	.000	364.52	.00	.16311
192.	30.760	30.760	10.151	0.	0.	.000	30.760	0.	10.909	.27650
	15.400	5.909	1300.0	0.	0.	.000	5.909	0.	6.559	.20205
	.000	.000	.000	.000	.0	.000	.000	360.89	4.797	60.000
	42.000	15.597	27.168	7.209	.000	20.000	34.378	71.91	77.11	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	42.000	.000	.000	.000	.000	.000	.000	364.52	.00	.16311

TABLE 7.1 Continued

198.	30.760	30.760	10.151	0.	0.	.000	30.760	0.	11.814	.27650
	15.400	5.909	1300.0	0.	0.	.000	5.909	0.	16.359	.20205
	.000	.000	.000	.000	.0	.000	.000	332.66	3.832	60.000
	42.000	14.179	27.168	13.780	.000	20.000	40.948	81.88	82.48	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	42.000	.000	.000	.000	.000	.000	.000	364.52	.00	.16311
204.	30.760	30.760	10.151	0.	0.	.000	30.760	0.	12.719	.27650
	15.400	6.189	1333.6	0.	0.	.000	6.062	0.	2.164	.20205
	7.272	7.272	2.454	.000	.0	.000	5.454	304.55	17.668	60.000
	42.000	8.220	19.591	22.409	.000	20.000	42.000	99.03	80.69	.49091
	36.000	0.	0.	1.943	0.	0.	1.943	.000	.000	.17000
	42.000	.000	.000	.000	.000	.000	.000	364.52	.00	.16311
210.	23.070	23.070	8.121	0.	0.	.000	24.608	0.	10.578	.27650
	11.550	6.953	1501.6	0.	0.	.000	6.825	0.	10.580	.20205
	18.180	18.180	7.363	.000	.0	.000	18.362	288.33	11.235	60.000
	42.000	5.248	11.722	12.978	.000	20.000	24.701	151.60	28.74	.49091
	36.000	0.	0.	15.177	0.	0.	15.177	10.288	.000	.17000
	42.000	.000	.000	2.999	.000	.000	2.999	364.52	.00	.16311
216.	13.842	13.842	5.075	0.	0.	.000	15.380	0.	11.669	.27650
	6.930	6.930	1669.6	0.	0.	20.000	7.589	0.	20.015	.20205
	29.068	29.068	12.272	.000	.0	.000	27.270	269.20	15.432	60.000
	42.000	4.595	7.955	9.211	.000	.000	17.166	175.67	4.14	.49091
	36.000	0.	0.	5.465	0.	0.	5.465	29.003	.000	.17000
	39.900	.000	.000	.000	.000	.000	.000	367.52	.00	.16311
222.	4.614	4.614	2.030	0.	0.	.000	6.152	0.	14.528	.27650
	2.310	2.310	677.6	0.	0.	.000	3.080	0.	7.614	.20205
	36.360	36.360	16.362	.000	2360.4	20.000	36.360	235.83	28.241	60.000
	42.000	24.869	9.386	.000	.000	20.000	9.387	201.73	23.35	.49091
	36.000	0.	0.	.000	0.	0.	.000	38.054	.000	.17000
	27.300	.000	.000	.000	.000	.000	.000	367.52	.00	.16311
228.	.000	.000	.000	0.	0.	19.604	.000	0.	19.604	.27650
	.000	.000	.0	0.	0.	9.308	.000	0.	9.308	.20205
	36.360	36.360	16.362	.000	8469.1	20.000	36.360	213.12	35.614	60.000
	42.000	42.000	3.638	.000	.000	20.000	3.638	208.07	46.27	.49091
	.000	0.	0.	.000	0.	0.	.000	38.054	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	367.52	.00	.16311

TABLE 7.1 Continued

234.	.000	.000	.000	0.	0.	.000	.000	0.	.000	.27650
	.000	.000	.0	0.	0.	.000	.000	0.	.000	.20205
	36.360	36.360	16.362	.000	1325.7	20.000	36.360	180.05	27.179	60.000
	42.000	26.996	27.155	.000	.000	20.000	27.155	229.03	71.30	.49091
	.000	0.	0.	.000	0.	0.	.000	38.054	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	367.52	.00	.16311
240.	.000	.000	.000	0.	0.	.000	.000	0.	.000	.27650
	.000	.000	.0	0.	0.	.000	.000	0.	.000	.20205
	36.360	36.360	16.362	.000	1684.7	20.000	36.360	141.66	40.898	60.000
	42.000	34.913	25.974	.000	.000	20.000	25.974	229.03	89.23	.49091
	.000	0.	0.	.000	0.	0.	.000	38.054	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	367.52	.00	.16311
246.	.000	.000	.000	0.	0.	.000	.000	0.	.000	.27650
	.000	.000	.0	0.	0.	.000	.000	0.	.000	.20205
	36.360	36.360	16.362	.000	1652.8	20.000	36.360	120.16	27.778	60.000
	42.000	25.586	26.079	.000	.000	20.000	26.079	232.43	129.68	.49091
	.000	0.	0.	.000	0.	0.	.000	38.054	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	367.52	.00	.16311
252.	.000	.000	.000	0.	0.	.000	.000	0.	.000	.27650
	.000	.000	.0	0.	0.	.000	.000	0.	.000	.20205
	36.360	36.360	16.362	.000	1655.8	20.000	36.360	80.36	42.066	60.000
	37.800	35.038	26.069	.000	.000	20.000	26.069	232.43	145.74	.49091
	.000	0.	0.	.000	0.	0.	.000	38.054	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	367.52	.00	.16311
258.	.000	.000	.000	0.	0.	.000	.000	0.	.000	.27650
	.000	.000	.0	0.	0.	.000	.000	0.	.000	.20205
	30.906	30.906	14.726	.000	9046.9	20.000	32.724	40.06	35.744	60.000
	25.200	6.504	6.584	.000	.000	20.000	6.584	235.95	163.55	.49091
	.000	0.	0.	.000	0.	0.	.000	38.054	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	367.52	.00	.16311
264.	.000	.000	.000	0.	0.	.000	.000	0.	.000	.27650
	.000	.000	.0	0.	0.	.000	.000	0.	.000	.20205
	19.998	19.998	9.817	.000	.0	20.000	21.816	.00	28.051	60.000
	12.600	6.024	6.104	.000	40.327	20.000	6.104	73.09	228.42	.49091
	.000	0.	0.	.000	0.	0.	.000	38.054	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	367.52	.00	.16311

TABLE 7.1 Continued

270.	.000	.000	.000	0.	0.	.000	.000	0.	.000	.27650
	.000	.000	.0	0.	0.	.000	.000	0.	.000	.20205
	9.090	9.090	4.909	.000	.0	.000	10.908	.00	14.682	60.000
	.000	.000	2.100	.000	.000	20.000	2.100	.00	208.17	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	10.823	.17000
	.000	.000	.000	.000	57.020	20.000	.000	163.14	123.94	.16311
276.	.000	.000	.000	0.	0.	.000	.000	0.	.000	.27650
	.000	.000	.0	0.	0.	.000	.000	0.	.000	.20205
	.000	.000	.000	.000	.0	.000	.000	.00	11.863	60.000
	.000	.000	.000	.000	.000	20.000	.000	.00	90.22	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	20.000	.000	.00	150.77	.16311
282.	.000	.000	.000	0.	0.	.000	.000	0.	.000	.27650
	.000	.000	.0	0.	0.	.000	.000	0.	.000	.20205
	.000	.000	.000	.000	.0	.000	.000	.00	.000	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	10.22	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	20.000	.000	.00	30.77	.16311
288.	.000	.000	.000	0.	0.	.000	.000	0.	.000	.27650
	.000	.000	.0	0.	0.	.000	.000	0.	.000	.20205
	.000	.000	.000	.000	.0	.000	.000	.00	.000	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
294.	.000	.000	.000	0.	0.	.000	.000	0.	.000	.27650
	.000	.000	.0	0.	0.	.000	.000	0.	.000	.20205
	.000	.000	.000	.000	.0	.000	.000	.00	.000	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311
300.	.000	.000	.000	0.	0.	.000	.000	0.	.000	.27650
	.000	.000	.0	0.	0.	.000	.000	0.	.000	.20205
	.000	.000	.000	.000	.0	.000	.000	.00	.000	60.000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.49091
	.000	0.	0.	.000	0.	0.	.000	.000	.000	.17000
	.000	.000	.000	.000	.000	.000	.000	.00	.00	.16311

7.2.2 Economic Viewpoint

Table 7.2 presents the associated economic viewpoint for the inshore fish processing model when the quantities of raw material available has been doubled while all other variables remain constant. The computer print-out is given every 150 days.

From this print-out we see that the retained earnings at TIME 300 has increased from its original value of $80,230 (Table 6.2) to $222,080. This increase in retained earnings is attributed to the plant processing larger quantities of higher profitable species, i.e., cod, flounder and herring. Since the plant does have larger quantities of raw material available it can be selective on which species it processes so as to obtain higher profit, while in the original print-out (Table 6.2) there was a limited supply of raw material resulting in the processing operation running consistently at lower than plant capacity. With larger quantities of raw material available, the plant was able to freeze large quantities of raw material for processing later. While the freezing of raw material does give a lower marginal profit for the particular species, this approach does result in the plant operating for a longer season with higher daily processing rates.

The processing of such large quantities of raw material has resulted in cash balance (CASHP) dropping at TIME = 150 to - $286,690, which is above the $250,000 bank limit for short term financing (BLIMIT). Considering that the plant has accounts receivables (ARP) at TIME = 150 of $177,750 and cash balance at TIME = 300 of $332,960, the bank should not have any difficulty securing the extra cash required.

TABLE 7.2

COMPUTER PRINT-OUT FOR 100% INCREASE IN SUPPLY OF RAW MATERIAL FOR ALL SPECIES AS COMPARED TO BASIC MODEL DISCUSSED IN SECTION 6.4, ECONOMIC VIEWPOINT

	ARR111	ARR21	BRR111	BRR21	BRR511	BRR61	CRR111	CRR21	DRR111
PRESENT	770.0	15.40T	1818.	36.36T	1818.	36.36T	2100.	42.00T	1538.
ORIGINAL	385.0	7700.	909.0	18.18T	909.0	18.18T	1050.	21.00T	769.0

	DRR21	ERR111	ERR21	FRR11	QUAHR	QUAHF	QUAM	QUAC	QUAS	QUAB
PRESENT	30.76T	2100.	42.00T	36.00T	500.0T	850.0T	2800.T	1400.T	4000.T	920.0T
ORIGINAL	15.38T	1050.	21.00T	18.00T	250.0T	425.0T	1400.T	700.0T	2000.T	460.0T

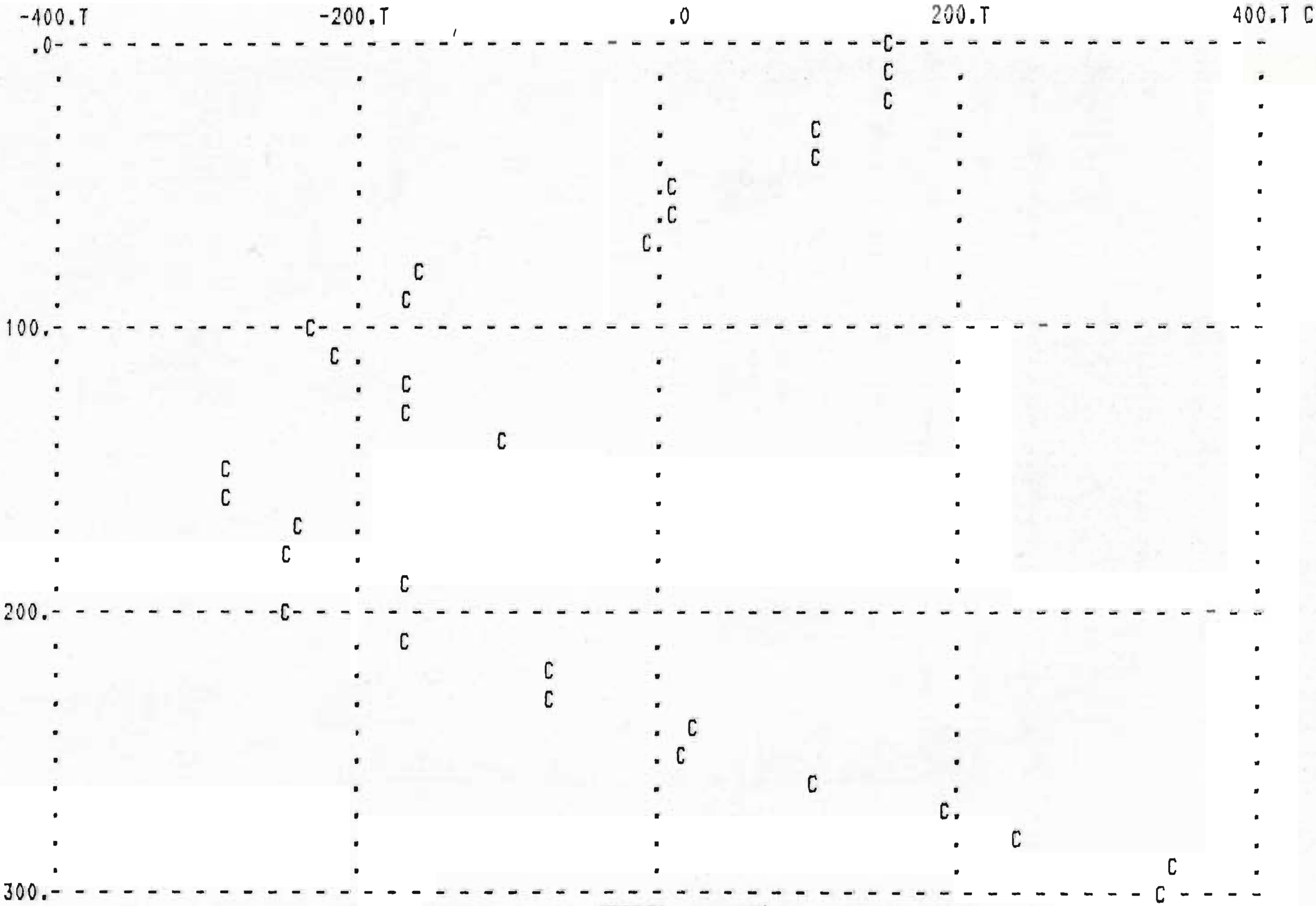
RUN-DOUBLE FISH PROCESSI MODEL OF A NFLD INSHORE FREEZER PLANT

TIME	AFGRP	ACRMP	ALCP	ACPGP	TRSP	GTMP	NPBT	SHRCAP	EEE	MPHR	GPR
	BFGRP	BCRMP	BLCP	BCPGP	VALIVU	TINBLP	TTAXA	BLTL	TDEP	MPHF	OPR
	CFGRP	CCRMP	CLCP	CCPGP	TRMCP	TDEP	TDIVA	RETPRF	BFAST	MPM	EXR
	DFGRP	DCRMP	DLCP	DCPGP	TLCP	TOFOH	RETPRF	ACPAY	CASHP	MPC	NPBTR
	EFGRP	ECRMP	ELCP	ECPGP	TCPGP	TADE		DERITX	ARP	MPS	ROCER
	FFGRP	FCRMP	FLCP	FCPGP	TPRODE	TINLTP		DIVSPY	VALIV	MPB	ROTASR
	QFGRP	TRMCP	TLCP	TCPGP	GTMP	TSLE		CURLIB	CURAST		
	TRSP					NPBT		TLLIAB	TLAST		
- - - - - - - - -											
E+00	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E-03	E+00
	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+00	E+03	E+00	E+00
	E+03	E+03	E+00	E+00	E+03	E+03		E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+00	E+03	E+03		E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03		E+03	E+03		
	E+03					E+03		E+03	E+03		
- - - - - - - - -											

.0	.0	.00	.00	.000	.0	.00	.00	250.00	1100.0	.27650	.00000
	.00	.00	.00	.000	.00	.000	.00	1000.0	.000	.20205	.0000
	.00	.00	.00	.000	.0	.000	.000	.00	1100.0	60.000	.0000
	.00	.00	.000	.000	.00	.000	.00	.0	150.00	.49091	.0000
	.000	.000	.0	.0	.00	.000		.00	.00	.17000	.0000
	.000	.000	.000	.0	.00	.000		.000	.00	.16311	.00000
	.000	.0	.00	.00	.00	.00		.00	150.00		
	.0					.00		1250.0	1250.0		
- - - - - - - - -											
150.	620.0	263.69	97.66	31.721	1070.2	250.23	46.57	250.00	1100.0	.27650	.23381
	192.00	117.35	76.32	12.705	96.23	4.693	22.82	1000.0	36.667	.20205	.7662
	254.20	115.35	37.72	31.731	496.4	36.667	2.375	21.38	1063.3	60.000	.1560
	.00	.00	.000	.000	211.71	28.500	21.38	6000.6	-286.69	.49091	.0435
	.000	.000	.0	.0	76.16	43.800		14.13	177.75	.17000	.2028
	.000	.000	.000	.0	132.00	.000		1.470	338.57	.16311	.01653
	4.050	496.4	211.71	76.16	250.23	90.00		21.60	229.64		
	1070.2					46.57		1293.0	1293.0		
- - - - - - - - -											
300.	1319.6	539.83	199.94	65.980	3037.5	942.12	483.84	250.00	1100.0	.27650	.31016
	316.13	179.62	116.83	19.758	.02	10.352	237.08	998.3	73.333	.20205	.6898
	709.02	234.45	100.02	86.466	1103.2	73.333	24.676	222.08	1026.7	60.000	.1267
	585.95	109.69	45.156	65.106	479.96	57.000	222.08	.0	332.96	.49091	.1593
	22.193	13.319	5533.8	1232.9	248.31	87.600		42.14	9.53	.17000	.9834
	73.218	26.244	12.490	9762.4	264.00	50.000		6.169	149.51	.16311	.14623
	11.399	1103.2	479.96	248.31	942.12	180.00		48.31	492.01		
	3037.5					483.84		1518.7	1518.7		
- - - - - - - - -											

TABLE 7.2 Continued

CASHP=C



7.3 Scenerio For Increasing Plant's Cold Storage Capacity by 300% and Raw Material Supply by 100% as Compared to Basic Model in Section 6.4

Table 7.3 gives the computer print-out for the inshore fish processing plant when cold storage capacity and raw material supply has increased by 300% and 100% respectively. The computer print-out is given every 150 days.

From this print-out we see that the retained earnings at TIME = 300 has increased from $222,080 (Table 7.2) to $248,950 when increasing cold storage capacity by 300%. With this increase in cold storage capacity the plant was able to freeze and process larger raw material quantities from TIME = 174 to TIME 264 (Table 7.1), however, it is doubtful if such a small increase, (10%) would be justifiable with the given raw material input pattern since construction and additional maintenance expense would also increase but were not considered for this computer print-out.

TABLE 7.3

COMPUTER PRINT-OUT FOR 300% INCREASE IN COLD STORAGE CAPACITY AND 100% INCREASE IN SUPPLY OF RAW MATERIAL FOR ALL SPECIES AS COMPARED TO BASIC MODEL DISCUSSED IN SECTION 6.4

	ARR111	ARR21	BRR111	BRR21	BRR511	BRR61	CRR111	CRR21	DRR111	TBBB
PRESENT	770.0	15.40T	1818.	36.36T	1818.	36.36T	2100.	42.00T	1538.	3000.T
ORIGINAL	385.0	7700.	909.0	18.18T	909.0	18.18T	1050.	21.00T	769.0	1000.T

	DRR21	ERR111	ERR21	FRR11	QUAHR	QUAHF	QUAM	QUAC	QUAS	QUAB
PRESENT	30.76T	2100.	42.00T	36.00T	500.0T	850.0T	2800.T	1400.T	4000.T	920.0T
ORIGINAL	15.38T	1050.	21.00T	18.00T	250.0T	425.0T	1400.T	700.0T	2000.T	460.0T

RUN-THREE FISH PROCESSI MODEL OF A NFLD INSHORE FREEZER PLANT

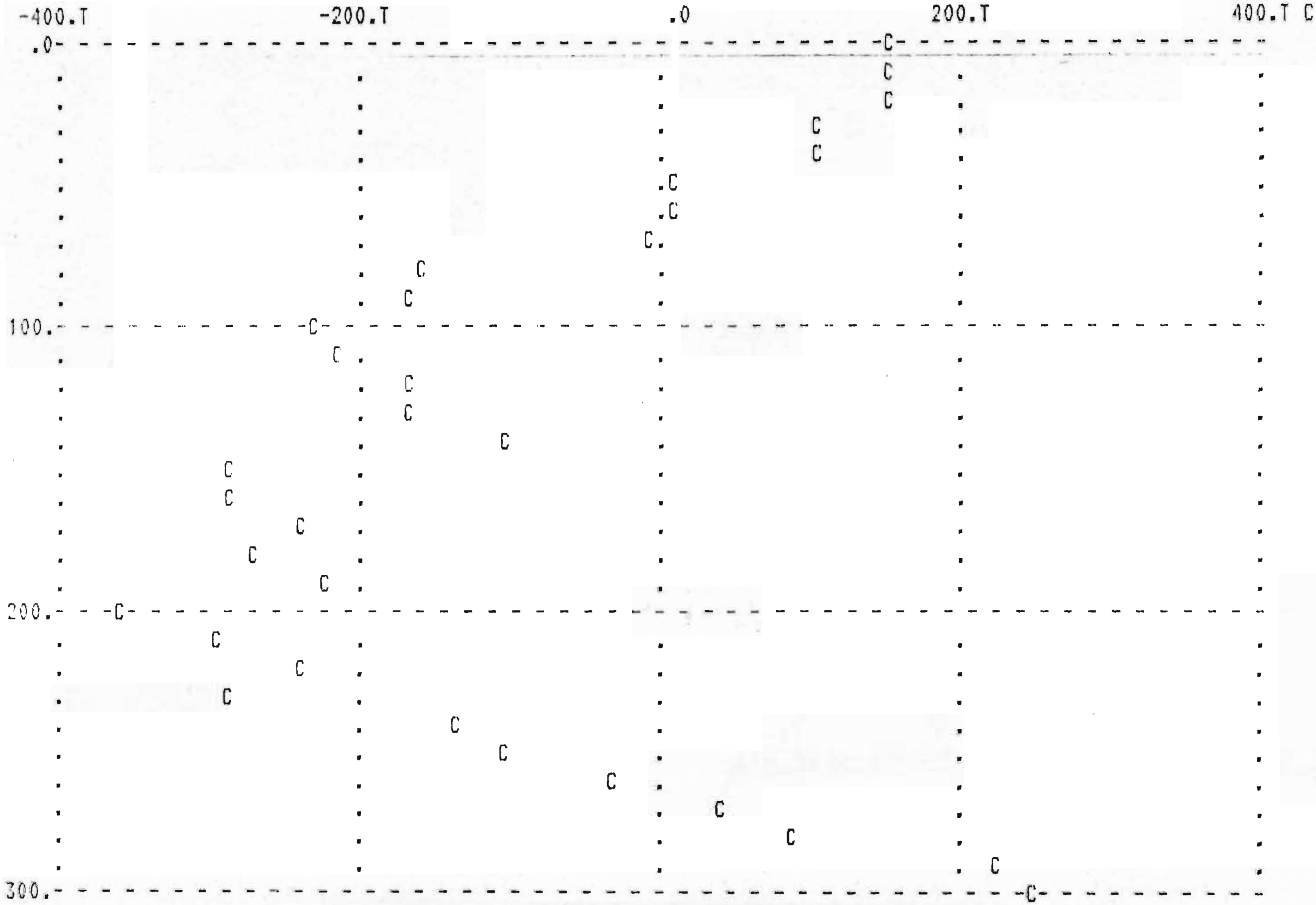
TIME	AFGRP	ACRMP	ALCP	ACPGP	TRSP	GTMP	NPBT	SHRCAP	EEE	MPHR	GPR
	BFGRP	BCRMP	BLCP	BCPGP	VALIVU	TINBLP	TTAXA	BLTL	TDEP	MPHF	OPR
	CFGRP	CCRMP	CLCP	CCPGP	TRMCP	TDEP	TDIVA	RETPRF	BFAST	MPM	EXR
	DFGRP	DCRMP	DLCP	DCPGP	TLCP	TOFOH	RETPRF	ACPAY	CASHP	MPC	NPBTR
	EFGRP	ECRMP	ELCP	ECPGP	TCPGP	TADE		DERITX	ARP	MPS	ROCER
	FFGRP	FCRMP	FLCP	FCPGP	TPRODE	TINLTP		DIVSPY	VALIV	MPB	ROTASR
	QFGRP	TRMCP	TLCP	TCPGP	GTMP	TSLE		CURLIB	CURAST		
	TRSP					NPBT		TLLIAB	TLAST		
- - - - - - - - -											
E+00	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E-03	E+00
	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+00	E+03	E+00	E+00
	E+03	E+03	E+03	E+00	E+03	E+03		E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03		E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03		E+03	E+03		
	E+03					E+03		E+03	E+03		
- - - - - - - - -											

TABLE 7.3 Continued

.0	.0	.00	.00	.000	.0	.0	.00	250.00	1100.0	.27650	.00000
	.00	.00	.00	.000	.00	.000	.00	1000.0	.000	.20205	.0000
	.00	.00	.00	.000	.0	.000	.000	.00	1100.0	60.000	.0000
	.00	.00	.000	.000	.00	.000	.00	.0	150.00	.49091	.0000
	.00	.000	.000	.0	.00	.000		.00	.00	.17000	.0000
	.00	.000	.000	.000	.00	.000		.000	.00	.16311	.00000
	.000	.0	.00	.00	.0	.00		.00	150.00		
	.0					.00		1250.0	1250.0		
- - - - - - - - -											
150.	620.0	263.69	97.66	31.721	1070.2	250.2	46.57	250.00	1100.0	.27650	.23381
	192.00	117.35	76.32	12.705	96.23	4.693	22.82	1000.0	36.667	.20205	.7662
	254.20	115.35	37.72	31.731	496.4	36.667	2.375	21.38	1063.3	60.000	.1560
	.00	.00	.000	.000	211.71	28.500	21.38	6000.6	-286.69	.49091	.0435
	.00	.000	.000	.0	76.16	43.800		14.13	177.75	.17000	.2028
	.00	.000	.000	.000	132.00	.000		1.470	338.57	.16311	.01653
	4.050	496.4	211.71	76.16	250.2	90.00		21.60	229.64		
	1070.2					46.57		1293.0	1293.0		
- - - - - - - - -											
300.	1319.6	539.83	199.94	65.980	3204.4	1003.4	542.38	250.00	1100.0	.27650	.31314
	316.13	179.62	116.83	19.758	129.64	13.109	265.77	998.3	73.333	.20205	.6869
	711.73	235.33	100.38	86.796	1244.6	73.333	27.661	248.95	1026.7	60.000	.1210
	577.09	109.69	46.935	64.122	544.38	57.000	248.95	.0	246.39	.49091	.1693
	160.20	91.950	36.327	8899.9	277.63	87.600		66.44	47.74	.17000	.9972
	108.11	88.201	43.974	32.074	264.00	50.000		6.915	249.80	.16311	.15851
	11.549	1244.6	544.38	277.63	1003.4	180.00		73.36	543.93		
	3204.4					542.38		1570.6	1570.6		
- - - - - - - - -											

TABLE 7.3 Continued

CASHP=C



7.4 Scenerio for 20% Increase in Raw Material Price for Cod as Compared to Basic Model in Section 6.4

Table 7.4 gives the computer print-out for the inshore fish processing plant when the raw material price for cod was increased by 20% while all other variables remain constant. The computer print-out is given every 150 days.

From this print-out we see that the retained earnings at TIME = 300 has reduced from its original value of $80,230 to $54,760 with a corresponding reduction in the unit marginal profit for cod from 49¢/lb to 41¢/lb., thus showing that retained earnings are very sensitive to raw materials price.

TABLE 7.4

COMPUTER PRINT-OUT FOR 20% INCREASE IN RAW MATERIAL PRICE FOR COD AS COMPARED TO BASIC MODEL IN SECTION 6.4

	RPC2
PRESENT	.2000
ORIGINAL	0.

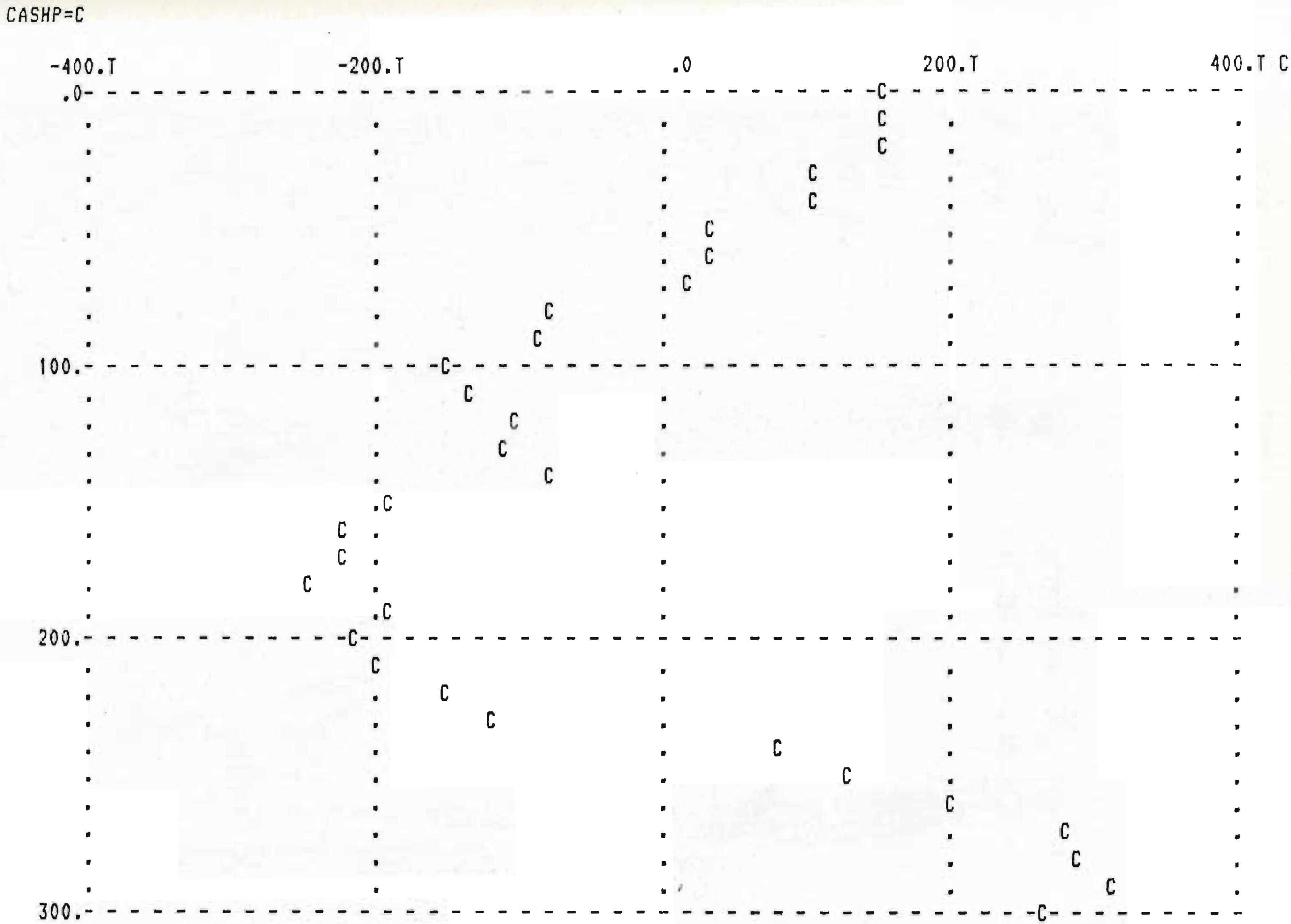
RUN-RAW FISH PROCESSI MODEL OF A NFLD INSHORE FREEZER PLANT

TIME	AFGRP	ACRMP	ALCP	ACPGP	TRSP	GTMP	NPBT	SHRCAP	EEE	MPHR	GPR
	BFGRP	BCRMP	BLCP	BCPGP	VALIVU	TINBLP	TTAXA	BLTL	TDEP	MPHF	OPR
	CFGRP	CCRMP	CLCP	CCPGP	TRMCP	TDEP	TDIVA	RETPRF	BFAST	MPM	EXR
	DFGRP	DCRMP	DLCP	DCPGP	TLCP	TOFOH	RETPRF	ACPAY	CASHP	MPC	NPBTR
	EFGRP	ECRMP	ELCP	ECPGP	TCPGP	TADE		DERITX	ARP	MPS	ROCER
	FFGRP	FCRMP	FLCP	FCPGP	TPRODE	TINLTP		DIVSPY	VALIV	MPB	ROTASR
	QFGRP	TRMCP	TLCP	TCPGP	GTMP	TSLE		CURLIB	CURAST		
	TRSP					NPBT		TLLIAB	TLAST		
- - - - - - - - -											
E+00	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+00	E+03	E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E-03	E+00
	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03		E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03		E+00	E+03	E+00	E+00
	E+00	E+03	E+03	E+03	E+03	E+03		E+03	E+03		
	E+03					E+03		E+03	E+03		
- - - - - - - - -											

TABLE 7.4 Continued

.0	.00	.00	.000	.000	.0	.00	.00	250.00	1100.0	.27650	.0000
	.00	.00	.000	.000	.00	.0	.00	1000.0	.000	.20205	.0000
	.00	.00	.000	.000	.00	.000	.000	.00	1100.0	60.000	.0000
	.00	.000	.000	.000	.00	.000	.00	.000	150.00	.40909	.0000
	.00	.00	.000	.000	.00	.000		.000	.00	.17000	.000
	.00	.000	.000	.000	.00	.000		.0	.00	.16311	.00000
	.0	.00	.00	.00	.00	.00		.000	150.00		
	.0					.00		1250.0	1250.0		
- - - - - - - - -											
150.	300.00	158.21	48.831	15.861	583.3	51.15	-150.66	250.00	1100.0	.27650	.0877
	96.00	58.67	38.162	6.352	33.01	2840.1	.00	1000.0	36.667	.20205	.9123
	184.48	59.99	24.613	22.498	276.88	36.667	.000	-150.66	1063.3	60.000	.2831
	.00	.000	.000	.000	111.61	28.500	-150.66	3.416	-191.84	.40909	-.2583
	.00	.00	.000	.000	44.71	43.800		.000	83.71	.17000	-3.822
	.00	.000	.000	.000	132.00	.000		.0	147.55	.16311	-.13662
	2850.0	276.88	111.61	44.71	51.15	90.00		3.416	39.42		
	583.3					-150.66		1102.8	1102.8		
- - - - - - - - -											
300.	659.80	323.90	99.969	32.990	2277.3	576.18	119.31	250.00	1100.0	.27650	.2530
	211.41	120.12	78.126	13.213	.00	8935.5	58.46	998.3	73.333	.20205	.7470
	368.96	119.99	49.225	44.995	889.49	73.333	6.085	54.76	1026.7	60.000	.1684
	538.64	99.747	39.900	59.850	353.59	57.000	54.76	.000	267.96	.40909	.0524
	291.60	157.50	57.600	16.200	194.01	87.600		-4.150	.90	.17000	.436
	200.68	68.250	28.769	26.758	264.00	50.000		1521.2	4.89	.16311	.04211
	6173.0	889.49	353.59	194.01	576.18	180.00		-2.629	273.76		
	2277.3					119.31		1300.4	1300.4		
- - - - - - - - -											

TABLE 7.4 Continued



7.5 Scenerio for 10% Decrease in Finished Product Price for Cod as Compared to Basic Model in Section 6.4

Table 7.5 gives the computer print-out for the model when the finished product price for cod has reduced by 10% while all other variables remain constant.

This print-out shows that the retained earnings at TIME = 300 has now reduced from its original value of $80,230 to $49,270. When comparing Table 7.4 with Table 7.5 we notice that it is more economical to have a 20% increase in raw material price than to have a 10% decrease in finished product price for cod.

TABLE 7.5

COMPUTER PRINT-OUT FOR 10% DECREASE IN FINISHED PRODUCT PRICE FOR COD AS COMPARED TO BASIC MODEL IN SECTION 6.4

	FPC2
PRESENT	-.1000
ORIGINAL	0.

RUN-SELLING FISH PROCESSI MODEL OF A NFLD INSHORE FREEZER PLANT

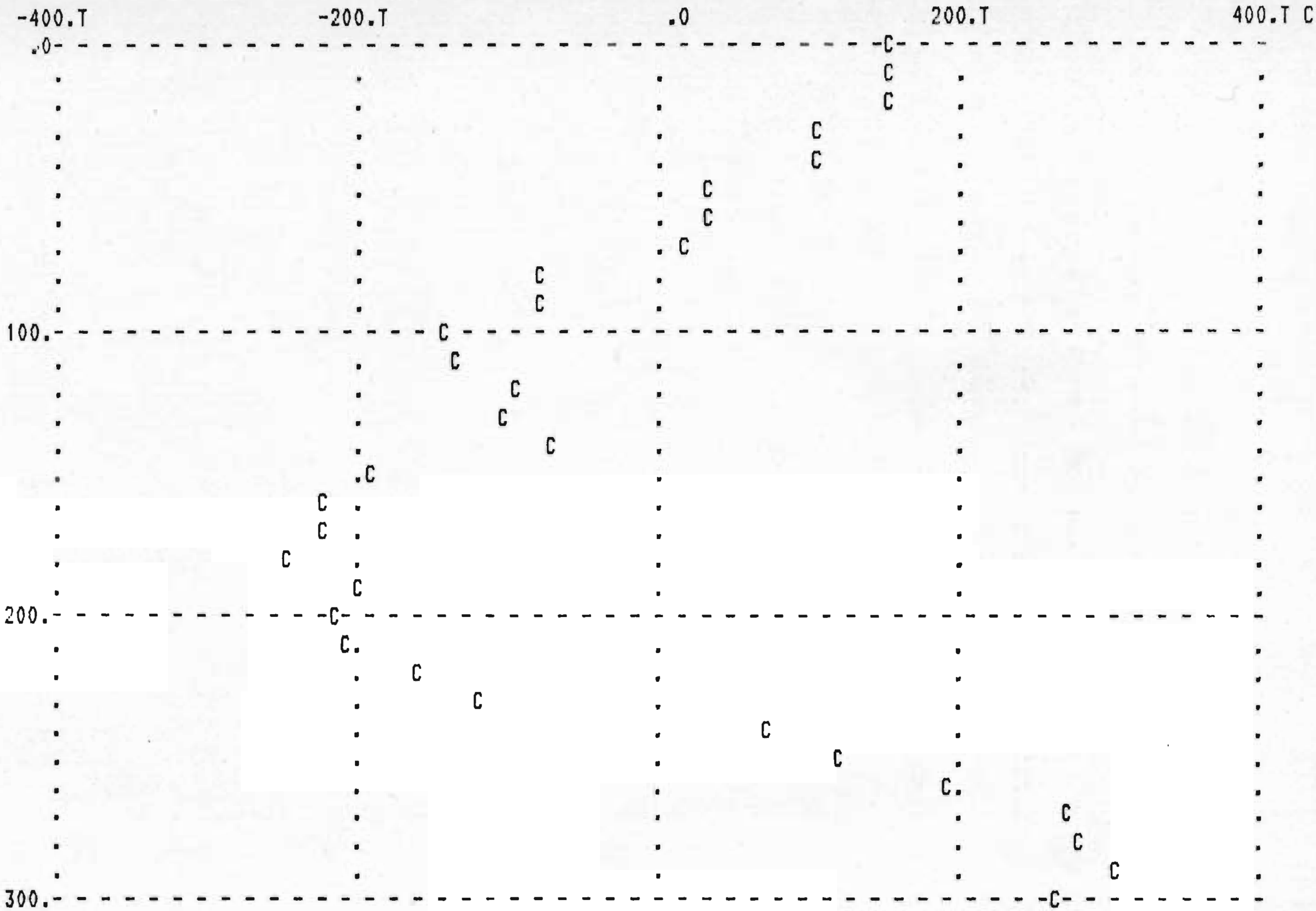
TIME	AFGRP	ACRMP	ALCP	ACPGP	TRSP	GTMP	NPBT	SHRCAP	EEE	MPHR	GPR
	BFGRP	BCRMP	BLCP	BCPGP	VALIVU	TINBLP	TTAXA	BLTL	TDEP	MPHF	OPR
	CFGRP	CCRMP	CLCP	CCPGP	TRMCP	TDEP	TDIVA	RETPRF	BFAST	MPM	EXR
	DFGRP	DCRMP	DLCP	DCPGP	TLCP	TOFOH	RETPRF	ACPAY	CASHP	MPC	NPBTR
	EFGRP	ECRMP	ELCP	ECPGP	TCPGP	TADE		DERITX	ARP	MPS	ROCER
	FFGRP	FCRMP	FLCP	FCPGP	TPRODE	TINLTP		DIVSPY	VALIV	MPB	ROTASR
	QFGRP	TRMCP	TLCP	TCPGP	GTMP	TSLE		CURLIB	CURAST		
	TRSP					NPBT		TLLIAB	TLAST		
- - - - - - - - -											
E+00	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+00	E+03	E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E-03	E+00
	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03		E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03		E+00	E+03	E+00	E+00
	E+00	E+03	E+03	E+03	E+03	E+03		E+03	E+03		
	E+03					E+03		E+03	E+03		
- - - - - - - - -											

TABLE 7.5 Continued

.0	.00	.00	.000	.000	.0	.00	.00	250.00	1100.0	.27650	.0000
	.00	.00	.000	.000	.00	.0	.00	1000.0	.000	.20205	.0000
	.00	.00	.000	.000	.00	.000	.000	.00	1100.0	60.000	.0000
	.00	.000	.000	.000	.00	.000	.00	.000	150.00	.39091	.0000
	.00	.00	.000	.000	.00	.000		.000	.00	.17000	.00
	.00	.000	.000	.000	.00	.000		.0	.00	.16311	.00000
	.0	.00	.00	.00	.00	.00		.000	150.00		
	.0					.00		1250.0	1250.0		
- - - - - - - - -											
150.	270.00	131.84	48.831	15.861	553.3	44.87	-156.85	250.00	1100.0	.27650	.0811
	96.00	58.67	38.162	6.352	30.37	2756.3	.00	1000.0	36.667	.20205	.9189
	184.48	59.99	24.613	22.498	250.51	36.667	.000	-156.85	1063.3	60.000	.2983
	.00	.000	.000	.000	111.61	28.500	-156.85	3.000	-190.04	.39091	-.2835
	.00	.00	.000	.000	44.71	43.800		.000	77.94	.17000	-4.78
	.00	.000	.000	.000	132.00	.000		.0	144.91	.16311	-.14309
	2850.0	250.51	111.61	44.71	44.87	90.00		3.000	32.81		
	553.3					-156.85		1096.1	1096.1		
- - - - - - - - -											
300.	593.82	269.91	99.969	32.990	2211.3	564.18	107.34	250.00	1100.0	.27650	.2551
	211.41	120.12	78.126	13.213	.00	8911.9	52.60	998.3	73.333	.20205	.7449
	368.96	119.99	49.225	44.995	835.51	73.333	5.474	49.27	1026.7	60.000	.1734
	538.64	99.747	39.900	59.850	353.59	57.000	49.27	.000	260.84	.39091	.0485
	291.60	157.50	57.600	16.200	194.01	87.600		-5.618	.90	.17000	.40
	200.68	68.250	28.769	26.758	264.00	50.000		1368.5	4.89	.16311	.03809
	6173.0	835.51	353.59	194.01	564.18	180.00		-4.249	266.64		
	2211.3					107.34		1293.3	1293.3		
- - - - - - - - -											

TABLE 7.5 Continued

CASHP=C



7.6 Scenerio for 10% Increase in Yield for Cod as Compared to Basic Model in Section 6.4

Table 7.6 gives the computer print-out for the model when there has been a 10% increase in yield for cod while all other variables remain constant. The computer print-out is given every 150 days.

The retained earnings at TIME = 300 has now increased from its original value of $80,230 to $109,650. Such a scenerio identifies to management the importance of considering various ways in which yield could be increased, such as incentives, method changes, supervision or more efficient equipment.

TABLE 7.6

COMPUTER PRINT-OUT FOR 10% INCREASE IN YIELD FOR COD AS COMPARED TO BASIC MODEL IN SECTION 6.4

	YC2
PRESENT	.1000
ORIGINAL	0.

RUN-YIELD FISH PROCESSI MODEL OF A NFLD INSHORE FREEZER PLANT

TIME	AFGRP	ACRMP	ALCP	ACPGP	TRSP	GTMP	NPBT	SHRCAP	EEE	MPHR	GPR
	BFGRP	BCRMP	BLCP	BCPGP	VALIVU	TINBLP	TTAXA	BLTL	TDEP	MPHF	OPR
	CFGRP	CCRMP	CLCP	CCPGP	TRMCP	TDEP	TDIVA	RETPRF	BFAST	MPM	EXR
	DFGRP	DCRMP	DLCP	DCPGP	TLCP	TOFOH	RETPRF	ACPAY	CASHP	MPC	NPBTR
	EFGRP	ECRMP	ELCP	ECPGP	TCPGP	TADE		DERITX	ARP	MPS	ROCER
	FFGRP	FCRMP	FLCP	FCPGP	TPRODE	TINLTP		DIVSPY	VALIV	MPB	ROTASR
	QFGRP	TRMCP	TLCP	TCPGP	GTMP	TSLE		CURLIB	CURAST		
	TRSP					NPBT		TLLIAB	TLAST		
- - - - - - - - -											
E+00	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+00	E+03	E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E-03	E+00
	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03		E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03		E+03	E+03	E+00	E+00
	E+00	E+03	E+03	E+03	E+03	E+03		E+03	E+03		
	E+03					E+03		E+03	E+03		
- - - - - - - - -											

TABLE 7.6 Continued

.0	.00	.00	.000	.000	.0	.00	.00	250.00	1100.0	.27650	.0000
	.00	.00	.000	.000	.00	.0	.00	1000.0	.000	.20205	.0000
	.00	.00	.000	.000	.00	.000	.000	.00	1100.0	60.000	.0000
	.00	.000	.000	.000	.00	.000	.00	.000	150.00	.52810	.0000
	.00	.00	.000	.000	.00	.000		.000	.00	.17000	.0000
	.00	.000	.000	.000	.00	.000		.000	.00	.16311	.00000
	.0	.00	.00	.00	.00	.00		.00	150.00		
	.0					.00		1250.0	1250.0		
- - - - - - - - -											
150.	340.00	131.84	48.831	17.447	623.3	107.68	-93.62	250.00	1100.0	.27650	.1728
	96.00	58.67	38.162	6.352	24.82	2333.5	.00	1000.0	36.667	.20205	.8272
	184.48	59.99	24.613	22.498	250.51	36.667	.000	-93.62	1063.3	60.000	.2641
	.00	.000	.000	.000	111.61	28.500	-93.62	3.000	-141.69	.52810	-.1502
	.00	.00	.000	.000	46.30	43.800		.000	99.97	.17000	-.9747
	.00	.000	.000	.000	132.00	.000		.000	137.77	.16311	-.08075
	2800.0	250.51	111.61	46.30	107.68	90.00		3.00	96.05		
	623.3					-93.62		1159.4	1159.4		
- - - - - - - - -											
300.	725.78	269.91	99.969	36.289	2343.1	692.72	238.88	250.00	1100.0	.27650	.2956
	211.41	120.12	78.126	13.213	.00	5902.0	117.05	998.3	73.333	.20205	.7044
	368.96	119.99	49.225	44.995	835.51	73.333	12.183	109.65	1026.7	60.000	.1624
	538.64	99.747	39.900	59.850	353.59	57.000	109.65	.000	342.31	.52810	.1020
	291.60	157.50	57.600	16.200	197.30	87.600		10.497	.91	.17000	.6928
	200.68	68.250	28.769	26.758	264.00	50.000		3.046	1.59	.16311	.07995
	6049.3	835.51	353.59	197.30	692.72	180.00		13.54	344.81		
	2343.1					238.88		1371.5	1371.5		
- - - - - - - - -											

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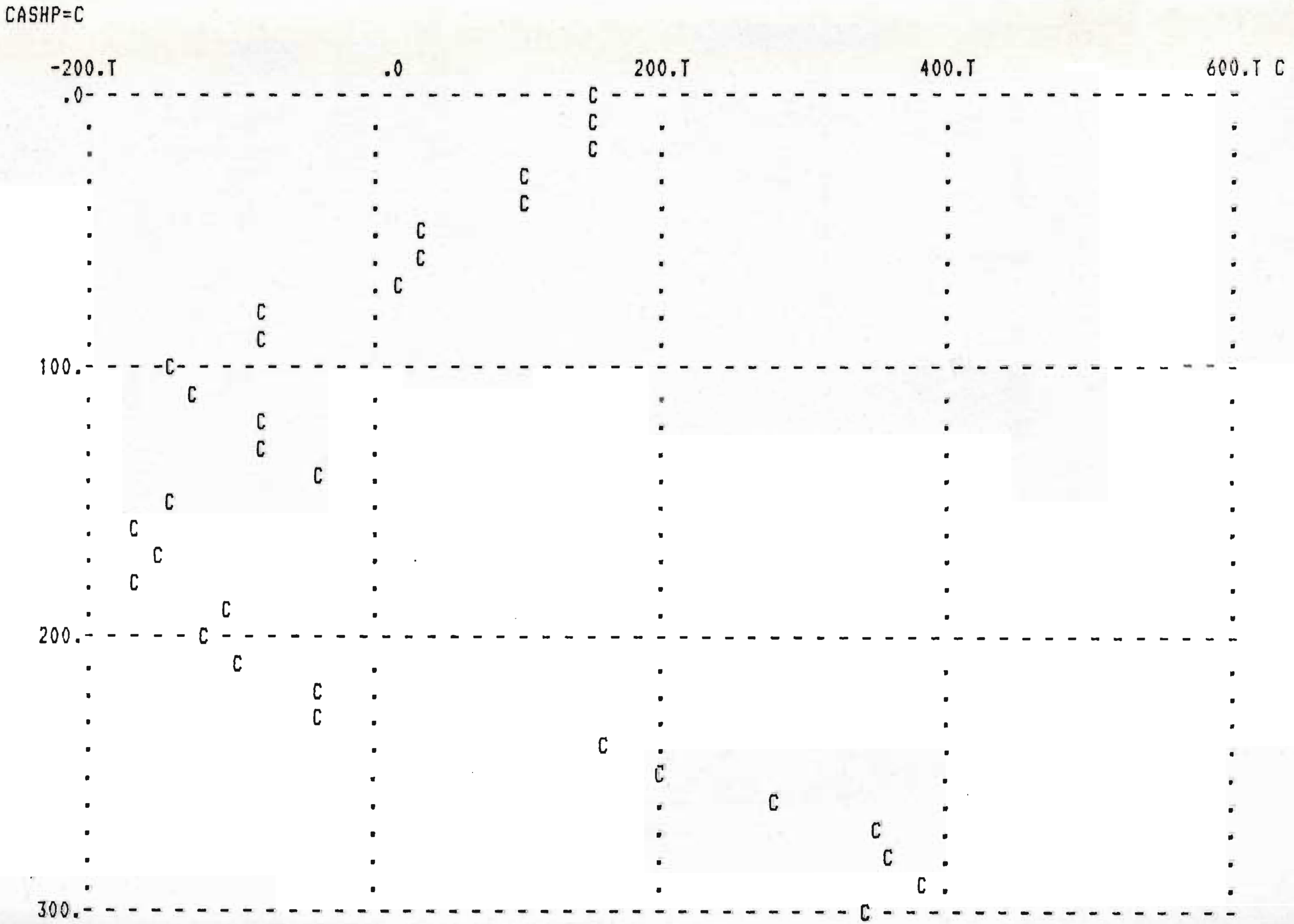
TABLE 7.6 Continued



7.7 Scenerio for 10% Increase in Labour Cost for all Species as Compared to Basic Model in Section 6.4

Table 7.7 gives the computer print-out for the model when the labour cost for each species has increased by 10% while all other variables remain constant. The computer print-out is given every 150 days.

The retained earnings at TIME = 300 has now reduced from its original value of $80,230 to $63,660. Such a scenerio would assist in observing the sensitivity of changes in profits due to changes in labour rates and establish a basis for bargaining procedures for management during labour contract negotiations.

TABLE 7.7

COMPUTER PRINT-OUT FOR 10% INCREASE IN LABOUR COST FOR ALL SPECIES AS COMPARED TO BASIC MODEL IN SECTION 6.4

	LCHR2	LCHF2	LCM2	LCC2	LCS2	LCB2
PRESENT	.1000	.1000	.1000	.1000	.1000	.1000
ORIGINAL	0.	0.	0.	0.	0.	0.

RUN-LABOUR FISH PROCESSI MODEL OF A NFLD INSHORE FREEZER PLANT

TIME	AFGRP	ACRMP	ALCP	ACPGP	TRSP	GTMP	NPBT	SHRCAP	EEE	MPHR	GPR
	BFGRP	BCRMP	BLCP	BCPGP	VALIVU	TINBLP	TTAXA	BLTL	TDEP	MPHF	OPR
	CFGRP	CCRMP	CLCP	CCPGP	TRMCP	TDEP	TDIVA	RETPRF	BFAST	MPM	EXR
	DFGRP	DCRMP	DLCP	DCPGP	TLCP	TOFOH	RETPRF	ACPAY	CASHP	MPC	NPBTR
	EFGRP	ECRMP	ELCP	ECPGP	TCPGP	TADE		DERITX	ARP	MPS	ROCER
	FFGRP	FCRMP	FLCP	FCPGP	TPRODE	TINLTP		DIVSPY	VALIV	MPB	ROTASR
	QFGRP	TRMCP	TLCP	TCPGP	GTMP	TSLE		CURLIB	CURAST		
	TRSP					NPBT		TLLIAB	TLAST		

- - - - - - - - -

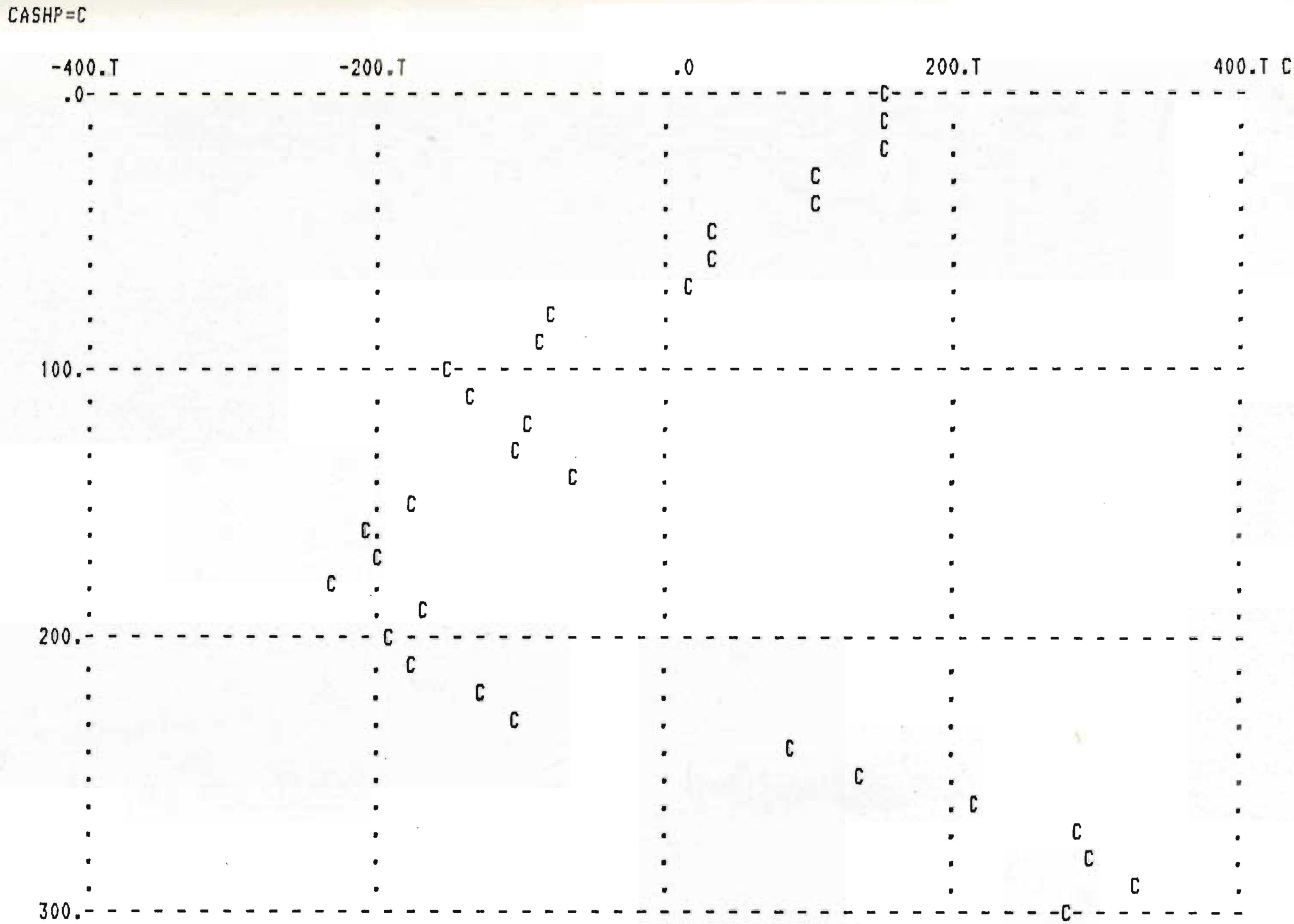
E+00	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+00	E+03	E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E-03	E+00
	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03		E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03		E+00	E+03	E+00	E+00
	E+00	E+03	E+03	E+03	E+03	E+03		E+03	E+03		
	E+03					E+03		E+03	E+03		

- - - - - - - - -

TABLE 7.7 Continued

.0	.00	.00	.00	.000	.0	.00	.00	250.00	1100.0	.26869	.0000
	.00	.00	.000	.000	.00	.0	.00	1000.0	.000	.19959	.0000
	.00	.00	.000	.000	.00	.000	.000	.00	1100.0	58.000	.0000
	.00	.000	.000	.000	.00	.000	.00	.000	150.00	.48591	.0000
	.00	.00	.000	.000	.00	.000		.000	.00	.16800	.0000
	.00	.000	.000	.000	.00	.000		.0	.00	.15031	.00000
	.0	.00	.00	.00	.00	.00		.000	150.00		
	.0					.00		1250.0	1250.0		
- - - - - - - - -											
150.	300.00	131.84	53.71	15.861	583.3	65.94	-135.73	250.00	1100.0	.26869	.1130
	96.00	58.67	41.978	6.352	32.60	2707.1	.00	1000.0	36.667	.19959	.8870
	184.48	59.99	27.074	22.498	250.51	36.667	.000	-135.73	1063.3	58.000	.2829
	.00	.000	.000	.000	122.77	28.500	-135.73	3.000	-176.91	.48591	-.2327
	.00	.00	.000	.000	44.71	43.800		.000	83.71	.16800	-2.5169
	.00	.000	.000	.000	132.00	.000		.0	147.14	.15031	-.12149
	2850.0	250.51	122.77	44.71	65.94	90.00		3.000	53.93		
	583.3					-135.73		1117.3	1117.3		
- - - - - - - - -											
300.	659.80	269.91	109.97	32.990	2277.3	594.81	138.70	250.00	1100.0	.26869	.2612
	211.41	120.12	85.938	13.213	.00	8173.9	67.96	998.3	73.333	.19959	.7388
	368.96	119.99	54.148	44.995	835.51	73.333	7.074	63.66	1026.7	58.000	.1681
	538.64	99.747	43.890	59.850	388.95	57.000	63.66	.000	279.48	.48591	.0609
	291.60	157.50	63.360	16.200	194.01	87.600		-1.778	.90	.16800	.4862
	200.68	68.250	31.646	26.758	264.00	50.000		1768.4	4.89	.15031	.04853
	6173.0	835.51	388.95	194.01	594.81	180.00		-.010	285.27		
	2277.3					138.70		1312.0	1311.9		
- - - - - - - - -											

TABLE 7.7 Continued



7.8 Scenerio for 10% Increase in Labour Productivity for all Species as Compared to Basic Model in Section 6.4

Table 7.8 gives the computer print-out for the model when the labour productivity for each species has increased by 10% while all other variables remain constant. The computer print-out is given every 150 days.

This print-out shows that the retained earnings at TIME = 300 has now increased from its original value of $80,230 to $95,260. This scenerio would assist management in establishing the increase in labour productivity required to offset any potential increase in labour rates as discussed in Section 7.7

TABLE 7.8

COMPUTER PRINT-OUT FOR 10% INCREASE IN LABOUR PRODUCTIVITY FOR ALL SPECIES AS COMPARED TO BASIC MODEL IN SECTION 6.4

	LPHR2	LPHF2	LPM2	LPC2	LPS2	LPB2
PRESENT	.1000	.1000	.1000	.1000	.1000	.1000
ORIGINAL	0.	0.	0.	0.	0.	0.

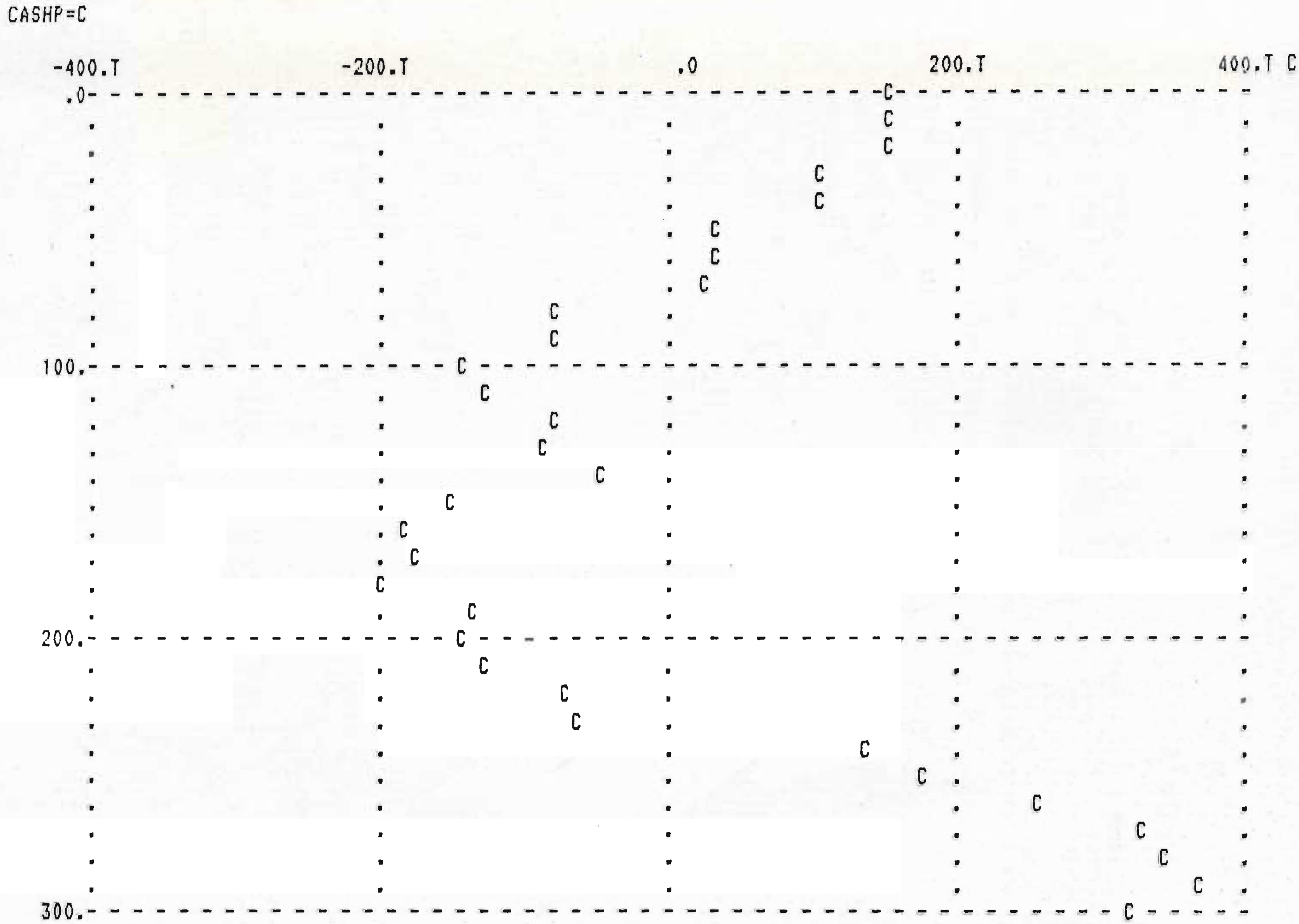
RUN-PRODUCTI FISH PROCESSI MODEL OF A NFLD INSHORE FREEZER PLANT

TIME	AFGRP	ACRMP	ALCP	ACPGP	TRSP	GTMP	NPBT	SHRCAP	EEE	MPHR	GPR
	BFGRP	BCRMP	BLCP	BCPGP	VALIVU	TINBLP	TTAXA	BLTL	TDEP	MPHF	OPR
	CFGRP	CCRMP	CLCP	CCPGP	TRMCP	TDEP	TDIVA	RETPRF	BFAST	MPM	EXR
	DFGRP	DCRMP	DLCP	DCPGP	TLCP	TOFOH	RETPRF	ACPAY	CASHP	MPC	NPBTR
	EFGRP	ECRMP	ELCP	ECPGP	TCPGP	TADE		DERITX	ARP	MPS	ROCER
	FFGRP	FCRMP	FLCP	FCPGP	TPRODE	TINLTP		DIVSPY	VALIV	MPB	ROTASR
	QFGRP	TRMCP	TLCP	TCPGP	GTMP	TSLE		CURLIB	CURAST		
	TRSP					NPBT		TLLIAB	TLAST		
- - - - - - - - -											
E+00	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+00	E+03	E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E-03	E+00
	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03		E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03		E+03	E+03	E+00	E+00
	E+00	E+03	E+03	E+03	E+03	E+03		E+03	E+03		
	E+03					E+03		E+03	E+03		
- - - - - - - - -											

TABLE 7.8 Continued

.0	.00	.00	.000	.000	.0	.00	.00	250.00	1100.0	.28359	.0000
	.00	.00	.000	.000	.00	.0	.00	1000.0	.000	.20429	.0000
	.00	.00	.000	.000	.00	.000	.000	.00	1100.0	61.818	.0000
	.00	.00	.000	.000	.00	.000	.00	.000	150.00	.49545	.0000
	.00	.000	.000	.000	.00	.000		.000	.00	.17182	.0000
	.00	.000	.000	.000	.00	.000		.000	.00	.17475	.00000
	.0	.00	.00	.00	.00	.00		.000	150.00		
	.0					.00		1250.0	1250.0		
- - - - - - - - -											
150.	300.00	131.84	44.392	15.861	583.3	87.25	-114.15	250.00	1100.0	.28359	.1496
	96.00	58.67	34.693	6.352	32.60	2426.0	.00	1000.0	36.667	.20429	.8504
	184.48	59.99	22.375	22.498	250.51	36.667	.000	-114.15	1063.3	61.818	.2824
	.00	.00	.000	.000	101.46	28.500	-114.15	3.000	-155.32	.49545	-.1957
	.00	.000	.000	.000	44.71	43.800		.000	83.71	.17182	-1.5115
	.00	.000	.000	.000	132.00	.000		.000	147.14	.17475	-.10023
	2850.0	250.51	101.46	44.71	87.25	90.00		3.000	75.52		
	583.3					-114.15		1138.9	1138.9		
- - - - - - - - -											
300.	659.80	269.91	90.880	32.990	2277.3	662.23	207.54	250.00	1100.0	.28359	.2908
	211.41	120.12	71.024	13.213	.00	6760.1	101.69	998.3	73.333	.20429	.7092
	368.96	119.99	44.751	44.995	835.51	73.333	10.584	95.26	1026.7	61.818	.1675
	291.60	157.50	52.364	16.200	321.52	57.000	95.26	.000	320.39	.49545	.0911
	538.64	99.747	36.273	59.850	194.01	87.600		6.659	.90	.17182	.6363
	200.68	68.250	26.233	26.758	264.00	50.000		2.646	4.89	.17475	.07041
	6173.0	835.51	321.52	194.01	662.23	180.00		9.305	326.19		
	2277.3					207.54		1352.9	1352.9		
- - - - - - - - -											

TABLE 7.8 Continued



7.9 Scenerio for 10% Increase in Labour Cost and Productivity for Species as Compared to Basic Model in Section 6.4

Table 7.9 gives the computer print-out for the model when labour, cost and productivity have both increased by 10% while all other variables remain constant. The computer print-out is given every 150 days.

This print-out shows that the retained earnings at TIME = 300 has now changed from its original value of $80,230 to $80,190. A manager with Tables 7.7 to 7.9 at his disposal could point out to union members during labour negotiations the effects of an increase in labour cost and what would be needed to offset such cost increases.

TABLE 7.9

COMPUTER PRINT-OUT FOR 10% INCREASE IN LABOUR COST AND PRODUCTIVITY FOR ALL SPECIES AS COMPARED TO BASIC MODEL IN SECTION 6.4

	LPHR2	LPHF2	LPM2	LPC2	LPS2	LPB2	LCHR2	LCHF2	LCM2	LCC2	LCS2	LCB2
PRESENT	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000
ORIGINAL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

RUN-COSTPROD FISH PROCESSI MODEL OF A NFLD INSHORE FREEZER PLANT

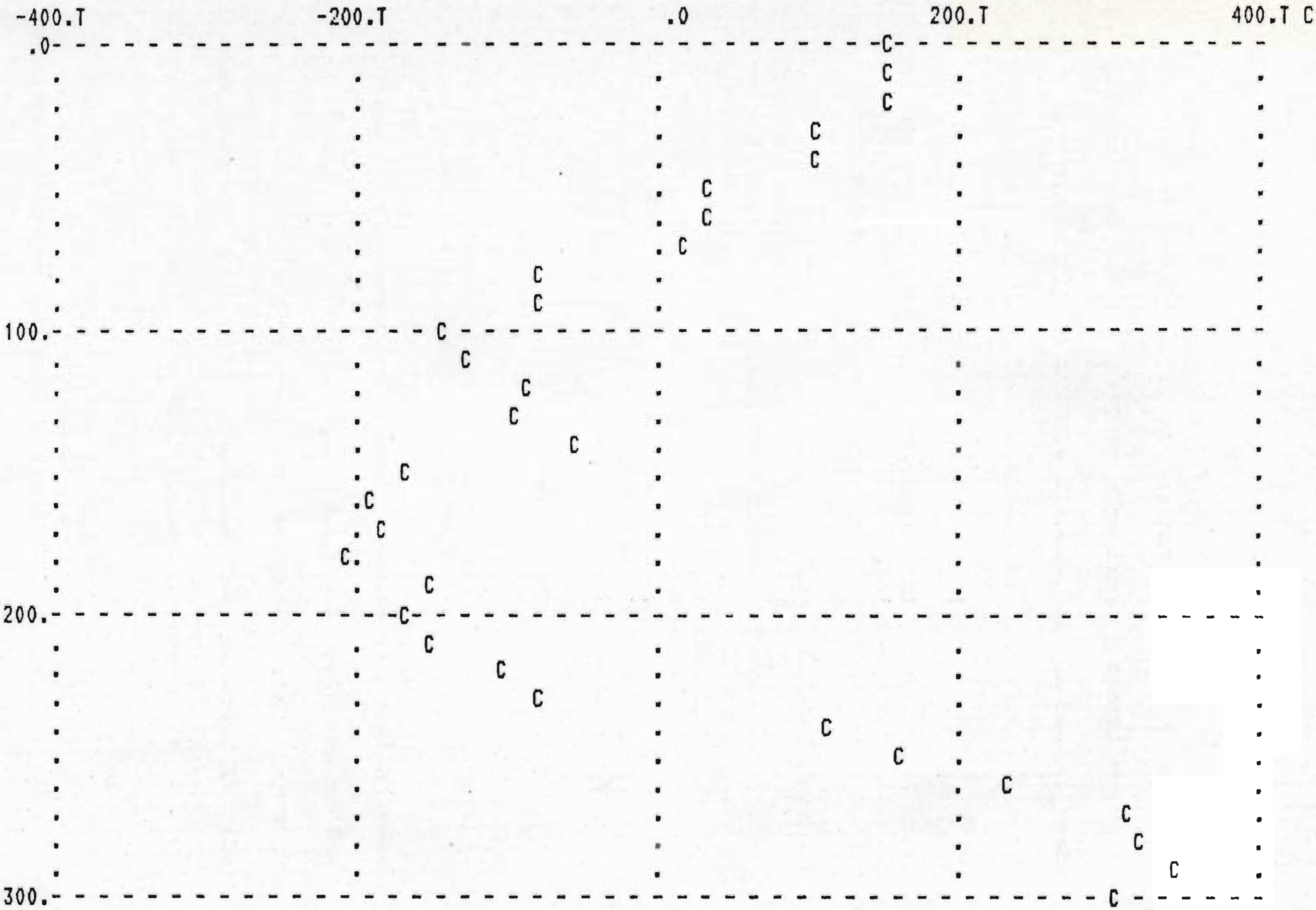
TIME	AFGRP	ACRMP	ALCP	ACPGP	TRSP	GTMP	NPBT	SHRCAP	EEE	MPHR	GPR
	BFGRP	BCRMP	BLCP	BCPGP	VALIVU	TINBLP	TTAXA	BLTL	TDEP	MPHF	OPR
	CFGRP	CCRMP	CLCP	CCPGP	TRMCP	TDEP	TDIVA	RETPRF	BFAST	MPM	EXR
	DFGRP	DCRMP	DLCP	DCPGP	TLCP	TOFDH	RETPRF	ACPAY	CASHP	MPC	NPBTR
	EFGRP	ECRMP	ELCP	ECPGP	TCPGP	TADE		DERITX	ARP	MPS	ROCER
	FFGRP	FCRMP	FLCP	FCPGP	TPRODE	TINLTP		DIVSPY	VALIV	MPB	ROTASR
	QFGRP	TRMCP	TLCP	TCPGP	GTMP	TSLE		CURLIB	CURAST		
	TRSP					NPBT		TLLIAB	TLAST		
- - - - - - - - -											
E+00	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+00	E+03	E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E-03	E+00
	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03		E+03	E+03	E+00	E+00
	E+03	E+03	E+03	E+03	E+03	E+03		E+00	E+03	E+00	E+00
	E+00	E+03	E+03	E+03	E+03	E+03		E+03	E+03		
	E+03					E+03		E+03	E+03		
- - - - - - - - -											

TABLE 7.9 Continued

.0	.00	.00	.000	.000	.0	.00	.00	250.00	1100.0	.27650	.0000
	.00	.00	.000	.000	.00	.0	.00	1000.0	.000	.20205	.0000
	.00	.00	.000	.000	.00	.000	.000	.00	1100.0	60.000	.0000
	.00	.000	.000	.000	.00	.000	.00	.000	150.00	.49091	.0000
	.00	.00	.000	.000	.00	.000		.000	.00	.17000	.0000
	.00	.000	.000	.000	.00	.000		.0	.00	.16311	.00000
	.0	.00	.00	.00	.00	.00		.000	150.00		
	.0					.00		1250.0	1250.0		
- - - - - - - - -											
150.	300.00	131.84	48.831	15.861	583.3	77.10	-124.43	250.00	1100.0	.27650	.1322
	96.00	58.67	38.162	6.352	32.60	2559.9	.00	1000.0	36.667	.20205	.8678
	184.48	59.99	24.613	22.498	250.51	36.667	.000	-124.43	1063.3	60.000	.2826
	.00	.000	.000	.000	111.61	28.500	-124.43	3.000	-165.60	.49091	-.2133
	.00	.00	.000	.000	44.71	43.800		.000	83.71	.17000	-1.9073
	.00	.000	.000	.000	132.00	.000		.0	147.14	.16311	-.11025
	2850.0	250.51	111.61	44.71	77.10	90.00		3.000	65.24		
	583.3					-124.43		1128.6	1128.6		
- - - - - - - - -											
300.	659.80	269.91	99.969	32.990	2277.3	630.08	174.71	250.00	1100.0	.27650	.2767
	211.41	120.12	78.126	13.213	.00	7430.1	85.61	998.3	73.333	.20205	.7233
	368.96	119.99	49.225	44.995	835.51	73.333	8.910	80.19	1026.7	60.000	.1678
	538.64	99.747	39.900	59.850	353.68	57.000	80.19	.000	300.88	.49091	.0767
	291.60	157.50	57.601	16.200	194.01	87.600		2.636	.90	.17000	.5697
	200.68	68.250	28.856	26.758	264.00	50.000		2227.6	4.89	.16311	.06014
	6173.0	835.51	353.68	194.01	630.08	180.00		4.864	306.68		
	2277.3					174.71		1333.4	1333.3		
- - - - - - - - -											

TABLE 7.9 Continued

CASHP=C



CHAPTER 8

CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

8.1 Conclusions

For over three centuries, fisheries have been a very major part of the life of Newfoundland people. The fishing operation up until 25 years ago was mainly an inshore fishery, but in recent years, long distant water trawlers have been employed for the harvesting of offshore marine renewable resources. The total annual Canadian catch of fish during the past five years have ranged between 1 to 1.3 million metric tons. Newfoundland's share of the total Canadian catch by weight have ranged between 0.3 to 0.5 million metric tons. About 50% of the total Newfoundland catch is obtained from distant waters, particularly from the area of the Grand Banks in the North West Atlantic. The other 50% of the total catch is obtained from inshore and coastal waters. The percentage of employment in Newfoundland fish harvesting operation in relation to inshore and offshore fishery is approximately ten to one. The offshore fishery is highly capital intensive, whereas the inshore fish harvesting operation is highly labour intensive.

The Newfoundland processing industry during the past 25 years has also gone through major changes, particularly in relation to the type of species and product form produced, equipment, plant layouts and facilities, however very little change has been observed in relation to the labour intensiveness in the fish processing operation.

The supply of fish to the processing plants has been one of the major factors in determining the production patterns. Normally an inshore plant would buy fish from local fishermen mainly during the months from April to November. These seasonal fish plants therefore operate only part of the year, which makes it rather difficult to run at optimum efficiency throughout the year. The plant equipment and facilities are under utilized, manpower hiring, training and administration activities increase, labour productivity suffers due to short term employment at the plant and the apportioned unit overhead costs are higher as compared to an all year plant operation.

Besides the problem of the supply of fish, there are other variables which the plant manager encounters, such as changes in prices of raw material, labour rates, equipment breakdowns, selling price fluctuations and market demands, etc.

Other requirements for an efficient plant operation are related to the managerial skills, mainly one of predicting or forecasting what actions need to be taken. These skills relate to the extent to which management is able to quickly and accurately analyse and establish the best course of action. Management should be able to forecast likely outcome of possible events that could occur during normal running of the plant. These changes in the variables could either be within the control of the management or they could be external variables upon which the management has no direct control, i.e., raw material prices, drop in the catching rate of inshore fishery, etc. The management today continually ask questions such as:

- What is my profit margin per species?
- Do I have the necessary cash for the operation of the plant?
- What happens if raw material prices increase?
- What happens if market demand reduces?
- Should I process all fish or round freeze part of it?
- What could be the projected cost of raw material, labour and overhead?

The above are only some of the questions which are continually being asked, for which adequate procedures have not been developed in the fish processing industry to provide quick and reliable answers. A manual calculating procedure could be established by the management which could take into account the time-variant and interactive nature of the variables of the processing operation. However, any such manual system is going to take a long time in calculating and establishing possible outcomes from a number of alternative courses of actions which management take. In such an event, the long time factor may in many instances render the information useless since appropriate actions could not be taken at the right time. The efficiency of a management information system and analysis, is of paramount importance in the successful operation of the industry. It was therefore considered that a computer assisted systems dynamic model of a fish processing operation be developed so as to simulate on the computer various scenerios from which management could observe the possible outcomes due to the changes of the variables within the plant operation as well as observe the effects of those variables which are outside the direct control of the management.

This study undertook to develop a systems dynamic model of a Newfoundland inshore fish processing plant. The procedure of systems dynamics was based on Forrester's works in industrial dynamics,(Forrester 1960).

A detailed description of systems dynamics and a critical review was discussed in earlier chapters. A typical seasonal fish plant in Newfoundland was selected for this study.

A model logic was first developed based on the actual physical observations of the plant. The model logic consisted of flow rates and levels related to the supply of raw material, inventory holdings, production rates, order demand rates, shipping rates, labour productivity, labour rates, yields, prices of raw material, selling price, physical space constraints, cold storage space, freezing capacity, fish meal production, type of species produced, employment policy, beginning of the year balances of assets and liabilities, cash balances, loans and interest payments, debtor collection and creditor payment policies, and some other management decision making priorities based on profit margins and raw material purchase policies.

After the model logic had been tested on the computer, simulations were performed based on the initial data input of the plant. The model was built to simulate every day operation for a 300 working day year. Various computer simulations were performed for a selected number of changes in the initial data input and possible economic and production outcomes were compared.

These comparisons relate to profits, cash flows, sales revenue and costs, assets and liabilities, profit return ratios, production rates, freezing rates, inventory holdings, employment, etc. The exercise of developing a systems dynamic model and its subsequent use as a simulation tool to assist management in decision making has been adequately demonstrated. Normally, each simulation took approximately 30 seconds of central processing unit (CPU) computing time, which using manual procedures could have taken several mandays. This study has also shown that an on-line procedure of the computer assisted systems dynamic model could be used for daily decision-making in production planning and scheduling of fish processing operations.

8.2 Limitations of the Study

This study undertook, to develop a computer assisted systems dynamic model of a Newfoundland seasonal fish plant, where five fishery products and one blueberry product were processed. The supply of raw material was assumed to be seasonal, depending upon the time of the year during which the various fish species and blueberries were harvested. The model logic was built around these two main variables of six species products and a time-variant raw material supply. The equations of the model were written for six end products for the particular time at which the raw material was supplied to the plant.

The main limitations of this systems dynamic model is the restriction to only six end products. If however, it is necessary to increase the number of end products, the appropriate modifications could be made in the model equations to account for this increase. This model is not restricted to the kinds of species processed as long as the total number does not exceed six.

With regard to the time-variant nature of the raw material supply, appropriate modifications would be needed to the model equations if the kinds of end products considered were produced from a different fish species combination than those used in the model. This model considered end products as: cod fillets, flounder fillets, herring fillets, squid round, blueberries, mackerel round. Thus, if another kind of end product was considered, for example, "perch fillets" then the time-variant characteristics of the supply of round perch would be different than those considered above.

Another limitation of this model is that the time-variant nature of the supply of raw material to the processing plant is also dependent on the geographic location and the seasonality of the plant operation. If, for example, the plant under consideration, was situated on the southwest coast of Newfoundland as compared to the existing location on the east coast, then appropriate modification to the raw material supply equations would be necessary. If the raw material to the plant was supplied by all year round offshore trawler as compared to supply by the small inshore boats, then such changes of a time-variant nature in the raw material supply would be required to be incorporated in the model.

The initial input data regarding the raw material prices, finished product selling prices, labour productivity, physical plant capacities, yields, labour rates, etc. were considered to remain constant in the model during each simulation run. However these input data could be made to behave stochastically during the simulation of the model. The initial input data could also be changed at the initial stage, that is, before the start of each simulation. This can be done by changing the appropriate values. For example, if management wanted to observe the effect of the change in raw material price of cod, then appropriate input data would be changed first before a new simulation was performed. This enables the management to consider various alternative scenerios if such changes were to occur in real practice.

The basic model logic is designed in relation to the type of physical layout and processing constraints of a particular plant. For example, the plant has certain cold storage holding space, freezing capacities or processes certain types of fish species using a particular method and equipment. Under these circumstances, the model internal parameters act as limiting values or multipliers which remain constant and unique to that plant. These parameters could also be made to behave stochastically if such a situation becomes a possibility, e.g., breakdown of equipment, or labour strike, etc.

The initial input data regarding the financial status of the plant operation can be changed when economics of a new capital expenditure is anticipated or another plant was considered. Appropriate changes in the initial data input would be required so that new information regarding the beginning of the year assets, liabilities, cash balances, loans, depreciation rates and interest are inputed before the start of a simulation run.

The model logic developed for this study considered a production priority rule based on marginal profits. This rule was based on the assumption, that it would be profitable to allot production capacities for freezing round, freezing fillets and cold storage space to end products which give the highest marginal profit. After production allotment had been made for the product with the highest profit margin and a surplus in production capacity exist then the model logic would consider processing the next highest marginal profit end product. This kind of production priority rule was built into the model as the most rational method that management would want to use in production planning and scheduling. Thus, if another type of production priority rule was considered then such a new rule would be required to be incorporated.

For example, a new type of production rule could be developed to satisfy customer demands for committed orders. Another example of production rule could be based on a certain minimum or maximum inventory holding.

The computer model of the Newfoundland seasonal fish processing plant is based on Forrester's technique of systems dynamics. This technique basically uses levels and flow rates for building model logic. Levels are considered as accumulations at any point in time such as inventory holdings, cash balances, number of employees, etc. Rates are considered as flows into and out of a level. Rates are therefore amounts or quantities flowing per unit of time. The fish processing model which was built on the systems dynamic technique is therefore limited in its use as regards to the type of computer software required for simulation. The model simulation could only be done by a "Dynamo Simulation Compiler". It should be mentioned that the model logic of a fish processing plant could have been built using other types of computer simulation software such as C.S.M.P., or Simscript. These other kinds of simulation languages would impose a similar type of constraint as Dynamo, since any model logic built in relation to a simulation language would require only that particular software for operation.

The advantages of the systems dynamics technique in the development and use of the fish processing model were that it was possible to build small logic modules at a time, and after testing joined together for the complete model. When compared to the manual method used in calculation of possible outcome from alternative scenerios, the use of system dynamics would not only be many times faster but also be accurate (if input data was reliable) and allow the management to observe the simulated dynamic behavior of the various variables, which would not be possible to do properly with manual methods.

Greater numbers of alternative scenerios could be considered at a much faster speed, if time constraint was an important factor in decision making. Thus, an on-line system with interactive capability would allow the management to make quick and detailed analysis and assessment of a number of options before making a decision. In any event a cost-benefit exercise would be desirable to establish the economics and practical viability of using a computer assisted systems dynamics technique. The economics and viability would depend on the enormity and complexity of a particular industrial operation.

This study has developed a model for a part of the Newfoundland fish processing industry and has simulated and analysed a certain number of alternative scenerios. The study has reported in great detail the model development procedure, computer simulation outputs and scenerio analysis.

8.3 Recommendations

The model as presented in earlier chapters is only the beginning to the study of the dynamic behavior of the fishing industry. Further work could be done on making the model as presented, more flexible. The model could be refined so that it will accept multi-species and multi-pack combinations with time varying species pack production rates, labour productivity, raw material prices, finished product prices, labour cost, overheads, etc., thus making it suitable for applications over a wide spectrum of the fish processing industry.

A further extension to the model could make it applicable to the offshore processing industry where the scheduling of trawler fleets is incorporated with the processing sector. Here, the length of time a boat trawling at sea and the species being harvested could be co-ordinated with processing operation so as to provide optimum strategies for the overall fish harvesting and processing operation. Depending on the market demand, species quotas, anticipated specie harvesting quantities, marginal profits for individual species, plant capacities, etc., the deployment of fishing trawlers could be regulated so as to obtain maximum efficiency and profits.

The biological aspects of the fisheries could also be modeled, provided reliable data are available and appropriate interactions understood, to establish anticipated species quantities for harvesting, which species are being overexploited or underexploited, where the best locations for harvesting are, etc., so that managers and fishermen would be able to effectively manage the particular species and in the process obtain the most economic return in the long run.

The marketing of fish products could be modeled which would identify the major competitors in the market place and where the most likely markets are. The model could follow the basic approach of looking at all exporting, importing and producing countries for a particular specie type pack in the following manner:

- The country's landing, present and anticipated
- The country's processing capacities, present and anticipated
- The country's imports from different countries, individual and total
- The country's exports to different countries, individual and total

- The country's apparent consumption, present and anticipated
- Other similar products in that country that compete in the same market area

Analysing all countries for each species-pack in the above manner would identify major market competitors and market areas so that governments and private industry could identify possible market areas where the likelihood of success is greatest.

The optimum model of the fisheries should include all aspects of the fishing industry, i.e., harvesting, transporting, unloading, processing, distributing and marketing. With such a model, government and industry could define short and long term fishery policies considering all aspects of the fishery. Different scenerios could be analysed so as to identify problem areas where monitoring should take place and the actions required if events do occur.

In building such large multi-variable models, a word of caution at this stage would be appropriate. The validity and updating of the dynamic model is very important. The validity criteria for the model should not only include the correctness and accuracy of the various values of the variables but also the truth of the logical inter-relationships established for the various parameters of the model with the real world situation, and these iterative steps of validation and updating should be continuous. Remembering that the level, sequence and time frame work of the model objective and the inter-active variables are also dynamic, since they also change with time, as new values and understanding are realized by the management. What it means is that the design of the model should incorporate an adaptive component in its logic.

Thus, the development and application of the dynamic model should be truly dynamic. This is the real challenge.

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APPENDIX "A"

The following are detailed extracts from Plugh III, Alexander L. Dynamo II User's Manual, Cambridge, Massachusetts, The M.I.T. press, 1973.

A.1 Introduction

This section is the reference manual for the Dynamo language. First it will discuss the details of card punching. Next, it describes equation formulation and the functions that may be used in equations. Finally, it discusses the direction cards and the permissible card order.

A.2 Card Punching

A.2.1 Card Format

Each card has its type punched beginning in column 1 (see continuation cards in next section for a possible exception). The card type is either an equation type (L, A, R, S, N, C, CP, T, TP, or SPEC) or a direction card type (PRINT, PLOT, NOTE, RUN, *, NOISE, MACRO, or MEND).

The equation or other information is separated from the card type by one or more spaces. Standardizing on the columns improves readability. For example, start all direction and SPEC information in column 7 and all other equations in column 4.

No spaces are permitted within equation or direction information. The first space signifies the end of the equation, etc., and permits the user to add comments after this space to aid in reading the model. For example, one might add comments to each equation explaining the mnemonics and providing the dimensions of the quantity defined. If this comment does not fit entirely on the card, it should be continued on a NOTE card.

NOTE, RUN, or * cards are exceptions to the rule of no spaces. Spaces may appear wherever the user wishes.

A.2.2 Continuation Cards

Should the material not fit on the first card, one or more continuation cards may be used. These are punched with an X in column 1, and the material is continued starting after one to nine spaces. If the material is continued it need not go through column 72 of the original card, but may be broken after a quantity name, number or arithmetic operator. The unused portion of the card must be blank, i.e., no comments are permitted within the information.

A.2.3 Quantity Names

Quantity names consist of from one through six alphabetic or numeric characters, the first of which must be alphabetic. For example

X
INV
LEV3
BACKLO

The names DT, LENGTH, PRTPER, PLTPER and TIME have special meaning in DYNAMO and may not be used for other purposes.

A.3 Equation Cards

A.3.1 Equation Types

There are seven equation types in Dynamo, namely:

Level (L) equations are the integral equations of DYNAMO. They relate a quantity at the current time to its value at the previous time that calculations were made, and to its rates of change during the interval between calculations.

Auxiliary (A) equations are simple algebraic functions of levels and other auxiliary variables at the same time instant. Auxiliary equations may not depend upon other auxiliaries which in turn depend on the auxiliary defined: i.e., simultaneous equations among auxiliary equations are not permitted.

Rate (R) equations are much like auxiliary equations in that they are algebraic functions of levels and auxiliaries at the same time instant.

Supplementary (S) equations are algebraic equations that are computed only to provide output. If there is a significant number of solution intervals between each output period, a small saving in computer time can be made by computing as supplementaries those quantities that are only printed or plotted, or are used only in other supplementary equations.

An initial value (N) equation must be provided for every level, and may be provided for any auxiliary or rate. A constant may also be computed initially by this equation type. (The N equation is the only equation that exists for the quantity).

A given constant (C) differs from an initially computed constant in that the right of the equal sign is restricted to a numerical value. Given constants and tables are the only quantities that can be changed in a rerun.

A table (T) is an array of numerical values that provides the values upon which the table look-up function operates.

A.3.2 Equation Writing

Equations are written according to the usual rules of algebra.

A.3.2 Subscript Convention

	Quantity Type on Left of Equation	Subscript on Left	Subscripts on Quantities on Right if Quantity is					
			L	A	R	S	C	N
L	Level	K	J	J	JK	np	none	none
A	Auxiliary	K	K	K	JK	np	none	none
R	Rate	KL	K	K	JK	np	none	none
S	Supplementary	K	K	K	JK	np	none	none
C	Constant	none	np	np	np	np	np	np
N	Initial value or computed constant	none	none	none	none	none	none	none

np = not permitted

Note that every quantity that appears on the right side of any equation must be defined, ie., appear on the left of that or some other equation.

A.3.3 Initial Values

In order to get a model started, some variables will require initial values. Some of these initial values can be computed by DYNAMO; others will require explicit user-provided values.

All levels require initial values which must be provided by the user in N equations. Auxiliaries that appear in some initial value equation and rates that are used on the right side of auxiliary, rate, supplementary, or initial value equations must have an initial value equation provided either by the user or by DYNAMO.

A.3.4 Run Specifications

There are four quantities that specify the essential parameters of a similation run:

DT	the interval of Time between TIME.J and TIME.K
LENGTH	the value of TIME when the run is to be terminated
PRTPER	the interval of TIME between each tabulation of the results
PLTPER	the interval of TIME between each plot output of the results

The choice of the size of DT requires a compromise between a large DT which demands slightly less computer time and a small DT which assures numerical accuracy. A good way to choose DT is first to select a value based on the delays in the model, and then to check this choice by rerunning some run with a much smaller DT (eg. one-fourth as large). The accuracy of the model results associated with any particular DT is almost impossible to determine except by this procedure.

Zero values of LENGTH, PRTPER, and PLTPER have special meaning

LENGTH = 0-in the basic model indicates that DYNAMO should skip to the first rerun without running the basic model. The rerun option will also achieve the same result.

PRTPER = 0-no tabular output is desired even though one or more PRINT cards may have been included in the model.

PLTPER = 0-no plotted output is desired even though one or more PLOT cards may have been included in the model.

The four quantities may alternately be specified in equations that change their value during the run. By doing so, the user can tabulate more frequently during a portion of his run or postpone the start of the plot until interesting things begin to happen. Results are tabulated when PRTPER is greater than zero, and when the last time for which data was tabulated plus PRTPER is less than or equal to the current value of TIME. The same applies to plotted results and PLTPER. The run is terminated when LENGTH is less than or equal to the current value of TIME. For example

A PRTPER.K = 10 + STEP(40, 60)

will result in tabular results at TIME = 0, 10, 20, 30, 40, 50, 100, 150 ...

TIME is a level (subscripted .K or .J) that is built into DYNAMO, the user should not include an equation for it. If the user would like his simulation to start at some time other than zero, he may provide an N equation for TIME giving the value. The simulation will run from that value until TIME is equal to LENGTH. (Perhaps LENGTH is a poor term for the "stop time" but it is a carryover from DYNAMO I in which TIME always started with zero). Incidentally, the initial STEP, RAMP, and PULSE are also triggered by a comparison with TIME and not the elapsed time since the model started.

A.4 Functions

A function is a convenient way to relate a value to other values. The form of the relationship is not expressed explicitly, but understood from the name of the function. A macro is a function that is computed by one or more DYNAMO equations.

A.4.1 Built-In Functions And Macros

Clipping or Limiting Function

CLIP(P, Q, R, S)

$$\text{CLIP} = P \qquad \text{if } R \geq S$$

$$\text{CLIP} = Q \qquad \text{if } R < S$$

where P, Q, R, S need not be distinct. The name CLIP is the DYNAMO I name anddescribes one possible use of the function, clipping a variable depending on the value of two other variables.

Delays

There are two classes of delays: material and information. The difference between these classes is unimportant unless the length of thedelay is changing. In the material delay whatever is in the delay is conserved as the length changes; in the information delay it is not.

Delays also can be characterized by their order. The order relates to how fast the output starts to change after a change in the input. Low order delays respond more quickly than high order delays with the same average delay. The order of the delay is the number of cascaded first-order delays that compose the delay.

DYNAMO provides a first- and a third-order material delay and a third-order information delay. The SMOOTH macro may be used as a first-order information delay; the equations are identical.

Also available is a third-order delay with the quantity in the delay available as the third argument. This quantity is computed within the DELAYP Macro; it must be a quantity name that is not defined elsewhere in the model.

```
DELAY1  (IN,  DEL)
DELAY3  (IN,  DEL)
DELAYP  (IN,  DEL,PPL)
DLINF3  (IN,  DEL)
```

IN - input to the delay
DEL - magnitude of the delay
PPL - quantity in pipeline

Maximum Function

MAX(P,Q)

$$\text{MAX} = P \qquad \text{if } P \geq Q$$

$$\text{MAX} = Q \qquad \text{if } P < Q$$

where P and Q need not be distinct. In particular, setting Q equal to -P sets MAX equal to the absolute value of P.

Mimimum Function

MIN(P,Q)

MIN = P if P Q

MIN = Q if P Q

Random Numbers

DYNAMO generates random numbers by computing a sequence of "pseudo-random" numbers. A sequence of pseudo-random numbers is a sequence of numbers that satisfies all statistical tests of randomness, but in which each number is calculated from the previous one. Thus, if we know the generation procedure and one number in the sequence, we can calculate the next number in the sequence and similarly, all the following numbers in the sequence in complete violation of the principle of randomness. Nevertheless, anyone unfamiliar with the generation procedure cannot detect that these numbers are not completely random.

There are two random-number functions in DYNAMO.

NOISE()

gives random numbers uniformly distributed between -1/2 and +1/2. Note the parentheses but no argument.

NORMRN(MEAN, STDV)

gives random numbers normally distributed (normal deviates) with mean, MEAN, and standard deviation, STDV. NORMRN starts with a number from the same generator that NOISE above uses, and then alters it to conform to a normal distribution.

Pulse Source

PULSE(HGHT, FRST, INTVL)

HGHT	- pulse height
FRST	- TIME of first pulse
INTVL	- interval between pulses

provides a pulse train in which the pulses are of width DT and height HGHT. The first pulse appears at time FRST, and subsequent pulses appear at TIME = FRST + INTVL, FRST + 2*INTVL, FRST + 3*INTVL, and so on. HGHT can be a variable giving a variable height to the pulses. If FRST and INTVL are variables, the first pulse occurrs when the initial value of FRST less the initial value of INTVL plus the current value of INTVL exceeds TIME - DT/2.

Ramp Function

RAMP(SLP, STRT)

$$\text{RAMP} = 0 \qquad \text{if TIME} \leq \text{STRT}$$

$$\text{RAMP} = \sum_{\text{STRT}}^{\text{TIME}} \text{SLP*DT} \qquad \text{if TIME} > \text{STRT}$$

If SLP and STRT are both constants, RAMP is merely a ramp with slope SLP that starts at time STRT. If STRT is a variable, the ramp time is determined by the method discussed in section A.4.2. If SLP is a variable, RAMP is DT times the sum of all SLP since the time STRT.

Sample Function

SAMPLE(X,INTVL,ISAM)

X	- variable to be sampled
INTVL	- sample interval
ISAM	- initial value of SAMPLE

SAMPLE is set equal to X at sample times separated by intervals of length INTVL and retains this value until the next sample time. If INTVL is a constant, these times are of course INTVL, 2*INTVL, 3*INTVL, and so on. Variable sample times are discussed in section A.4.2. SAMPLE will have the value ISAM until the first sample time.

Smooth Function

SMOOTH(IN,DEL)

IN	- input
DEL	- smoothing constant or delay

The smooth function provides a way to exponentially smooth a quantity. It is a built-in macro that besides smoothing the input, initialized the smoothed value to the initial input. This macro can also be used as a first order information delay.

Step Function

STEP(HGHT,STTM)

$$\text{STEP} = 0 \qquad \text{if TIME} < \text{STTM}$$

$$\text{STEP} = \text{HGHT} \qquad \text{if TIME} \geq \text{STTM}$$

Both HGHT and STTM may be variables. If STTM is a variable, the step time is determined by the method described in section A.4.2. If HGHT is a variable, the step function has the effect of a gate function that "opens" the gate allowing STEP to equal HGHT from time STTM onwards. The STEP will equal 0 until the step time (and any time that TIME is less than STTM).

Switch Function

SWITCH(P,Q,R)

SWITCH = P	if R = 0
SWITCH = Q	if $R \neq 0$

SWITCH is the DYNAMO I name which suggest the principal use of the function.

Table Functions

The DYNAMO user will occasionally desire to express a variable which has a rather artitrary relationship to another variable. Frequently this relationship can be expressed most easily by a graph or table corresponding to the graph. A table corresponding to the graph can be made by dividing the range of the independent variable (X) into equal segments and noting the corresponding values of the dependent variable (Y).

The form of the table look-up function is:

TABLE(TAB,X,XLOW,XHIGH,XINCR)

TAB - name of the table
X - independent variable
XLOW - lowest value of range of independent variable
XHIGH - highest value of range of independent variable
XINCR - increment of independent variable.

If Y in the previous example is an auxiliary, then the equation for Y would be:

A Y.K = TABLE(YTAB, X.K, -3, 3, 1)

where YTAB is thename of the table for Y; YTAB would be given by a table card as follows:

T YTAB = -20/0/10/16/20/24/30

Trigonometric Functions

There are five trigonometric functions available in DYNAMO: exponential natural logarithm, square root, sine, and cosine. All these functions behave exactly as described in elementary courses in calculus.

DYNAMO Spelling	Function	Restriction on Argument
EXP(A)	ϵ^A	$A \leq 174$
LOGN(A)	$\log_\epsilon(A)$	$A > 0$
SORT(A)	$\sqrt{A}$	$A \geq 0$
SIN(A)	sine(A)	$A < 823{,}000$
COS(A)	cosine(A)	$A < 823{,}000$

The sine and cosine functions will be used frequently to generate functions of TIME.

A INPUT.K = 100 + SNAMP*SIN (6.283*TIME.K/PERD)

A to the Bth power can be computed as

EXP(B*LOGN(A))

A.4.2 Time Related Events

There are two questions pertaining to when an action (a pulse, ramp, sample, or step) will occur. The first relates to instances when TIME and the action time are nearly but not exactly equal; the second addresses the situations with variable action times.

An action will occur if TIME is greater than the action time, or if the two agree within DT/2.

The second issue pertains to pulses and samples when the interval between actions is not an integer multiple of DT. If the interval is 1.6 and DT is 1.0, does DYNAMO produce 8 or 10 actions after 16 units of time? If one records the exact TIME when an action takes place and adds the interval to it to compute the next action time, he would take 8 actions in the above example. Alternatively, if he records the TIME when the action was supposed to occur (which may differ from the actual TIME by as much as DT/2), he would take 10 actions in the above example. While these actions would not be evenly spaced (occurring at TIME = 2,3,5,6,8, 10, 11, 13, 14, 16), there would be 16/1.6 = 10 actions. The proper number of actions is generally more important than the evenness of the spacing, so DYNAMO follows the second method.

A.5 Direction Cards

The direction cards specify variables to be plotted, page headings, and other miscellaneous information. They include the asterisk, NOISE, NOTE, PLOT, PRINT, and RUN cards.

A.5.1 Asterisk Card

The asterisk card, the first card in the deck, provides the information listed on the top of each page, along with the page number and run description. Typically, it is a several-word title for the model. The card is punched with an asterisk in colum 1 and the "title" beginning in column 3 or later. The title may not be longer than 50 characters, nor may any word in the title contain more than 16 characters. For example:

*Production-Distribution Model

A.5.2 Noise Cards

As explained in the Section A.4.1 in the discussion of the NOISE and NORMRN functions, the particular sequence of random numbers in any run can be altered by the inclusion of a NOISE card. This card sets the initial value of the seed which starts the sequence. The number should be odd and between 100,001 and 99,999,999. The form of the card is

NOISE 333333

(The built-in seed is 1,234,567).

A.5.3 Note Cards

DYNAMO prints all the equation and direction cards preceding the printed and plotted results; thus, a DYNAMO user can be certain which set of equations produced the results. It is sometimes convenient to insert a line of remarks or comments along with the equation cards (in addition to the comments on the cards proper, mentioned in section A.2.2). Such remarks may be punched on a NOTE card, beginning in column 6 or later and ending before column 73. Any number of spaces may be used. No continuation cards are permitted, but a remark may be continued on additional NOTE cards. A NOTE card is identified by "NOTE" punched in columns 1 through 4.

NOTE MANUFACTURING SECTOR

A.5.4 Plot Cards

In addition to tabulating results, DYNAMO will plot the results (versus TIME) on the same printer as the tabulation. Much flexibility is available in these plots. The user specifies which quantities have the same scales and can either specify the scales or let DYNAMO choose the scales so that all the data are on scale.

Each quantity name is followed by an equal sign and the character that is to identify it on the graph. Quantities that are to be plotted to the same scale are separated by commas. Quantities or groups of quantities that are to be plotted to different scales are separated by slashes. For example:

PLOT RPQ = R, TUV = T/XYZ = X

In the preceding example, RPQ and TUV are plotted on the same scale, while XYZ is plotted on its own scale. If the Dynamo user wishes to specify the scale, he follows the quantity name and plotting character (of the last quantity in a group with the same scale) with a left parenthesis, the lower limit, comma, the upper limit, and a right parenthesis. If he would like DYNAMO to set one of the two limits, he puts an asterisk in place of the limit value. For example:

PLOT AUX = A,ABC = C/XYZ = X(0,*)/TUV = T, SUPL = S(0,1000)

In this example, AUX and ABC are plotted with the same limits, and these limits are set by DYNAMO. XYZ is plotted on its own scale, and while the lower limit is 0, the upper limit is chosen by DYNAMO. TUV and SUPL are plotted on a scale running from 0 to 1000.

More than one plot may be specified by using additional PLOT cards. No more than 10 quantities may be specified on any one plot, but a particular quantity may be specified on any number of plots.

A.5.5 Print Cards

DYNAMO can print any quantity desired in a tabular form.

TIME is automatically printed by itself in the leftmost column. The user may specify any number of quantities in each of the 14 remaining columns. The name of the quantity being tabulated is automatically printed at the top of each page. The scale factors (see next section) are printed on the first page under the names. The data follow, with dashes separating the data corresponding to different times.

There are two modes for specifying where the data should appear on the page: row and column. In the row mode, the quanity names are given, separated by commas or slashes, in the order they are to appear across the page. For example:

PRINT ABC,BCD,CDE

In the column mode, the column number is given, followed by a right parenthesis and quantity names in the order they are to appear down the colum. Commas or slashes separate the quantity names. More than one column number may appear on a card (separated from the previous quantity name by a comma or slash).

Scaling of Quantities for Printing

As DYNAMO prints but 5 significant figures, very large or very small numbers must be divided by some power of ten before printing so that the 5 or fewer significant figures will suffice. Such division before printing is called scaling.

Scale factors are printed on the first page following the quantity names. They appear as the letter E followed by the power of 10. As the results were divided by this power of 10 before printing, they must be multiplied by this power of 10 in order to reconstruct the original number. For example, LEV = 2000 with a scale factor of E+03 means that the value of 2000 should be multiplied by 10^3 or 1000 giving a value of 2 million.

A.5.6 Run Card

Each run (or rerun) is assigned a run description which identifies it. This description appears at the top of each page along with the page number and model identifier. The number is provided by a card with RUN in columns 1, 2 and 3, and the run number starting in column 5 or later.

A.6. Order of Cards; Basic Run and Reruns

By appropriately ordering his cards, the user may instruct DYNAMO to compile his model and make any number of runs with different values of constants and tables. The following describes the rules concerning the order of the cards in the basic model and in reruns.

A.6.1 Card Order, Basic Model

The customary order of cards for the basic model is:

1. asterisk card
2. macro definitions (if any)
3. equation and NOTE cards (intermized in any convenient order)
4. PRINT card(s)
5. PLOT card(s)
6. SPEC card (if run of basic model is desired)
7. RUN card

If the user wishes to maintain one set of constants in his basic model and make changes only in reruns, he can suppress the run of the basic model by inserting the SPEC card in the first rerun by using the RERUN option.

The requirements on card order are quite lenient. Continuation cards must be in order and must follow the card they continue.

The PRINT and PLOT cards must be included in or before the run or rerun to which they pertain. The SPEC card must be in the basic model or first rerun. One or more additional SPEC cards may be included in subsequent reruns. A NOISE card must appear in the run to which it pertains.

A.6.2 Reruns

No equation may be changed or added in a rerun; only constants and tables may be altered. If several reruns are planned and the constant or table is to be changed in each or is to revert to the original value(s) in subsequent reruns, a C or T card is used to alter its value. On the otherhand, a CP or TP card will alter a constant permanently for all subsequent reruns, or until the constant or table is altered again. If a constant or table is altered "permanently" then changed again with a C or T card, it will revert to the original value in subsequent reruns unless it is changed once more.

PRINT and PLOT cards may also be used in reruns. If they are used, the new request replaces rather than supplements any earlier request.

The only crucial issue relative to order is that the RUN card must be last in any rerun.

APPENDIX "B"

MODEL EQUATIONS OF INSHORE FISH PROCESSING PLANT

```
        *  FISH PROCESSING MODEL OF A NFLD INSHORE FREEZER PLANT
NOTE       P R O C E S S I N G   S E C T O R
NOTE     PRODUCTION LINE "A"
1A   AEEE.K=AIAP.K-ASS6.K
1A   ABBB.K=TBBB-(AEEE.K+BEEE.K+CEEE.K+DEEE.K+EEEE.K+FEEE.K+ARMPF.K+BRMPF
X1   .K+CRMPF.K+DRMPF.K+ERMPF.K+FRMPF.K)
1A   AFF1.K=ABBB.K-(ADDD.K+ACCC1.K+BDDD.K+BCCC1.K+CDDD.K+CCCC1.K+DDDD.K+D
X1   CCC1.K+EDDD.K+ECCC1.K+FDDD.K+FCCC1.K)
1A   ACCC1.K=ACCC.K-ALM1.K
1A   AGGG.K=MIN(AORDY.K,AFF1.K)
1A   ALR1.K=MIN(AGGG.K,AMWP.K)
1A   ALR3.K=NDFI*(AGG1.K+ALMF.K)-(ACCC.K-ALMF.K-ALM1.K)
1A   ALR2.K=MAX(ALR3.K,0)
1A   ARRF.K=MIN(ALR1.K,ALR2.K)
1R   ARMF.KL=ARRF.K
1N   ARMF=0
1R   AERMR.KL=AMWP.K-ARRF.K
1L   AERML.K=AERML.J+(DT)(AERMR.JK-0)
1N   AERML=0
1L   ARMPL.K=ARMPL.J+(DT)(ARMF.JK-(AMDP1.JK+AMDP1Q.JK+AFNP.JK+AMDP3Q.JK))
1N   ARMPL=0
1A   AALP.K=AAAA.K
1A   AFCA1.K=TFVC.K/AYLD.K
1A   TFVC.K=TFVC1+(TFVC2*TFVC1)
1A   AGG1.K=MIN(AALP.K,AFCA1.K)
1A   ADDD.K=MIN(ARMPL.K,AGG1.K)
1A   ACCC.K=ARMPL.K-ADDD.K
1R   AMDP1.KL=ADDD.K*AYLD.K
1R   AMDP1Q.KL=(ADDD.K)(1-AYLD.K)
1R   AFNP.KL=ALMF.K
1A   ALMF.K=MIN(ACCC.K,ALL1.K)
1A   ALL1.K=(FFCA1.K-FDDD.K)*FYLD.K
1R   AMDP3Q.KL=ALM1.K
1A   ALM1.K=CLIP(0,ALM3.K,ALM2.K,AFDL.K)
1A   ALM3.K=ARMPL.K-ALM2.K
1A   ALM2.K=ALMF.K+ADDD.K
1R   AFDI.KL=ACCC.K-ALMF.K
1L   AFDL.K=AFDL.J+(DT)(AFDI.JK-AFDO.JK)
1N   AFDL=0
1R   AFDO.KL=AFDL.K
1L   ARMPF.K=ARMPF.J+(DT)(AFNP.JK-(AMDP2.JK+AMDP2Q.JK))
1N   ARMPF=0
1A   AYLDD.K=AYLD.K-(AYLD.K*TYLD)
1R   AMDP2.KL=AMDD.K*AYLDD.K
1R   AMDP2Q.KL=(AMDD.K)(1-AYLDD.K)
1A   AMDD.K=MIN(ADDE.K,ARMPF.K)
1A   ADDE.K=MIN(ASAP.K,AALLP.K)
1A   AALLP.K=((FALP.K-FDDD.K)/FAAA.K)*AAAA.K
1A   ASAP.K=(FLL1.K-FLMF.K)/AYLDD.K
1L   AIAP.K=AIAP.J+(DT)((AMDP1.JK+AMDP2.JK)-ASSP.JK)
1N   AIAP=0
```

```
00520 1R   ASSP.KL=ASS6.K
00530 A    ASS1.K=CLIP(TSS,0,AIAP.K,TSS)
00540 A    ASS2.K=CLIP(0,ASS3.K,0,AIAP.K)
00550 A    ASS3.K=CLIP(ASS4.K,0,0,ASS5.K)
00560 A    ASS4.K=CLIP(AIAP.K,0,0,AMOP.K)
00570 1A   AMOP.K=AMDP1.JK+AMDP2.JK
00580 A    ASS5.K=AS1L.K+AS2L.K+AS3L.K+AS4L.K
00590 A    ASS6.K=CLIP(ASS1.K,ASS2.K,ASS1.K,TSS)
00600 R    AS1R.KL=ASS6.K
00610 R    AS2R.KL=AS1L.K
00620 R    AS3R.KL=AS2L.K
00630 R    AS4R.KL=AS3L.K
00640 R    AS5R.KL=AS4L.K
00650 L    AS1L.K=AS1L.J+(DT)(AS1R.JK-AS2R.JK)
00660 L    AS2L.K=AS2L.J+(DT)(AS2R.JK-AS3R.JK)
00670 L    AS3L.K=AS3L.J+(DT)(AS3R.JK-AS4R.JK)
00680 L    AS4L.K=AS4L.J+(DT)(AS4R.JK-AS5R.JK)
00690 N    AS1L=0
00700 N    AS2L=0
00710 N    AS3L=0
00720 N    AS4L=0
00730 1R   AORDF.KL=ASS6.K
00740 1L   AORDB.K=AORDB.J+(DT)(AORD.JK-AORDF.JK)
00750 1N   AORDB=0
00760 1R   AORD.KL=AOLD.K
00770 1R   AORD1R.KL=AOLD.K
00780 1L   AORD1L.K=AORD1L.J+(DT)(AORD1R.JK-AORD2R.JK)
00790 1N   AORD1L=0
00800 1R   AORD2R.KL=AORD1L.K
00810 1A   AORDC.K=AOLD.K*ALFA
00820 1A   AORDL.K=AORD1L.K*(1-ALFA)
00830 1A   AORDE.K=AORDC.K+AORDL.K
00840 1R   AORDE1.KL=AORDE.K
00850 1L   AORDET.K=AORDET.J+(DT)(AORDE1.JK-AORDE2.JK)
00860 1N   AORDET=0
00870 1R   AORDE2.KL=AORDY1.K
00880 1A   AORDY1.K=ARRF.K*AYLD.K
00890 1A   AORDY.K=AORDET.K/AYLD.K
00900 1L   APPPP.K=APPPP.J+(DT)(ASSP.JK-0)
00910 1N   APPPP=0
00920 NOTE    PRODUCTION LINE "B"
00930 1A   BEEE.K=BIAP.K-BSS6.K
00940 1A   BBBB.K=TBBB-(AEEE.K+BEEE.K+CEEE.K+DEEE.K+EEEE.K+FEEE.K+ARMPF.K+BRMPF
00950 X1   .K+CRMPF.K+DRMPF.K+ERMPF.K+FRMPF.K)
00960 1A   BFF1.K=BBBB.K-(ADDD.K+ACCC1.K+BDDD.K+BCCC1.K+CDDD.K+CCCC1.K+DDDD.K+D
00970 X1   CCC1.K+EDDD.K+ECCC1.K+FDDD.K+FCCC1.K+ARRF.K)
00980 1A   BCCC1.K=BCCC.K-BLM1.K
00990 1A   BGGG.K=MIN(BORDY.K,BFF1.K)
01000 1A   BLR1.K=MIN(BGGG.K,BMWP.K)
01010 1A   BLR3.K=NDFI*(BGG1.K+BLMF.K)-(BCCC.K-BLMF.K-BLM1.K)
01020 1A   BLR2.K=MAX(BLR3.K,0)
```

```
01030 1A   BRRF.K=MIN(BLR1.K,BLR2.K)
01040 1R   BRMF.KL=BRRF.K
01050 1N   BRMF=0
01060 1R   BERMR.KL=BMWP.K-BRRF.K
01070 1L   BERML.K=BERML.J+(DT)(BERMR.JK-0)
01080 1N   BERML=0
01090 1L   BRMPL.K=BRMPL.J+(DT)(BRMF.JK-(BMDP1.JK+BMDP1Q.JK+BFNP.JK+BMDP3Q.JK))
01100 1N   BRMPL=0
01110 1A   BALP.K=((AALP.K-ADDD.K)/AAAA.K)*BAAA.K
01120 1A   BFCA1.K=((AFCA1.K-ADDD.K)*AYLD.K)/BYLD.K
01130 1A   BGG1.K=MIN(BALP.K,BFCA1.K)
01140 1A   BDDD.K=MIN(BRMPL.K,BGG1.K)
01150 1A   BCCC.K=BRMPL.K-BDDD.K
01160 1R   BMDP1.KL=BDDD.K*BYLD.K
01170 1R   BMDP1Q.KL=(BDDD.K)(1-BYLD.K)
01180 1R   BFNP.KL=BLMF.K
01190 1A   BLMF.K=MIN(BCCC.K,BLL1.K)
01200 1A   BLL1.K=ALL1.K-ALMF.K
01210 1R   BMDP3Q.KL=BLM1.K
01220 1A   BLM1.K=CLIP(0,BLM3.K,BLM2.K,BFDL.K)
01230 1A   BLM3.K=BRMPL.K-BLM2.K
01240 1A   BLM2.K=BLMF.K+BDDD.K
01250 1R   BFDI.KL=BCCC.K-BLMF.K
01260 1L   BFDL.K=BFDL.J+(DT)(BFDI.JK-BFDO.JK)
01270 1N   BFDL=0
01280 1R   BFDO.KL=BFDL.K
01290 1L   BRMPF.K=BRMPF.J+(DT)(BFNP.JK-(BMDP2.JK+BMDP2Q.JK))
01300 1N   BRMPF=0
01310 1A   BYLDD.K=BYLD.K-(BYLD.K*TYLD)
01320 1R   BMDP2Q.KL=(BMDD.K)(1-BYLDD.K)
01330 1R   BMDP2.KL=BMDD.K*BYLDD.K
01340 1A   BMDD.K=MIN(BDDE.K,BRMPF.K)
01350 1A   BDDE.K=MIN(BSAP.K,BALLP.K)
01360 1A   BALLP.K=((AALLP.K-AMDD.K)/AAAA.K)*BAAA.K
01370 1A   BSAP.K=((ASAP.K-AMDD.K)*AYLDD.K)/BYLDD.K
01380 1L   BIAP.K=BIAP.J+(DT)((BMDP1.JK+BMDP2.JK)-BSSP.JK)
01390 1N   BIAP=0
01400 1R   BSSP.KL=BSS6.K
01410 A    BSS1.K=CLIP(TSS,0,BIAP.K,TSS)
01420 A    BSS2.K=CLIP(0,BSS3.K,0,BIAP.K)
01430 A    BSS3.K=CLIP(BSS4.K,0,0,BSS5.K)
01440 A    BSS4.K=CLIP(BIAP.K,0,0,BMOP.K)
01450 1A   BMOP.K=BMDP1.JK+BMDP2.JK
01460 A    BSS5.K=BS1L.K+BS2L.K+BS3L.K+BS4L.K
01470 A    BSS6.K=CLIP(BSS1.K,BSS2.K,BSS1.K,TSS)
01480 R    BS1R.KL=BSS6.K
01490 R    BS2R.KL=BS1L.K
01500 R    BS3R.KL=BS2L.K
01510 R    BS4R.KL=BS3L.K
01520 R    BS5R.KL=BS4L.K
01530 L    BS1L.K=BS1L.J+(DT)(BS1R.JK-BS2R.JK)
```

```
L     BS2L.K=BS2L.J+(DT)(BS2R.JK-BS3R.JK)
L     BS3L.K=BS3L.J+(DT)(BS3R.JK-BS4R.JK)
L     BS4L.K=BS4L.J+(DT)(BS4R.JK-BS5R.JK)
N     BS1L=0
N     BS2L=0
N     BS3L=0
N     BS4L=0
1R    BORDF.KL=BSS6.K
1L    BORDB.K=BORDB.J+(DT)(BORD.JK-BORDF.JK)
1N    BORDB=0
1R    BORD.KL=BOLD.K
1R    BORD1R.KL=BOLD.K
1L    BORD1L.K=BORD1L.J+(DT)(BORD1R.JK-BORD2R.JK)
1N    BORD1L=0
1R    BORD2R.KL=BORD1L.K
1A    BORDC.K=BOLD.K*ALFA
1A    BORDL.K=BORD1L.K*(1-ALFA)
1A    BORDE.K=BORDC.K+BORDL.K
1R    BORDE1.KL=BORDE.K
1L    BORDET.K=BORDET.J+(DT)(BORDE1.JK-BORDE2.JK)
1N    BORDET=0
1R    BORDE2.KL=BORDY1.K
1A    BORDY1.K=BRRF.K*BYLD.K
1A    BORDY.K=BORDET.K/BYLD.K
1L    BPPPP.K=BPPPP.J+(DT)(BSSP.JK-0)
1N    BPPPP=0
NOTE     PRODUCTION LINE "C"
1A    CEEE.K=CIAP.K-CSS6.K
1A    CBBB.K=TBBB-(AEEE.K+BEEE.K+CEEE.K+DEEE.K+EEEE.K+FEEE.K+ARMPF.K+BRMPF
X1    .K+CRMPF.K+DRMPF.K+ERMPF.K+FRMPF.K)
1A    CFF1.K=CBBB.K-(ADDD.K+ACCC1.K+BDDD.K+BCCC1.K+CDDD.K+CCCC1.K+DDDD.K+D
X1    CCC1.K+EDDD.K+ECCC1.K+FDDD.K+FCCC1.K+ARRF.K+BRRF.K)
1A    CCCC1.K=CCCC.K-CLM1.K
1A    CGGG.K=MIN(CORDY.K,CFF1.K)
1A    CLR1.K=MIN(CGGG.K,CMWP.K)
1A    CLR3.K=NDFI*(CGG1.K+CLMF.K)-(CCCC.K-CLMF.K-CLM1.K)
1A    CLR2.K=MAX(CLR3.K,0)
1A    CRRF.K=MIN(CLR1.K,CLR2.K)
1R    CRMF.KL=CRRF.K
1N    CRMF=0
1R    CERMR.KL=CMWP.K-CRRF.K
1L    CERML.K=CERML.J+(DT)(CERMR.JK-0)
1N    CERML=0
1L    CRMPL.K=CRMPL.J+(DT)(CRMF.JK-(CMDP1.JK+CMDP1Q.JK+CFNP.JK+CMDP3Q.JK))
1N    CRMPL=0
1A    CALP.K=((BALP.K-BDDD.K)/BAAA.K)*CAAA.K
1A    CFCA1.K=((BFCA1.K-BDDD.K)*BYLD.K)/CYLD.K
1A    CGG1.K=MIN(CALP.K,CFCA1.K)
1A    CDDD.K=MIN(CRMPL.K,CGG1.K)
1A    CCCC.K=CRMPL.K-CDDD.K
1R    CMDP1.KL=CDDD.K*CYLD.K
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```
02050 1R   CMDP1Q.KL=(CDDD.K)(1-CYLD.K)
02060 1R   CFNP.KL=CLMF.K
02070 1A   CLMF.K=MIN(CCCC.K,CLL1.K)
02080 1A   CLL1.K=BLL1.K-BLMF.K
02090 1R   CMDP3Q.KL=CLM1.K
02100 1A   CLM1.K=CLIP(0,CLM3.K,CLM2.K,CFDL.K)
02110 1A   CLM3.K=CRMPL.K-CLM2.K
02120 1A   CLM2.K=CLMF.K+CDDD.K
02130 1R   CFDI.KL=CCCC.K-CLMF.K
02140 1L   CFDL.K=CFDL.J+(DT)(CFDI.JK-CFDO.JK)
02150 1N   CFDL=0
02160 1R   CFDO.KL=CFDL.K
02170 1L   CRMPF.K=CRMPF.J+(DT)(CFNP.JK-(CMDP2.JK+CMDP2Q.JK))
02180 1N   CRMPF=0
02190 1A   CYLDD.K=CYLD.K-(CYLD.K*TYLD)
02200 1R   CMDP2.KL=CMDD.K*CYLDD.K
02210 1R   CMDP2Q.KL=(CMDD.K)(1-CYLDD.K)
02220 1A   CMDD.K=MIN(CDDE.K,CRMPF.K)
02230 1A   CDDE.K=MIN(CSAP.K,CALLP.K)
02240 1A   CALLP.K=((BALLP.K-BMDD.K)/BAAA.K)*CAAA.K
02250 1A   CSAP.K=((BSAP.K-BMDD.K)*BYLDD.K)/CYLDD.K
02260 1L   CIAP.K=CIAP.J+(DT)((CMDP1.JK+CMDP2.JK)-CSSP.JK)
02270 1N   CIAP=0
02280 1R   CSSP.KL=CSS6.K
02290 A    CSS1.K=CLIP(TSS,0,CIAP.K,TSS)
02300 A    CSS2.K=CLIP(0,CSS3.K,0,CIAP.K)
02310 A    CSS3.K=CLIP(CSS4.K,0,0,CSS5.K)
02320 A    CSS4.K=CLIP(CIAP.K,0,0,CMOP.K)
02330 1A   CMOP.K=CMDP1.JK+CMDP2.JK
02340 A    CSS5.K=CS1L.K+CS2L.K+CS3L.K+CS4L.K
02350 A    CSS6.K=CLIP(CSS1.K,CSS2.K,CSS1.K,TSS)
02360 R    CS1R.KL=CSS6.K
02370 R    CS2R.KL=CS1L.K
02380 R    CS3R.KL=CS2L.K
02390 R    CS4R.KL=CS3L.K
02400 R    CS5R.KL=CS4L.K
02410 L    CS1L.K=CS1L.J+(DT)(CS1R.JK-CS2R.JK)
02420 L    CS2L.K=CS2L.J+(DT)(CS2R.JK-CS3R.JK)
02430 L    CS3L.K=CS3L.J+(DT)(CS3R.JK-CS4R.JK)
02440 L    CS4L.K=CS4L.J+(DT)(CS4R.JK-CS5R.JK)
02450 N    CS1L=0
02460 N    CS2L=0
02470 N    CS3L=0
02480 N    CS4L=0
02490 1R   CORDF.KL=CSS6.K
02500 1L   CORDB.K=CORDB.J+(DT)(CORD.JK-CORDF.JK)
02510 1N   CORDB=0
02520 1R   CORD.KL=COLD.K
02530 1R   CORD1R.KL=COLD.K
02540 1L   CORD1L.K=CORD1L.J+(DT)(CORD1R.JK-CORD2R.JK)
02550 1N   CORD1L=0
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02560 1R   CORD2R.KL=CORD1L.K
02570 1A   CORDC.K=COLD.K*ALFA
02580 1A   CORDL.K=CORD1L.K*(1-ALFA)
02590 1A   CORDE.K=CORDC.K+CORDL.K
02600 1R   CORDE1.KL=CORDE.K
02610 1L   CORDET.K=CORDET.J+(DT)(CORDE1.JK-CORDE2.JK)
02620 1N   CORDET=0
02630 1R   CORDE2.KL=CORDY1.K
02640 1A   CORDY1.K=CRRF.K*CYLD.K
02650 1A   CORDY.K=CORDET.K/CYLD.K
02660 1L   CPPPP.K=CPPPP.J+(DT)(CSSP.JK-0)
02670 1N   CPPPP=0
02680 NOTE   PRODUCTION LINE "D"
02690 1A   DEEE.K=DIAP.K-DSS6.K
02700 1A   DBBB.K=TBBB-(AEEE.K+BEEE.K+CEEE.K+DEEE.K+EEEE.K+FEEE.K+ARMPF.K+BRMPF
02710 X1   .K+CRMPF.K+DRMPF.K+ERMPF.K+FRMPF.K)
02720 1A   DFF1.K=DBBB.K-(ADDD.K+ACCC1.K+BDDD.K+BCCC1.K+CDDD.K+CCCC1.K+DDDD.K+D
02730 X1   CCC1.K+EDDD.K+ECCC1.K+FDDD.K+FCCC1.K+ARRF.K+BRRF.K+CRRF.K)
02740 1A   DCCC1.K=DCCC.K-DLM1.K
02750 1A   DGGG.K=MIN(DORDY.K,DFF1.K)
02760 1A   DLR1.K=MIN(DGGG.K,DMWP.K)
02770 1A   DLR3.K=NDFI*(DGG1.K+DLMF.K)-(DCCC.K-DLMF.K-DLM1.K)
02780 1A   DLR2.K=MAX(DLR3.K,0)
02790 1A   DRRF.K=MIN(DLR1.K,DLR2.K)
02800 1R   DRMF.KL=DRRF.K
02810 1N   DRMF=0
02820 1R   DERMR.KL=DMWP.K-DRRF.K
02830 1L   DERML.K=DERML.J+(DT)(DERMR.JK-0)
02840 1N   DERML=0
02850 1L   DRMPL.K=DRMPL.J+(DT)(DRMF.JK-(DMDP1.JK+DMDP1Q.JK+DFNP.JK+DMDP3Q.JK))
02860 1N   DRMPL=0
02870 1A   DALP.K=((CALP.K-CDDD.K)/CAAA.K)*DAAA.K
02880 1A   DFCA1.K=((CFCA1.K-CDDD.K)*CYLD.K)/DYLD.K
02890 1A   DGG1.K=MIN(DALP.K,DFCA1.K)
02900 1A   DDDD.K=MIN(DRMPL.K,DGG1.K)
02910 1A   DCCC.K=DRMPL.K-DDDD.K
02920 1R   DMDP1.KL=DDDD.K*DYLD.K
02930 1R   DMDP1Q.KL=(DDDD.K)(1-DYLD.K)
02940 1R   DFNP.KL=DLMF.K
02950 1A   DLMF.K=MIN(DCCC.K,DLL1.K)
02960 1A   DLL1.K=CLL1.K-CLMF.K
02970 1R   DMDP3Q.KL=DLM1.K
02980 1A   DLM1.K=CLIP(0,DLM3.K,DLM2.K,DFDL.K)
02990 1A   DLM3.K=DRMPL.K-DLM2.K
03000 1A   DLM2.K=DLMF.K+DDDD.K
03010 1R   DFDI.KL=DCCC.K-DLMF.K
03020 1L   DFDL.K=DFDL.J+(DT)(DFDI.JK-DFDO.JK)
03030 1N   DFDL=0
03040 1R   DFDO.KL=DFDL.K
03050 1L   DRMPF.K=DRMPF.J+(DT)(DFNP.JK-(DMDP2.JK+DMDP2Q.JK))
03060 1N   DRMPF=0
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03070 1A   DYLDD.K=DYLD.K-(DYLD.K*TYLD)
03080 1R   DMDP2.KL=DMDD.K*DYLDD.K
03090 1R   DMDP2Q.KL=(DMDD.K)(1-DYLDD.K)
03100 1A   DMDD.K=MIN(DDDE.K,DRMPF.K)
03110 1A   DDDE.K=MIN(DSAP.K,DALLP.K)
03120 1A   DALLP.K=((CALLP.K-CMDD.K)/CAAA.K)*DAAA.K
03130 1A   DSAP.K=((CSAP.K-CMDD.K)*CYLDD.K)/DYLDD.K
03140 1L   DIAP.K=DIAP.J+(DT)((DMDP1.JK+DMDP2.JK)-DSSP.JK)
03150 1N   DIAP=0
03160 1R   DSSP.KL=DSS6.K
03170 A    DSS1.K=CLIP(TSS,0,DIAP.K,TSS)
03180 A    DSS2.K=CLIP(0,DSS3.K,0,DIAP.K)
03190 A    DSS3.K=CLIP(DSS4.K,0,0,DSS5.K)
03200 A    DSS4.K=CLIP(DIAP.K,0,0,DMOP.K)
03210 1A   DMOP.K=DMDP1.JK+DMDP2.JK
03220 A    DSS5.K=DS1L.K+DS2L.K+DS3L.K+DS4L.K
03230 A    DSS6.K=CLIP(DSS1.K,DSS2.K,DSS1.K,TSS)
03240 R    DS1R.KL=DSS6.K
03250 R    DS2R.KL=DS1L.K
03260 R    DS3R.KL=DS2L.K
03270 R    DS4R.KL=DS3L.K
03280 R    DS5R.KL=DS4L.K
03290 L    DS1L.K=DS1L.J+(DT)(DS1R.JK-DS2R.JK)
03300 L    DS2L.K=DS2L.J+(DT)(DS2R.JK-DS3R.JK)
03310 L    DS3L.K=DS3L.J+(DT)(DS3R.JK-DS4R.JK)
03320 L    DS4L.K=DS4L.J+(DT)(DS4R.JK-DS5R.JK)
03330 N    DS1L=0
03340 N    DS2L=0
03350 N    DS3L=0
03360 N    DS4L=0
03370 1R   DORDF.KL=DSS6.K
03380 1L   DORDB.K=DORDB.J+(DT)(DORD.JK-DORDF.JK)
03390 1N   DORDB=0
03400 1R   DORD.KL=DOLD.K
03410 1R   DORD1R.KL=DOLD.K
03420 1L   DORD1L.K=DORD1L.J+(DT)(DORD1R.JK-DORD2R.JK)
03430 1N   DORD1L=0
03440 1R   DORD2R.KL=DORD1L.K
03450 1A   DORDC.K=DOLD.K*ALFA
03460 1A   DORDL.K=DORD1L.K*(1-ALFA)
03470 1A   DORDE.K=DORDC.K+DORDL.K
03480 1R   DORDE1.KL=DORDE.K
03490 1L   DORDET.K=DORDET.J+(DT)(DORDE1.JK-DORDE2.JK)
03500 1N   DORDET=0
03510 1R   DORDE2.KL=DORDY1.K
03520 1A   DORDY1.K=DRRF.K*DYLD.K
03530 1A   DORDY.K=DORDET.K/DYLD.K
03540 1L   DPPPP.K=DPPPP.J+(DT)(DSSP.JK-0)
03550 1N   DPPPP=0
03560 NOTE    PRODUCTION LINE "E"
03570 1A   EEEE.K=EIAP.K-ESS6.K
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03580 1A   EBBB.K=TBBB-(AEEE.K+BEEE.K+CEEE.K+DEEE.K+EEEE.K+FEEE.K+ARMPF.K+BRMPF
03590 X1   .K+CRMPF.K+DRMPF.K+ERMPF.K+FRMPF.K)
03600 1A   EFF1.K=EBBB.K-(ADDD.K+ACCC1.K+BDDD.K+BCCC1.K+CDDD.K+CCCC1.K+DDDD.K+D
03610 X1   CCC1.K+EDDD.K+ECCC1.K+FDDD.K+FCCC1.K+ARRF.K+BRRF.K+CRRF.K+DRRF.K)
03620 1A   ECCC1.K=ECCC.K-ELM1.K
03630 1A   EGGG.K=MIN(EORDY.K,EFF1.K)
03640 1A   ELR1.K=MIN(EGGG.K,EMWP.K)
03650 1A   ELR3.K=NDFI*(EGG1.K+ELMF.K)-(ECCC.K-ELMF.K-ELM1.K)
03660 1A   ELR2.K=MAX(ELR3.K,0)
03670 1A   ERRF.K=MIN(ELR1.K,ELR2.K)
03680 1R   ERMF.KL=ERRF.K
03690 1N   ERMF=0
03700 1R   EERMR.KL=EMWP.K-ERRF.K
03710 1L   EERML.K=EERML.J+(DT)(EERMR.JK-0)
03720 1N   EERML=0
03730 1L   ERMPL.K=ERMPL.J+(DT)(ERMF.JK-(EMDP1.JK+EMDP1Q.JK+EFNP.JK+EMDP3Q.JK))
03740 1N   ERMPL=0
03750 1A   EALP.K=((DALP.K-DDDD.K)/DAAA.K)*EAAA.K
03760 1A   EFCA1.K=((DFCA1.K-DDDD.K)*DYLD.K)/EYLD.K
03770 1A   EGG1.K=MIN(EALP.K,EFCA1.K)
03780 1A   EDDD.K=MIN(ERMPL.K,EGG1.K)
03790 1A   ECCC.K=ERMPL.K-EDDD.K
03800 1R   EMDP1.KL=EDDD.K*EYLD.K
03810 1R   EMDP1Q.KL=(EDDD.K)(1-EYLD.K)
03820 1R   EFNP.KL=ELMF.K
03830 1A   ELMF.K=MIN(ECCC.K,ELL1.K)
03840 1A   ELL1.K=DLL1.K-DLMF.K
03850 1R   EMDP3Q.KL=ELM1.K
03860 1A   ELM1.K=CLIP(0,ELM3.K,ELM2.K,EFDL.K)
03870 1A   ELM3.K=ERMPL.K-ELM2.K
03880 1A   ELM2.K=ELMF.K+EDDD.K
03890 1R   EFDI.KL=ECCC.K-ELMF.K
03900 1L   EFDL.K=EFDL.J+(DT)(EFDI.JK-EFDO.JK)
03910 1N   EFDL=0
03920 1R   EFDO.KL=EFDL.K
03930 1L   ERMPF.K=ERMPF.J+(DT)(EFNP.JK-(EMDP2.JK+EMDP2Q.JK))
03940 1N   ERMPF=0
03950 1A   EYLDD.K=EYLD.K-(EYLD.K*TYLD)
03960 1R   EMDP2.KL=EMDD.K*EYLDD.K
03970 1R   EMDP2Q.KL=(EMDD.K)(1-EYLDD.K)
03980 1A   EMDD.K=MIN(EDDE.K,ERMPF.K)
03990 1A   EDDE.K=MIN(ESAP.K,EALLP.K)
04000 1A   EALLP.K=((DALLP.K-DMDD.K)/DAAA.K)*EAAA.K
04010 1A   ESAP.K=((DSAP.K-DMDD.K)*DYLDD.K)/EYLDD.K
04020 1L   EIAP.K=EIAP.J+(DT)((EMDP1.JK+EMDP2.JK)-ESSP.JK)
04030 1N   EIAP=0
04040 1R   ESSP.KL=ESS6.K
04050 A    ESS1.K=CLIP(TSS,0,EIAP.K,TSS)
04060 A    ESS2.K=CLIP(0,ESS3.K,0,EIAP.K)
04070 A    ESS3.K=CLIP(ESS4.K,0,0,ESS5.K)
04080 A    ESS4.K=CLIP(EIAP.K,0,0,EMOP.K)
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04090 1A   EMOP.K=EMDP1.JK+EMDP2.JK
04100 A    ESS5.K=ES1L.K+ES2L.K+ES3L.K+ES4L.K
04110 A    ESS6.K=CLIP(ESS1.K,ESS2.K,ESS1.K,TSS)
04120 R    ES1R.KL=ESS6.K
04130 R    ES2R.KL=ES1L.K
04140 R    ES3R.KL=ES2L.K
04150 R    ES4R.KL=ES3L.K
04160 R    ES5R.KL=ES4L.K
04170 L    ES1L.K=ES1L.J+(DT)(ES1R.JK-ES2R.JK)
04180 L    ES2L.K=ES2L.J+(DT)(ES2R.JK-ES3R.JK)
04190 L    ES3L.K=ES3L.J+(DT)(ES3R.JK-ES4R.JK)
04200 L    ES4L.K=ES4L.J+(DT)(ES4R.JK-ES5R.JK)
04210 N    ES1L=0
04220 N    ES2L=0
04230 N    ES3L=0
04240 N    ES4L=0
04250 1R   EORDF.KL=ESS6.K
04260 1L   EORDB.K=EORDB.J+(DT)(EORD.JK-EORDF.JK)
04270 1N   EORDB=0
04280 1R   EORD.KL=EOLD.K
04290 1R   EORD1R.KL=EOLD.K
04300 1L   EORD1L.K=EORD1L.J+(DT)(EORD1R.JK-EORD2R.JK)
04310 1N   EORD1L=0
04320 1R   EORD2R.KL=EORD1L.K
04330 1A   EORDC.K=EOLD.K*ALFA
04340 1A   EORDL.K=EORD1L.K*(1-ALFA)
04350 1A   EORDE.K=EORDC.K+EORDL.K
04360 1R   EORDE1.KL=EORDE.K
04370 1L   EORDET.K=EORDET.J+(DT)(EORDE1.JK-EORDE2.JK)
04380 1N   EORDET=0
04390 1R   EORDE2.KL=EORDY1.K
04400 1A   EORDY1.K=ERRF.K*EYLD.K
04410 1A   EORDY.K=EORDET.K/EYLD.K
04420 1L   EPPPP.K=EPPPP.J+(DT)(ESSP.JK-0)
04430 1N   EPPPP=0
04440 NOTE    PRODUCTION LINE "F"
04450 1A   FEEE.K=FIAP.K-FSS6.K
04460 1A   FBBB.K=TBBB-(AEEE.K+BEEE.K+CEEE.K+DEEE.K+EEEE.K+FEEE.K+ARMPF.K+BRMPF
04470 X1   .K+CRMPF.K+DRMPF.K+ERMPF.K+FRMPF.K)
04480 1A   FFF1.K=FBBB.K-(ADDD.K+ACCC1.K+BDDD.K+BCCC1.K+CDDD.K+CCCC1.K+DDDD.K+D
04490 X1   CCC1.K+EDDD.K+ECCC1.K+FDDD.K+FCCC1.K+ARRF.K+BRRF.K+CRRF.K+DRRF.K+ERR
04500 X2   F.K)
04510 1A   FCCC1.K=FCCC.K-FLM1.K
04520 1A   FGGG.K=MIN(FORDY.K,FFF1.K)
04530 1A   FLR1.K=MIN(FGGG.K,FMWP.K)
04540 1A   FLR3.K=NDFI*(FGG1.K+FLMF.K)-(FCCC.K-FLMF.K-FLM1.K)
04550 1A   FLR2.K=MAX(FLR3.K,0)
04560 1A   FRRF.K=MIN(FLR1.K,FLR2.K)
04570 1R   FRMF.KL=FRRF.K
04580 1N   FRMF=0
04590 1R   FERMR.KL=FMWP.K-FRRF.K
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04600 1L   FERML.K=FERML.J+(DT)(FERMR.JK-0)
04610 1N   FERML=0
04620 1L   FRMPL.K=FRMPL.J+(DT)(FRMF.JK-(FMDP1.JK+FMDP1Q.JK+FFNP.JK+FMDP3Q.JK))
04630 1N   FRMPL=0
04640 1A   FALP.K=((EALP.K-EDDD.K)/EAAA.K)*FAAA.K
04650 1A   FFCA1.K=((EFCA1.K-EDDD.K)*EYLD.K)/FYLD.K
04660 1A   FGG1.K=MIN(FALP.K,FFCA1.K)
04670 1A   FDDD.K=MIN(FRMPL.K,FGG1.K)
04680 1A   FCCC.K=FRMPL.K-FDDD.K
04690 1R   FMDP1.KL=FDDD.K*FYLD.K
04700 1R   FMDP1Q.KL=(FDDD.K)(1-FYLD.K)
04710 1R   FFNP.KL=FLMF.K
04720 1A   FLMF.K=MIN(FCCC.K,FLL1.K)
04730 1A   FLL1.K=ELL1.K-ELMF.K
04740 1R   FMDP3Q.KL=FLM1.K
04750 1A   FLM1.K=CLIP(0,FLM3.K,FLM2.K,FFDL.K)
04760 1A   FLM3.K=FRMPL.K-FLM2.K
04770 1A   FLM2.K=FLMF.K+FDDD.K
04780 1R   FFDI.KL=FCCC.K-FLMF.K
04790 1L   FFDL.K=FFDL.J+(DT)(FFDI.JK-FFDO.JK)
04800 1N   FFDL=0
04810 1R   FFDO.KL=FFDL.K
04820 1L   FRMPF.K=FRMPF.J+(DT)(FFNP.JK-(FMDP2.JK+FMDP2Q.JK))
04830 1N   FRMPF=0
04840 1A   FYLDD.K=FYLD.K-(FYLD.K*TYLD)
04850 1R   FMDP2.KL=FMDD.K*FYLDD.K
04860 1R   FMDP2Q.KL=(FMDD.K)(1-FYLDD.K)
04870 1A   FMDD.K=MIN(FDDE.K,FRMPF.K)
04880 1A   FDDE.K=MIN(FSAP.K,FALLP.K)
04890 1A   FALLP.K=((EALLP.K-EMDD.K)/EAAA.K)*FAAA.K
04900 1A   FSAP.K=((ESAP.K-EMDD.K)*EYLDD.K)/FYLDD.K
04910 1L   FIAP.K=FIAP.J+(DT)((FMDP1.JK+FMDP2.JK)-FSSP.JK)
04920 1N   FIAP=0
04930 1R   FSSP.KL=FSS6.K
04940 A    FSS1.K=CLIP(TSS,0,FIAP.K,TSS)
04950 A    FSS2.K=CLIP(0,FSS3.K,0,FIAP.K)
04960 A    FSS3.K=CLIP(FSS4.K,0,0,FSS5.K)
04970 A    FSS4.K=CLIP(FIAP.K,0,0,FMOP.K)
04980 1A   FMOP.K=FMDP1.JK+FMDP2.JK
04990 A    FSS5.K=FS1L.K+FS2L.K+FS3L.K+FS4L.K
05000 A    FSS6.K=CLIP(FSS1.K,FSS2.K,FSS1.K,TSS)
05010 R    FS1R.KL=FSS6.K
05020 R    FS2R.KL=FS1L.K
05030 R    FS3R.KL=FS2L.K
05040 R    FS4R.KL=FS3L.K
05050 R    FS5R.KL=FS4L.K
05060 L    FS1L.K=FS1L.J+(DT)(FS1R.JK-FS2R.JK)
05070 L    FS2L.K=FS2L.J+(DT)(FS2R.JK-FS3R.JK)
05080 L    FS3L.K=FS3L.J+(DT)(FS3R.JK-FS4R.JK)
05090 L    FS4L.K=FS4L.J+(DT)(FS4R.JK-FS5R.JK)
05100 N    FS1L=0
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```
05110 N    FS2L=0
05120 N    FS3L=0
05130 N    FS4L=0
05140 1R   FORDF.KL=FSS6.K
05150 1L   FORDB.K=FORDB.J+(DT)(FORD.JK-FORDF.JK)
05160 1N   FORDB=0
05170 1R   FORD.KL=FOLD.K
05180 1R   FORD1R.KL=FOLD.K
05190 1L   FORD1L.K=FORD1L.J+(DT)(FORD1R.JK-FORD2R.JK)
05200 1N   FORD1L=0
05210 1R   FORD2R.KL=FORD1L.K
05220 1A   FORDC.K=FOLD.K*ALFA
05230 1A   FORDL.K=FORD1L.K*(1-ALFA)
05240 1A   FORDE.K=FORDC.K+FORDL.K
05250 1R   FORDE1.KL=FORDE.K
05260 1L   FORDET.K=FORDET.J+(DT)(FORDE1.JK-FORDE2.JK)
05270 1N   FORDET=0
05280 1R   FORDE2.KL=FORDY1.K
05290 1A   FORDY1.K=FRRF.K*FYLD.K
05300 1A   FORDY.K=FORDET.K/FYLD.K
05310 1L   FPPPP.K=FPPPP.J+(DT)(FSSP.JK-0)
05320 1N   FPPPP=0
05330 NOTE    FISH MEAL SUBMODEL
05340 1R   FMEAL.KL=QYLD*(AMDP1Q.JK+AMDP2Q.JK+AMDP3Q.JK+BMDP1Q.JK+BMDP2Q.JK+BMD
05350 X1   P3Q.JK+CMDP1Q.JK+CMDP2Q.JK+CMDP3Q.JK+DMDP1Q.JK+DMDP2Q.JK+DMDP3Q.JK+E
05360 X2   MDP1Q.JK+EMDP2Q.JK+EMDP3Q.JK+FMDP1Q.JK+FMDP2Q.JK+FMDP3Q.JK)
05370 1L   MEAL.K=MEAL.J+(DT)(FMEAL.JK-QSSP.JK)
05380 1N   MEAL=0
05390 1R   QSSP.KL=QSS6.K
05400 A    QSS1.K=CLIP(TSS,0,MEAL.K,TSS)
05410 A    QSS2.K=CLIP(0,QSS3.K,0,MEAL.K)
05420 A    QSS3.K=CLIP(QSS4.K,0,0,QSS5.K)
05430 A    QSS4.K=CLIP(MEAL.K,0,0,FMEAL.JK)
05440 A    QSS5.K=QS1L.K+QS2L.K+QS3L.K+QS4L.K
05450 A    QSS6.K=CLIP(QSS1.K,QSS2.K,QSS1.K,TSS)
05460 R    QS1R.KL=QSS6.K
05470 R    QS2R.KL=QS1L.K
05480 R    QS3R.KL=QS2L.K
05490 R    QS4R.KL=QS3L.K
05500 R    QS5R.KL=QS4L.K
05510 L    QS1L.K=QS1L.J+(DT)(QS1R.JK-QS2R.JK)
05520 L    QS2L.K=QS2L.J+(DT)(QS2R.JK-QS3R.JK)
05530 L    QS3L.K=QS3L.J+(DT)(QS3R.JK-QS4R.JK)
05540 L    QS4L.K=QS4L.J+(DT)(QS4R.JK-QS5R.JK)
05550 N    QS1L=0
05560 N    QS2L=0
05570 N    QS3L=0
05580 N    QS4L=0
05590 1L   QPPPP.K=QPPPP.J+(DT)(QSSP.JK-0)
05600 1N   QPPPP=0
05610 NOTE    LABOUR SUBMODEL
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05620 2A   ALNP.K=(ADDD.K/ACPLP.K)+(AMDD.K/(TCPL*ACPLP.K))+(ALMF.K/CPLP.K)
05630 2A   BLNP.K=(BDDD.K/BCPLP.K)+(BMDD.K/(TCPL*BCPLP.K))+(BLMF.K/CPLP.K)
05640 2A   CLNP.K=(CDDD.K/CCPLP.K)+(CMDD.K/(TCPL*CCPLP.K))+(CLMF.K/CPLP.K)
05650 2A   DLNP.K=(DDDD.K/DCPLP.K)+(DMDD.K/(TCPL*DCPLP.K))+(DLMF.K/CPLP.K)
05660 2A   ELNP.K=(EDDD.K/ECPLP.K)+(EMDD.K/(TCPL*ECPLP.K))+(ELMF.K/CPLP.K)
05670 2A   FLNP.K=(FDDD.K/FCPLP.K)+(FMDD.K/(TCPL*FCPLP.K))+(FLMF.K/CPLP.K)
05680 2A   CPLP.K=CPLP1+(CPLP1*CPLP2)
05690 2A   TLNP.K=ALNP.K+BLNP.K+CLNP.K+DLNP.K+ELNP.K+FLNP.K
05700 2A   TLPP.K=TLNP.K-TMENPP.K
05710 2R   TLDNP.KL=CLIP(0,-TLPP.K,TLPP.K,0)
05720 2R   TLHP.KL=CLIP(TLPP.K,0,TLPP.K,0)
05730 2L   TMENPP.K=TMENPP.J+(DT)(TLHP.JK-TLDNP.JK)
05740 2N   TMENPP=0
05750 2N   TLHP=0
05760 2N   TLDNP=0
05770 NOTE  S E L E C T I N G  SPECIE PRODUCT  P R O R I T Y  BY PROFIT MARGIN
05780 NOTE   PROFIT  MARGIN  PER  SPECIE
05790 A    MPHR.K=FPHR.K-((RPHR.K/YHR.K)+(LCHR.K/LPHR.K)+VPHR.K)
05800 A    MPHF.K=FPHF.K-((RPHF.K/YHF.K)+(LCHF.K/LPHF.K)+VPHF.K)
05810 A    MPM.K=FPM.K-((RPM.K/YM.K)+(LCM.K/LPM.K)+VPM.K)
05820 A    MPC.K=FPC.K-((RPC.K/YC.K)+(LCC.K/LPC.K)+VPC.K)
05830 A    MPS.K=FPS.K-((RPS.K/YS.K)+(LCS.K/LPS.K)+VPS.K)
05840 A    MPB.K=FPB.K-((RPB.K/YB.K)+(LCB.K/LPB.K)+VPB.K)
05850 NOTE         RATING OF SPECIES BY PROFIT MARGINS
05860 A    MP1.K=MAX(MPHR.K,MPHF.K)
05870 A    MP2.K=MIN(MPHR.K,MPHF.K)
05880 A    MP3.K=MAX(MP1.K,MPM.K)
05890 A    MP4.K=MIN(MP1.K,MPM.K)
05900 A    MP5.K=MAX(MP3.K,MPC.K)
05910 A    MP6.K=MIN(MP3.K,MPC.K)
05920 A    MP7.K=MAX(MP5.K,MPS.K)
05930 A    MP8.K=MIN(MP5.K,MPS.K)
05940 A    MP9.K=MAX(MP7.K,MPB.K)          HIGHEST
05950 A    MP10.K=MIN(MP7.K,MPB.K)
05960 A    MP11.K=MAX(MP2.K,MP4.K)
05970 A    MP12.K=MIN(MP2.K,MP4.K)
05980 A    MP13.K=MAX(MP11.K,MP6.K)
05990 A    MP14.K=MIN(MP11.K,MP6.K)
06000 A    MP15.K=MAX(MP13.K,MP8.K)
06010 A    MP16.K=MIN(MP13.K,MP8.K)
06020 A    MP17.K=MAX(MP15.K,MP10.K)       SECOND HIGHEST
06030 A    MP18.K=MIN(MP15.K,MP10.K)
06040 A    MP19.K=MAX(MP12.K,MP14.K)
06050 A    MP20.K=MIN(MP12.K,MP14.K)
06060 A    MP21.K=MAX(MP19.K,MP16.K)
06070 A    MP22.K=MIN(MP19.K,MP16.K)
06080 A    MP23.K=MAX(MP21.K,MP18.K)       THIRD HIGHEST
06090 A    MP24.K=MIN(MP21.K,MP18.K)
06100 A    MP25.K=MAX(MP20.K,MP22.K)
06110 A    MP26.K=MIN(MP20.K,MP22.K)
06120 A    MP27.K=MAX(MP25.K,MP24.K)       FOURTH HIGHEST
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06130 A    MP28.K=MIN(MP25.K,MP24.K)
06140 A    MP29.K=MAX(MP26.K,MP28.K)      FIFTH HIGHEST
06150 A    MP30.K=MIN(MP26.K,MP28.K)      SIXTH HIGHEST
06160 NOTE    RAW  MATERIAL  INPUT
06170 A    QTAB1.K=CLIP(TABHR.K,0,MPHR.K,MP9.K)
06180 A    QTAB2.K=CLIP(TABHF.K,0,MPHF.K,MP9.K)
06190 A    QTAB3.K=CLIP(TABM.K,0,MPM.K,MP9.K)
06200 A    QTAB4.K=CLIP(TABC.K,0,MPC.K,MP9.K)
06210 A    QTAB5.K=CLIP(TABS.K,0,MPS.K,MP9.K)
06220 A    QTAB6.K=CLIP(TABB.K,0,MPB.K,MP9.K)
06230 A    AMWP.K=QTAB1.K+QTAB2.K+QTAB3.K+QTAB4.K+QTAB5.K+QTAB6.K
06240 A    RTAB1.K=CLIP(TABHR.K,0,MPHR.K,MP17.K)
06250 A    RTAB2.K=CLIP(TABHF.K,0,MPHF.K,MP17.K)
06260 A    RTAB3.K=CLIP(TABM.K,0,MPM.K,MP17.K)
06270 A    RTAB4.K=CLIP(TABC.K,0,MPC.K,MP17.K)
06280 A    RTAB5.K=CLIP(TABS.K,0,MPS.K,MP17.K)
06290 A    RTAB6.K=CLIP(TABB.K,0,MPB.K,MP17.K)
06300 A    BMWP.K=RTAB1.K+RTAB2.K+RTAB3.K+RTAB4.K+RTAB5.K+RTAB6.K-AMWP.K
06310 A    STAB1.K=CLIP(TABHR.K,0,MPHR.K,MP23.K)
06320 A    STAB2.K=CLIP(TABHF.K,0,MPHF.K,MP23.K)
06330 A    STAB3.K=CLIP(TABM.K,0,MPM.K,MP23.K)
06340 A    STAB4.K=CLIP(TABC.K,0,MPC.K,MP23.K)
06350 A    STAB5.K=CLIP(TABS.K,0,MPS.K,MP23.K)
06360 A    STAB6.K=CLIP(TABB.K,0,MPB.K,MP23.K)
06370 A    CMWP.K=STAB1.K+STAB2.K+STAB3.K+STAB4.K+STAB5.K+STAB6.K-AMWP.K-BMWP.K
06380 A    TTAB1.K=CLIP(TABHR.K,0,MPHR.K,MP27.K)
06390 A    TTAB2.K=CLIP(TABHF.K,0,MPHF.K,MP27.K)
06400 A    TTAB3.K=CLIP(TABM.K,0,MPM.K,MP27.K)
06410 A    TTAB4.K=CLIP(TABC.K,0,MPC.K,MP27.K)
06420 A    TTAB5.K=CLIP(TABS.K,0,MPS.K,MP27.K)
06430 A    TTAB6.K=CLIP(TABB.K,0,MPB.K,MP27.K)
06440 A    DMWP.K=TTAB1.K+TTAB2.K+TTAB3.K+TTAB4.K+TTAB5.K+TTAB6.K-AMWP.K-BMWP.K
06450 X1   -CMWP.K
06460 A    UTAB1.K=CLIP(TABHR.K,0,MPHR.K,MP29.K)
06470 A    UTAB2.K=CLIP(TABHF.K,0,MPHF.K,MP29.K)
06480 A    UTAB3.K=CLIP(TABM.K,0,MPM.K,MP29.K)
06490 A    UTAB4.K=CLIP(TABC.K,0,MPC.K,MP29.K)
06500 A    UTAB5.K=CLIP(TABS.K,0,MPS.K,MP29.K)
06510 A    UTAB6.K=CLIP(TABB.K,0,MPB.K,MP29.K)
06520 A    EMWP.K=UTAB1.K+UTAB2.K+UTAB3.K+UTAB4.K+UTAB5.K+UTAB6.K-AMWP.K-BMWP.K
06530 X1   -CMWP.K-DMWP.K
06540 A    VTAB1.K=CLIP(TABHR.K,0,MPHR.K,MP30.K)
06550 A    VTAB2.K=CLIP(TABHF.K,0,MPHF.K,MP30.K)
06560 A    VTAB3.K=CLIP(TABM.K,0,MPM.K,MP30.K)
06570 A    VTAB4.K=CLIP(TABC.K,0,MPC.K,MP30.K)
06580 A    VTAB5.K=CLIP(TABS.K,0,MPS.K,MP30.K)
06590 A    VTAB6.K=CLIP(TABB.K,0,MPB.K,MP30.K)
06600 A    FMWP.K=VTAB1.K+VTAB2.K+VTAB3.K+VTAB4.K+VTAB5.K+VTAB6.K-AMWP.K-BMWP.K
06610 X1   -CMWP.K-DMWP.K-EMWP.K
06620 1A   ARR1.K=CLIP(0,ARR11.K,TIME.K,96)
06630 1A   ARR11.K=RAMP(ARR111,75)
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1A   ARR2.K=PULSE(ARR21,96,1)
1A   ARR3.K=PULSE(-ARR21,226,1)
1A   ARR4.K=CLIP(0,ARR41.K,TIME.K,226)
1A   ARR41.K=RAMP(-ARR111,205)
1A   TABHR.K=ARR1.K+ARR2.K+ARR3.K+ARR4.K
1A   BRR1.K=CLIP(0,BRR11.K,TIME.K,71)
1A   BRR11.K=RAMP(BRR111,50)
1A   BRR2.K=PULSE(BRR21,71,1)
1A   BRR3.K=PULSE(-BRR21,126,1)
1A   BRR4.K=CLIP(0,BRR41.K,TIME.K,126)
1A   BRR41.K=RAMP(-BRR111,105)
1A   BRR5.K=CLIP(0,BRR51.K,TIME.K,221)
1A   BRR51.K=RAMP(BRR511,200)
1A   BRR6.K=PULSE(BRR61,221,1)
1A   BRR7.K=PULSE(-BRR61,276,1)
1A   BRR8.K=CLIP(0,BRR81.K,TIME.K,276)
1A   BRR81.K=RAMP(-BRR511,255)
1A   TABHF.K=BRR1.K+BRR2.K+BRR3.K+BRR4.K+BRR5.K+BRR6.K+BRR7.K+BRR8.K
1A   CRR1.K=CLIP(0,CRR11.K,TIME.K,161)
1A   CRR11.K=RAMP(CRR111,150)
1A   CRR2.K=PULSE(CRR21,161,1)
1A   CRR3.K=PULSE(-CRR21,226,1)
1A   CRR4.K=CLIP(0,CRR41.K,TIME.K,226)
1A   CRR41.K=RAMP(-CRR111,215)
1A    TABM.K=CRR1.K+CRR2.K+CRR3.K+CRR4.K
1A   DRR1.K=CLIP(0,DRR11.K,TIME.K,96)
1A   DRR11.K=RAMP(DRR111,75)
1A   DRR2.K=PULSE(DRR21,96,1)
1A   DRR3.K=PULSE(-DRR21,226,1)
1A   DRR4.K=CLIP(0,DRR41.K,TIME.K,226)
1A   DRR41.K=RAMP(-DRR111,205)
1A    TABC.K=DRR1.K+DRR2.K+DRR3.K+DRR4.K
1A   ERR11.K=RAMP(ERR111,155)
1A   ERR1.K=CLIP(0,ERR11.K,TIME.K,176)
1A   ERR2.K=PULSE(ERR21,176,1)
1A   ERR3.K=PULSE(-ERR21,271,1)
1A   ERR4.K=CLIP(0,ERR41.K,TIME.K,271)
1A   ERR41.K=RAMP(-ERR111,250)
1A    TABS.K=ERR1.K+ERR2.K+ERR3.K+ERR4.K
1A   FRR1.K=PULSE(FRR11,201,1)
1A   FRR2.K=PULSE(-FRR11,226,1)
A    TABB.K=FRR1.K+FRR2.K
NOTE   PRODUCTION  CAPACITY  PER  DAY
A    QP1.K=CLIP(PHR.K,0,MPHR.K,MP9.K)
A    QP2.K=CLIP(PHF.K,0,MPHF.K,MP9.K)
A    QP3.K=CLIP(PM.K,0,MPM.K,MP9.K)
A    QP4.K=CLIP(PC.K,0,MPC.K,MP9.K)
A    QP5.K=CLIP(PS.K,0,MPS.K,MP9.K)
A    QP6.K=CLIP(PB.K,0,MPB.K,MP9.K)
A    AAAA.K=QP1.K+QP2.K+QP3.K+QP4.K+QP5.K+QP6.K
A    RP1.K=CLIP(PHR.K,0,MPHR.K,MP17.K)
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07150 A    RP2.K=CLIP(PHF.K,0,MPHF.K,MP17.K)
07160 A    RP3.K=CLIP(PM.K,0,MPM.K,MP17.K)
07170 A    RP4.K=CLIP(PC.K,0,MPC.K,MP17.K)
07180 A    RP5.K=CLIP(PS.K,0,MPS.K,MP17.K)
07190 A    RP6.K=CLIP(PB.K,0,MPB.K,MP17.K)
07200 A    BAAA.K=RP1.K+RP2.K+RP3.K+RP4.K+RP5.K+RP6.K-AAAA.K
07210 A    SP1.K=CLIP(PHR.K,0,MPHR.K,MP23.K)
07220 A    SP2.K=CLIP(PHF.K,0,MPHF.K,MP23.K)
07230 A    SP3.K=CLIP(PM.K,0,MPM.K,MP23.K)
07240 A    SP4.K=CLIP(PC.K,0,MPC.K,MP23.K)
07250 A    SP5.K=CLIP(PS.K,0,MPS.K,MP23.K)
07260 A    SP6.K=CLIP(PB.K,0,MPB.K,MP23.K)
07270 A    CAAA.K=SP1.K+SP2.K+SP3.K+SP4.K+SP5.K+SP6.K-AAAA.K-BAAA.K
07280 A    TP1.K=CLIP(PHR.K,0,MPHR.K,MP27.K)
07290 A    TP2.K=CLIP(PHF.K,0,MPHF.K,MP27.K)
07300 A    TP3.K=CLIP(PM.K,0,MPM.K,MP27.K)
07310 A    TP4.K=CLIP(PC.K,0,MPC.K,MP27.K)
07320 A    TP5.K=CLIP(PS.K,0,MPS.K,MP27.K)
07330 A    TP6.K=CLIP(PB.K,0,MPB.K,MP27.K)
07340 A    DAAA.K=TP1.K+TP2.K+TP3.K+TP4.K+TP5.K+TP6.K-AAAA.K-BAAA.K-CAAA.K
07350 A    UP1.K=CLIP(PHR.K,0,MPHR.K,MP29.K)
07360 A    UP2.K=CLIP(PHF.K,0,MPHF.K,MP29.K)
07370 A    UP3.K=CLIP(PM.K,0,MPM.K,MP29.K)
07380 A    UP4.K=CLIP(PC.K,0,MPC.K,MP29.K)
07390 A    UP5.K=CLIP(PS.K,0,MPS.K,MP29.K)
07400 A    UP6.K=CLIP(PB.K,0,MPB.K,MP29.K)
07410 A    EAAA.K=UP1.K+UP2.K+UP3.K+UP4.K+UP5.K+UP6.K-AAAA.K-BAAA.K-CAAA.K-DAAA
07420 X1   .K
07430 A    VP1.K=CLIP(PHR.K,0,MPHR.K,MP30.K)
07440 A    VP2.K=CLIP(PHF.K,0,MPHF.K,MP30.K)
07450 A    VP3.K=CLIP(PM.K,0,MPM.K,MP30.K)
07460 A    VP4.K=CLIP(PC.K,0,MPC.K,MP30.K)
07470 A    VP5.K=CLIP(PS.K,0,MPS.K,MP30.K)
07480 A    VP6.K=CLIP(PB.K,0,MPB.K,MP30.K)
07490 A    FAAA.K=VP1.K+VP2.K+VP3.K+VP4.K+VP5.K+VP6.K-AAAA.K-BAAA.K-CAAA.K-DAAA
07500 X1   .K-EAAA.K
07510 A    PHR.K=PHR1+(PHR1*PHR2)
07520 A    PHF.K=PHF1+(PHF1*PHF2)
07530 A    PM.K=PM1+(PM1*PM2)
07540 A    PC.K=PC1+(PC1*PC2)
07550 A    PS.K=PS1+(PS1*PS2)
07560 A    PB.K=PB1+(PB1*PB2)
07570 NOTE   YIELD OF FINISH PRODUCT FROM RAW MATERIAL
07580 A    QY1.K=CLIP(YHR.K,0,MPHR.K,MP9.K)
07590 A    QY2.K=CLIP(YHF.K,0,MPHF.K,MP9.K)
07600 A    QY3.K=CLIP(YM.K,0,MPM.K,MP9.K)
07610 A    QY4.K=CLIP(YC.K,0,MPC.K,MP9.K)
07620 A    QY5.K=CLIP(YS.K,0,MPS.K,MP9.K)
07630 A    QY6.K=CLIP(YB.K,0,MPB.K,MP9.K)
07640 A    AYLD.K=QY1.K+QY2.K+QY3.K+QY4.K+QY5.K+QY6.K
07650 A    RY1.K=CLIP(YHR.K,0,MPHR.K,MP17.K)
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07660 A    RY2.K=CLIP(YHF.K,0,MPHF.K,MP17.K)
07670 A    RY3.K=CLIP(YM.K,0,MPM.K,MP17.K)
07680 A    RY4.K=CLIP(YC.K,0,MPC.K,MP17.K)
07690 A    RY5.K=CLIP(YS.K,0,MPS.K,MP17.K)
07700 A    RY6.K=CLIP(YB.K,0,MPB.K,MP17.K)
07710 A    BYLD.K=RY1.K+RY2.K+RY3.K+RY4.K+RY5.K+RY6.K-AYLD.K
07720 A    SY1.K=CLIP(YHR.K,0,MPHR.K,MP23.K)
07730 A    SY2.K=CLIP(YHF.K,0,MPHF.K,MP23.K)
07740 A    SY3.K=CLIP(YM.K,0,MPM.K,MP23.K)
07750 A    SY4.K=CLIP(YC.K,0,MPC.K,MP23.K)
07760 A    SY5.K=CLIP(YS.K,0,MPS.K,MP23.K)
07770 A    SY6.K=CLIP(YB.K,0,MPB.K,MP23.K)
07780 A    CYLD.K=SY1.K+SY2.K+SY3.K+SY4.K+SY5.K+SY6.K-AYLD.K-BYLD.K
07790 A    TY1.K=CLIP(YHR.K,0,MPHR.K,MP27.K)
07800 A    TY2.K=CLIP(YHF.K,0,MPHF.K,MP27.K)
07810 A    TY3.K=CLIP(YM.K,0,MPM.K,MP27.K)
07820 A    TY4.K=CLIP(YC.K,0,MPC.K,MP27.K)
07830 A    TY5.K=CLIP(YS.K,0,MPS.K,MP27.K)
07840 A    TY6.K=CLIP(YB.K,0,MPB.K,MP27.K)
07850 A    DYLD.K=TY1.K+TY2.K+TY3.K+TY4.K+TY5.K+TY6.K-AYLD.K-BYLD.K-CYLD.K
07860 A    UY1.K=CLIP(YHR.K,0,MPHR.K,MP29.K)
07870 A    UY2.K=CLIP(YHF.K,0,MPHF.K,MP29.K)
07880 A    UY3.K=CLIP(YM.K,0,MPM.K,MP29.K)
07890 A    UY4.K=CLIP(YC.K,0,MPC.K,MP29.K)
07900 A    UY5.K=CLIP(YS.K,0,MPS.K,MP29.K)
07910 A    UY6.K=CLIP(YB.K,0,MPB.K,MP29.K)
07920 A    EYLD.K=UY1.K+UY2.K+UY3.K+UY4.K+UY5.K+UY6.K-AYLD.K-BYLD.K-CYLD.K-DYLD
07930 X1   .K
07940 A    VY1.K=CLIP(YHR.K,0,MPHR.K,MP30.K)
07950 A    VY2.K=CLIP(YHF.K,0,MPHF.K,MP30.K)
07960 A    VY3.K=CLIP(YM.K,0,MPM.K,MP30.K)
07970 A    VY4.K=CLIP(YC.K,0,MPC.K,MP30.K)
07980 A    VY5.K=CLIP(YS.K,0,MPS.K,MP30.K)
07990 A    VY6.K=CLIP(YB.K,0,MPB.K,MP30.K)
08000 A    FYLD.K=VY1.K+VY2.K+VY3.K+VY4.K+VY5.K+VY6.K-AYLD.K-BYLD.K-CYLD.K-DYLD
08010 X1   .K-EYLD.K
08020 A    YHR.K=YHR1+(YHR1*YHR2)
08030 A    YHF.K=YHF1+(YHF1*YHF2)
08040 A    YM.K=YM1+(YM1*YM2)
08050 A    YC.K=YC1+(YC1*YC2)
08060 A    YS.K=YS1+(YS1*YS2)
08070 A    YB.K=YB1+(YB1*YB2)
08080 NOTE   LABOUR  PRODUCTIVITY  PER  DAY
08090 A    QLP1.K=CLIP(LPHR.K,0,MPHR.K,MP9.K)
08100 A    QLP2.K=CLIP(LPHF.K,0,MPHF.K,MP9.K)
08110 A    QLP3.K=CLIP(LPM.K,0,MPM.K,MP9.K)
08120 A    QLP4.K=CLIP(LPC.K,0,MPC.K,MP9.K)
08130 A    QLP5.K=CLIP(LPS.K,0,MPS.K,MP9.K)
08140 A    QLP6.K=CLIP(LPB.K,0,MPB.K,MP9.K)
08150 A    ACPLP.K=QLP1.K+QLP2.K+QLP3.K+QLP4.K+QLP5.K+QLP6.K
08160 A    RLP1.K=CLIP(LPHR.K,0.MPHR.K,MP17.K)
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08170 A    RLP2.K=CLIP(LPHF.K,0,MPHF.K,MP17.K)
08180 A    RLP3.K=CLIP(LPM.K,0,MPM.K,MP17.K)
08190 A    RLP4.K=CLIP(LPC.K,0,MPC.K,MP17.K)
08200 A    RLP5.K=CLIP(LPS.K,0,MPS.K,MP17.K)
08210 A    RLP6.K=CLIP(LPB.K,0,MPB.K,MP17.K)
08220 A    BCPLP.K=RLP1.K+RLP2.K+RLP3.K+RLP4.K+RLP5.K+RLP6.K-ACPLP.K
08230 A    SLP1.K=CLIP(LPHR.K,0,MPHR.K,MP23.K)
08240 A    SLP2.K=CLIP(LPHF.K,0,MPHF.K,MP23.K)
08250 A    SLP3.K=CLIP(LPM.K,0,MPM.K,MP23.K)
08260 A    SLP4.K=CLIP(LPC.K,0,MPC.K,MP23.K)
08270 A    SLP5.K=CLIP(LPS.K,0,MPS.K,MP23.K)
08280 A    SLP6.K=CLIP(LPB.K,0,MPB.K,MP23.K)
08290 A    CCPLP.K=SLP1.K+SLP2.K+SLP3.K+SLP4.K+SLP5.K+SLP6.K-ACPLP.K-BCPLP.K
08300 A    TLP1.K=CLIP(LPHR.K,0,MPHR.K,MP27.K)
08310 A    TLP2.K=CLIP(LPHF.K,0,MPHF.K,MP27.K)
08320 A    TLP3.K=CLIP(LPM.K,0,MPM.K,MP27.K)
08330 A    TLP4.K=CLIP(LPC.K,0,MPC.K,MP27.K)
08340 A    TLP5.K=CLIP(LPS.K,0,MPS.K,MP27.K)
08350 A    TLP6.K=CLIP(LPB.K,0,MPB.K,MP27.K)
08360 A    DCPLP.K=TLP1.K+TLP2.K+TLP3.K+TLP4.K+TLP5.K+TLP6.K-ACPLP.K-BCPLP.K-CC
08370 X1   PLP.K
08380 A    ULP1.K=CLIP(LPHR.K,0,MPHR.K,MP29.K)
08390 A    ULP2.K=CLIP(LPHF.K,0,MPHF.K,MP29.K)
08400 A    ULP3.K=CLIP(LPM.K,0,MPM.K,MP29.K)
08410 A    ULP4.K=CLIP(LPC.K,0,MPC.K,MP29.K)
08420 A    ULP5.K=CLIP(LPS.K,0,MPS.K,MP29.K)
08430 A    ULP6.K=CLIP(LPB.K,0,MPB.K,MP29.K)
08440 A    ECPLP.K=ULP1.K+ULP2.K+ULP3.K+ULP4.K+ULP5.K+ULP6.K-ACPLP.K-BCPLP.K-CC
08450 X1   PLP.K-DCPLP.K
08460 A    VLP1.K=CLIP(LPHR.K,0,MPHR.K,MP30.K)
08470 A    VLP2.K=CLIP(LPHF.K,0,MPHF.K,MP30.K)
08480 A    VLP3.K=CLIP(LPM.K,0,MPM.K,MP30.K)
08490 A    VLP4.K=CLIP(LPC.K,0,MPC.K,MP30.K)
08500 A    VLP5.K=CLIP(LPS.K,0,MPS.K,MP30.K)
08510 A    VLP6.K=CLIP(LPB.K,0,MPB.K,MP30.K)
08520 A    FCPLP.K=VLP1.K+VLP2.K+VLP3.K+VLP4.K+VLP5.K+VLP6.K-ACPLP.K-BCPLP.K-CC
08530 X1   PLP.K-DCPLP.K-ECPLP.K
08540 A    LPHR.K=LPHR1+(LPHR1*LPHR2)
08550 A    LPHF.K=LPHF1+(LPHF1*LPHF2)
08560 A    LPM.K=LPM1+(LPM1*LPM2)
08570 A    LPC.K=LPC1+(LPC1*LPC2)
08580 A    LPS.K=LPS1+(LPS1*LPS2)
08590 A    LPB.K=LPB1+(LPB1*LPB2)
08600 NOTE   FINISH  PRODUCT  PRICE  PER  POUND
08610 A    QFP1.K=CLIP(FPHR.K,0,MPHR.K,MP9.K)
08620 A    QFP2.K=CLIP(FPHF.K,0,MPHF.K,MP9.K)
08630 A    QFP3.K=CLIP(FPM.K,0,MPM.K,MP9.K)
08640 A    QFP4.K=CLIP(FPC.K,0,MPC.K,MP9.K)
08650 A    QFP5.K=CLIP(FPS.K,0,MPS.K,MP9.K)
08660 A    QFP6.K=CLIP(FPB.K,0,MPB.K,MP9.K)
08670 A    ACFG.K=QFP1.K+QFP2.K+QFP3.K+QFP4.K+QFP5.K+QFP6.K
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08680 A    RFP1.K=CLIP(FPHR.K,0,MPHR.K,MP17.K)
08690 A    RFP2.K=CLIP(FPHF.K,0,MPHF.K,MP17.K)
08700 A    RFP3.K=CLIP(FPM.K,0,MPM.K,MP17.K)
08710 A    RFP4.K=CLIP(FPC.K,0,MPC.K,MP17.K)
08720 A    RFP5.K=CLIP(FPS.K,0,MPS.K,MP17.K)
08730 A    RFP6.K=CLIP(FPB.K,0,MPB.K,MP17.K)
08740 A    BCFG.K=RFP1.K+RFP2.K+RFP3.K+RFP4.K+RFP5.K+RFP6.K-ACFG.K
08750 A    SFP1.K=CLIP(FPHR.K,0,MPHR.K,MP23.K)
08760 A    SFP2.K=CLIP(FPHF.K,0,MPHF.K,MP23.K)
08770 A    SFP3.K=CLIP(FPM.K,0,MPM.K,MP23.K)
08780 A    SFP4.K=CLIP(FPC.K,0,MPC.K,MP23.K)
08790 A    SFP5.K=CLIP(FPS.K,0,MPS.K,MP23.K)
08800 A    SFP6.K=CLIP(FPB.K,0,MPB.K,MP23.K)
08810 A    CCFG.K=SFP1.K+SFP2.K+SFP3.K+SFP4.K+SFP5.K+SFP6.K-ACFG.K-BCFG.K
08820 A    TFP1.K=CLIP(FPHR.K,0,MPHR.K,MP27.K)
08830 A    TFP2.K=CLIP(FPHF.K,0,MPHF.K,MP27.K)
08840 A    TFP3.K=CLIP(FPM.K,0,MPM.K,MP27.K)
08850 A    TFP4.K=CLIP(FPC.K,0,MPC.K,MP27.K)
08860 A    TFP5.K=CLIP(FPS.K,0,MPS.K,MP27.K)
08870 A    TFP6.K=CLIP(FPB.K,0,MPB.K,MP27.K)
08880 A    DCFG.K=TFP1.K+TFP2.K+TFP3.K+TFP4.K+TFP5.K+TFP6.K-ACFG.K-BCFG.K-CCFG.
08890 X1   K
08900 A    UFP1.K=CLIP(FPHR.K,0,MPHR.K,MP29.K)
08910 A    UFP2.K=CLIP(FPHF.K,0,MPHF.K,MP29.K)
08920 A    UFP3.K=CLIP(FPM.K,0,MPM.K,MP29.K)
08930 A    UFP4.K=CLIP(FPC.K,0,MPC.K,MP29.K)
08940 A    UFP5.K=CLIP(FPS.K,0,MPS.K,MP29.K)
08950 A    UFP6.K=CLIP(FPB.K,0,MPB.K,MP29.K)
08960 A    ECFG.K=UFP1.K+UFP2.K+UFP3.K+UFP4.K+UFP5.K+UFP6.K-ACFG.K-BCFG.K-CCFG.
08970 X1   K-DCFG.K
08980 A    VFP1.K=CLIP(FPHR.K,0,MPHR.K,MP30.K)
08990 A    VFP2.K=CLIP(FPHF.K,0,MPHF.K,MP30.K)
09000 A    VFP3.K=CLIP(FPM.K,0,MPM.K,MP30.K)
09010 A    VFP4.K=CLIP(FPC.K,0,MPC.K,MP30.K)
09020 A    VFP5.K=CLIP(FPS.K,0,MPS.K,MP30.K)
09030 A    VFP6.K=CLIP(FPB.K,0,MPB.K,MP30.K)
09040 A    FCFG.K=VFP1.K+VFP2.K+VFP3.K+VFP4.K+VFP5.K+VFP6.K-ACFG.K-BCFG.K-CCFG.
09050 X1   K-DCFG.K-ECFG.K
09060 A    FPHR.K=FPHR1+(FPHR1*FPHR2)
09070 A    FPHF.K=FPHF1+(FPHF1*FPHF2)
09080 A    FPM.K=FPM1+(FPM1*FPM2)
09090 A    FPC.K=FPC1+(FPC1*FPC2)
09100 A    FPS.K=FPS1+(FPS1*FPS2)
09110 A    FPB.K=FPB1+(FPB1*FPB2)
09120 NOTE    QUANTITY  OF  PACKAGING  MATERIAL
09130 A    QQP1.K=CLIP(QPHR.K,0,MPHR.K,MP9.K)
09140 A    QQP2.K=CLIP(QPHF.K,0,MPHF.K,MP9.K)
09150 A    QQP3.K=CLIP(QPM.K,0,MPM.K,MP9.K)
09160 A    QQP4.K=CLIP(QPC.K,0,MPC.K,MP9.K)
09170 A    QQP5.K=CLIP(QPS.K,0,MPS.K,MP9.K)
09180 A    QQP6.K=CLIP(QPB.K,0,MPB.K,MP9.K)
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09190 A    APGQC.K=QQP1.K+QQP2.K+QQP3.K+QQP4.K+QQP5.K+QQP6.K
09200 A    RQP1.K=CLIP(QPHR.K,0,MPHR.K,MP17.K)
09210 A    RQP2.K=CLIP(QPHF.K,0,MPHF.K,MP17.K)
09220 A    RQP3.K=CLIP(QPM.K,0,MPM.K,MP17.K)
09230 A    RQP4.K=CLIP(QPC.K,0,MPC.K,MP17.K)
09240 A    RQP5.K=CLIP(QPS.K,0,MPS.K,MP17.K)
09250 A    RQP6.K=CLIP(QPB.K,0,MPB.K,MP17.K)
09260 A    BPGQC.K=RQP1.K+RQP2.K+RQP3.K+RQP4.K+RQP5.K+RQP6.K-APGQC.K
09270 A    SQP1.K=CLIP(QPHR.K,0,MPHR.K,MP23.K)
09280 A    SQP2.K=CLIP(QPHF.K,0,MPHF.K,MP23.K)
09290 A    SQP3.K=CLIP(QPM.K,0,MPM.K,MP23.K)
09300 A    SQP4.K=CLIP(QPC.K,0,MPC.K,MP23.K)
09310 A    SQP5.K=CLIP(QPS.K,0,MPS.K,MP23.K)
09320 A    SQP6.K=CLIP(QPB.K,0,MPB.K,MP23.K)
09330 A    CPGQC.K=SQP1.K+SQP2.K+SQP3.K+SQP4.K+SQP5.K+SQP6.K-APGQC.K-BPGQC.K
09340 A    TQP1.K=CLIP(QPHR.K,0,MPHR.K,MP27.K)
09350 A    TQP2.K=CLIP(QPHF.K,0,MPHF.K,MP27.K)
09360 A    TQP3.K=CLIP(QPM.K,0,MPM.K,MP27.K)
09370 A    TQP4.K=CLIP(QPC.K,0,MPC.K,MP27.K)
09380 A    TQP5.K=CLIP(QPS.K,0,MPS.K,MP27.K)
09390 A    TQP6.K=CLIP(QPB.K,0,MPB.K,MP27.K)
09400 A    DPGQC.K=TQP1.K+TQP2.K+TQP3.K+TQP4.K+TQP5.K+TQP6.K-APGQC.K-BPGQC.K-CP
09410 X1   GQC.K
09420 A    UQP1.K=CLIP(QPHR.K,0,MPHR.K,MP29.K)
09430 A    UQP2.K=CLIP(QPHF.K,0,MPHF.K,MP29.K)
09440 A    UQP3.K=CLIP(QPM.K,0,MPM.K,MP29.K)
09450 A    UQP4.K=CLIP(QPC.K,0,MPC.K,MP29.K)
09460 A    UQP5.K=CLIP(QPS.K,0,MPS.K,MP29.K)
09470 A    UQP6.K=CLIP(QPB.K,0,MPB.K,MP29.K)
09480 A    EPGQC.K=UQP1.K+UQP2.K+UQP3.K+UQP4.K+UQP5.K+UQP6.K-APGQC.K-BPGQC.K-CP
09490 X1   GQC.K-DPGQC.K
09500 A    VQP1.K=CLIP(QPHR.K,0,MPHR.K,MP30.K)
09510 A    VQP2.K=CLIP(QPHF.K,0,MPHF.K,MP30.K)
09520 A    VQP3.K=CLIP(QPM.K,0,MPM.K,MP30.K)
09530 A    VQP4.K=CLIP(QPC.K,0,MPC.K,MP30.K)
09540 A    VQP5.K=CLIP(QPS.K,0,MPS.K,MP30.K)
09550 A    VQP6.K=CLIP(QPB.K,0,MPB.K,MP30.K)
09560 A    FPGQC.K=VQP1.K+VQP2.K+VQP3.K+VQP4.K+VQP5.K+VQP6.K-APGQC.K-BPGQC.K-CP
09570 X1   GQC.K-DPGQC.K-EPGQC.K
09580 A    QPHR.K=PULSE(QUAHR,70,300)
09590 A    QPHF.K=PULSE(QUAHF,45,150)
09600 A    QPM.K=PULSE(QUAM,145,300)
09610 A    QPC.K=PULSE(QUAC,70,300)
09620 A    QPS.K=PULSE(QUAS,145,300)
09630 A    QPB.K=PULSE(QUAB,195,300)
09640 NOTE    VALUE   OF   PACKAGING   MATERIAL   PER   POUND
09650 A    QVP1.K=CLIP(VPHR.K,0,MPHR.K.MP9.K)
09660 A    QVP2.K=CLIP(VPHF.K,0,MPHF.K,MP9.K)
09670 A    QVP3.K=CLIP(VPM.K,0,MPM.K,MP9.K)
09680 A    QVP4.K=CLIP(VPC.K,0,MPC.K,MP9.K)
09690 A    QVP5.K=CLIP(VPS.K,0,MPS.K,MP9.K)
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09700 A    QVP6.K=CLIP(VPB.K,0,MPB.K,MP9.K)
09710 A    ACPG.K=QVP1.K+QVP2.K+QVP3.K+QVP4.K+QVP5.K+QVP6.K
09720 A    RVP1.K=CLIP(VPHR.K,0,MPHR.K,MP17.K)
09730 A    RVP2.K=CLIP(VPHF.K,0,MPHF.K,MP17.K)
09740 A    RVP3.K=CLIP(VPM.K,0,MPM.K,MP17.K)
09750 A    RVP4.K=CLIP(VPC.K,0,MPC.K,MP17.K)
09760 A    RVP5.K=CLIP(VPS.K,0,MPS.K,MP17.K)
09770 A    RVP6.K=CLIP(VPB.K,0,MPB.K,MP17.K)
09780 A    BCPG.K=RVP1.K+RVP2.K+RVP3.K+RVP4.K+RVP5.K+RVP6.K-ACPG.K
09790 A    SVP1.K=CLIP(VPHR.K,0,MPHR.K,MP23.K)
09800 A    SVP2.K=CLIP(VPHF.K,0,MPHF.K,MP23.K)
09810 A    SVP3.K=CLIP(VPM.K,0,MPM.K,MP23.K)
09820 A    SVP4.K=CLIP(VPC.K,0,MPC.K,MP23.K)
09830 A    SVP5.K=CLIP(VPS.K,0,MPS.K,MP23.K)
09840 A    SVP6.K=CLIP(VPB.K,0,MPB.K,MP23.K)
09850 A    CCPG.K=SVP1.K+SVP2.K+SVP3.K+SVP4.K+SVP5.K+SVP6.K-ACPG.K-BCPG.K
09860 A    TVP1.K=CLIP(VPHR.K,0,MPHR.K,MP27.K)
09870 A    TVP2.K=CLIP(VPHF.K,0,MPHF.K,MP27.K)
09880 A    TVP3.K=CLIP(VPM.K,0,MPM.K,MP27.K)
09890 A    TVP4.K=CLIP(VPC.K,0,MPC.K,MP27.K)
09900 A    TVP5.K=CLIP(VPS.K,0,MPS.K,MP27.K)
09910 A    DCPG.K=TVP1.K+TVP2.K+TVP3.K+TVP4.K+TVP5.K+TVP6.K-ACPG.K-BCPG.K-CCPG.
09920 X1   K
09930 A    TVP6.K=CLIP(VPB.K,0,MPB.K,MP27.K)
09940 A    UVP1.K=CLIP(VPHR.K,0,MPHR.K,MP29.K)
09950 A    UVP2.K=CLIP(VPHF.K,0,MPHF.K,MP29.K)
09960 A    UVP3.K=CLIP(VPM.K,0,MPM.K,MP29.K)
09970 A    UVP4.K=CLIP(VPC.K,0,MPC.K,MP29.K)
09980 A    UVP5.K=CLIP(VPS.K,0,MPS.K,MP29.K)
09990 A    UVP6.K=CLIP(VPB.K,0,MPB.K,MP29.K)
10000 A    ECPG.K=UVP1.K+UVP2.K+UVP3.K+UVP4.K+UVP5.K+UVP6.K-ACPG.K-BCPG.K-CCPG.
10010 X1   K-DCPG.K
10020 A    VVP1.K=CLIP(VPHR.K,0,MPHR.K,MP30.K)
10030 A    VVP2.K=CLIP(VPHF.K,0,MPHF.K,MP30.K)
10040 A    VVP3.K=CLIP(VPM.K,0,MPM.K,MP30.K)
10050 A    VVP4.K=CLIP(VPC.K,0,MPC.K,MP30.K)
10060 A    VVP5.K=CLIP(VPS.K,0,MPS.K,MP30.K)
10070 A    VVP6.K=CLIP(VPB.K,0,MPB.K,MP30.K)
10080 A    FCPG.K=VVP1.K+VVP2.K+VVP3.K+VVP4.K+VVP5.K+VVP6.K-ACPG.K-BCPG.K-CCPG.
10090 X1   K-DCPG.K-ECPG.K
10100 A    VPHR.K=VPHR1+(VPHR1*VPHR2)
10110 A    VPHF.K=VPHF1+(VPHF1*VPHF2)
10120 A    VPM.K=VPM1+(VPM1*VPM2)
10130 A    VPC.K=VPC1+(VPC1*VPC2)
10140 A    VPS.K=VPS1+(VPS1*VPS2)
10150 A    VPB.K=VPB1+(VPB1*VPB2)
10160 NOTE   RAW  MATERIAL  PRICE  PER  POUND
10170 A    QRP1.K=CLIP(RPHR.K,0,MPHR.K,MP9.K)
10180 A    QRP2.K=CLIP(RPHF.K,0,MPHF.K,MP9.K)
10190 A    QRP3.K=CLIP(RPM.K,0,MPM.K,MP9.K)
10200 A    QRP4.K=CLIP(RPC.K,0,MPC.K,MP9.K)
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10210 A   QRP5.K=CLIP(RPS.K,0,MPS.K,MP9.K)
10220 A   QRP6.K=CLIP(RPB.K,0,MPB.K,MP9.K)
10230 A   ACRM.K=QRP1.K+QRP2.K+QRP3.K+QRP4.K+QRP5.K+QRP6.K
10240 A   RRP1.K=CLIP(RPHR.K,0,MPHR.K,MP17.K)
10250 A   RRP2.K=CLIP(RPHF.K,0,MPHF.K,MP17.K)
10260 A   RRP3.K=CLIP(RPM.K,0,MPM.K,MP17.K)
10270 A   RRP4.K=CLIP(RPC.K,0,MPC.K,MP17.K)
10280 A   RRP5.K=CLIP(RPS.K,0,MPS.K,MP17.K)
10290 A   RRP6.K=CLIP(RPB.K,0,MPB.K,MP17.K)
10300 A   BCRM.K=RRP1.K+RRP2.K+RRP3.K+RRP4.K+RRP5.K+RRP6.K-ACRM.K
10310 A   SRP1.K=CLIP(RPHR.K,0,MPHR.K,MP23.K)
10320 A   SRP2.K=CLIP(RPHF.K,0,MPHF.K,MP23.K)
10330 A   SRP3.K=CLIP(RPM.K,0,MPM.K,MP23.K)
10340 A   SRP4.K=CLIP(RPC.K,0,MPC.K,MP23.K)
10350 A   SRP5.K=CLIP(RPS.K,0,MPS.K,MP23.K)
10360 A   SRP6.K=CLIP(RPB.K,0,MPB.K,MP23.K)
10370 A   CCRM.K=SRP1.K+SRP2.K+SRP3.K+SRP4.K+SRP5.K+SRP6.K-ACRM.K-BCRM.K
10380 A   TRP1.K=CLIP(RPHR.K,0,MPHR.K,MP27.K)
10390 A   TRP2.K=CLIP(RPHF.K,0,MPHF.K,MP27.K)
10400 A   TRP3.K=CLIP(RPM.K,0,MPM.K,MP27.K)
10410 A   TRP4.K=CLIP(RPC.K,0,MPC.K,MP27.K)
10420 A   TRP5.K=CLIP(RPS.K,0,MPS.K,MP27.K)
10430 A   TRP6.K=CLIP(RPB.K,0,MPB.K,MP27.K)
10440 A   DCRM.K=TRP1.K+TRP2.K+TRP3.K+TRP4.K+TRP5.K+TRP6.K-ACRM.K-BCRM.K-CCRM.
10450 X1  K
10460 A   URP1.K=CLIP(RPHR.K,0,MPHR.K,MP29.K)
10470 A   URP2.K=CLIP(RPHF.K,0,MPHF.K,MP29.K)
10480 A   URP3.K=CLIP(RPM.K,0,MPM.K,MP29.K)
10490 A   URP4.K=CLIP(RPC.K,0,MPC.K,MP29.K)
10500 A   URP5.K=CLIP(RPS.K,0,MPS.K,MP29.K)
10510 A   URP6.K=CLIP(RPB.K,0,MPB.K,MP29.K)
10520 A   ECRM.K=URP1.K+URP2.K+URP3.K+URP4.K+URP5.K+URP6.K-ACRM.K-BCRM.K-CCRM.
10530 X1  K-DCRM.K
10540 A   VRP1.K=CLIP(RPHR.K,0,MPHR.K,MP30.K)
10550 A   VRP2.K=CLIP(RPHF.K,0,MPHF.K,MP30.K)
10560 A   VRP3.K=CLIP(RPM.K,0,MPM.K,MP30.K)
10570 A   VRP4.K=CLIP(RPC.K,0,MPC.K,MP30.K)
10580 A   VRP5.K=CLIP(RPS.K,0,MPS.K,MP30.K)
10590 A   VRP6.K=CLIP(RPB.K,0,MPB.K,MP30.K)
10600 A   FCRM.K=VRP1.K+VRP2.K+VRP3.K+VRP4.K+VRP5.K+VRP6.K-ACRM.K-BCRM.K-CCRM.
10610 X1  K-DCRM.K-ECRM.K
10620 A   RPHR.K=RPHR1+(RPHR1*RPHR2)
10630 A   RPHF.K=RPHF1+(RPHF1*RPHF2)
10640 A   RPM.K=RPM1+(RPM1*RPM2)
10650 A   RPC.K=RPC1+(RPC1*RPC2)
10660 A   RPS.K=RPS1+(RPS1*RPS2)
10670 A   RPB.K=RPB1+(RPB1*RPB2)
10680 NOTE   LABOUR  COST  PER  DAY
10690 A   QLC1.K=CLIP(LCHR.K,0,MPHR.K,MP9.K)
10700 A   QLC2.K=CLIP(LCHF.K,0,MPHF.K,MP9.K)
10710 A   QLC3.K=CLIP(LCM.K,0,MPM.K,MP9.K)
```

```
10720 A    QLC4.K=CLIP(LCC.K,0,MPC.K,MP9.K)
10730 A    QLC5.K=CLIP(LCS.K,0,MPS.K,MP9.K)
10740 A    QLC6.K=CLIP(LCB.K,0,MPB.K,MP9.K)
10750 A    ACWR.K=QLC1.K+QLC2.K+QLC3.K+QLC4.K+QLC5.K+QLC6.K
10760 A    RLC1.K=CLIP(LCHR.K,0,MPHR.K,MP17.K)
10770 A    RLC2.K=CLIP(LCHF.K,0,MPHF.K,MP17.K)
10780 A    RLC3.K=CLIP(LCM.K,0,MPM.K,MP17.K)
10790 A    RLC4.K=CLIP(LCC.K,0,MPC.K,MP17.K)
10800 A    RLC5.K=CLIP(LCS.K,0,MPS.K,MP17.K)
10810 A    RLC6.K=CLIP(LCB.K,0,MPB.K,MP17.K)
10820 A    BCWR.K=RLC1.K+RLC2.K+RLC3.K+RLC4.K+RLC5.K+RLC6.K-ACWR.K
10830 A    SLC1.K=CLIP(LCHR.K,0,MPHR.K,MP23.K)
10840 A    SLC2.K=CLIP(LCHF.K,0,MPHF.K,MP23.K)
10850 A    SLC3.K=CLIP(LCM.K,0,MPM.K,MP23.K)
10860 A    SLC4.K=CLIP(LCC.K,0,MPC.K,MP23.K)
10870 A    SLC5.K=CLIP(LCS.K,0,MPS.K,MP23.K)
10880 A    SLC6.K=CLIP(LCB.K,0,MPB.K,MP23.K)
10890 A    CCWR.K=SLC1.K+SLC2.K+SLC3.K+SLC4.K+SLC5.K+SLC6.K-ACWR.K-BCWR.K
10900 A    TLC1.K=CLIP(LCHR.K,0,MPHR.K,MP27.K)
10910 A    TLC2.K=CLIP(LCHF.K,0,MPHF.K,MP27.K)
10920 A    TLC3.K=CLIP(LCM.K,0,MPM.K,MP27.K)
10930 A    TLC4.K=CLIP(LCC.K,0,MPC.K,MP27.K)
10940 A    TLC5.K=CLIP(LCS.K,0,MPS.K,MP27.K)
10950 A    TLC6.K=CLIP(LCB.K,0,MPB.K,MP27.K)
10960 A    DCWR.K=TLC1.K+TLC2.K+TLC3.K+TLC4.K+TLC5.K+TLC6.K-ACWR.K-BCWR.K-CCWR.
10970 X1   K
10980 A    ULC1.K=CLIP(LCHR.K,0,MPHR.K,MP29.K)
10990 A    ULC2.K=CLIP(LCHF.K,0,MPHF.K,MP29.K)
11000 A    ULC3.K=CLIP(LCM.K,0,MPM.K,MP29.K)
11010 A    ULC4.K=CLIP(LCC.K,0,MPC.K,MP29.K)
11020 A    ULC5.K=CLIP(LCS.K,0,MPS.K,MP29.K)
11030 A    ULC6.K=CLIP(LCB.K,0,MPB.K,MP29.K)
11040 A    ECWR.K=ULC1.K+ULC2.K+ULC3.K+ULC4.K+ULC5.K+ULC6.K-ACWR.K-BCWR.K-CCWR.
11050 X1   K-DCWR.K
11060 A    VLC1.K=CLIP(LCHR.K,0,MPHR.K,MP30.K)
11070 A    VLC2.K=CLIP(LCHF.K,0,MPHF.K,MP30.K)
11080 A    VLC3.K=CLIP(LCM.K,0,MPM.K,MP30.K)
11090 A    VLC4.K=CLIP(LCC.K,0,MPC.K,MP30.K)
11100 A    VLC5.K=CLIP(LCS.K,0,MPS.K,MP30.K)
11110 A    VLC6.K=CLIP(LCB.K,0,MPB.K,MP30.K)
11120 A    FCWR.K=VLC1.K+VLC2.K+VLC3.K+VLC4.K+VLC5.K+VLC6.K-ACWR.K-BCWR.K-CCWR.
11130 X1   K-DCWR.K-ECWR.K
11140 A    LCHR.K=LCHR1+(LCHR1*LCHR2)
11150 A    LCHF.K=LCHF1+(LCHF1*LCHF2)
11160 A    LCM.K=LCM1+(LCM1*LCM2)
11170 A    LCC.K=LCC1+(LCC1*LCC2)
11180 A    LCS.K=LCS1+(LCS1*LCS2)
11190 A    LCB.K=LCB1+(LCB1*LCB2)
11200 NOTE    ORDER   INPUT   PER   DAY
11210 A    QO1.K=CLIP(OHR.K,0,MPHR.K,MP9.K)
11220 A    QO2.K=CLIP(OHF.K,0,MPHF.K,MP9.K)
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11230 A   Q03.K=CLIP(OM.K,0,MPM.K,MP9.K)
11240 A   Q04.K=CLIP(OC.K,0,MPC.K,MP9.K)
11250 A   Q05.K=CLIP(OS.K,0,MPS.K,MP9.K)
11260 A   Q06.K=CLIP(OB.K,0,MPB.K,MP9.K)
11270 A   AOLD.K=Q01.K+Q02.K+Q03.K+Q04.K+Q05.K+Q06.K
11280 A   R01.K=CLIP(OHR.K,0,MPHR.K,MP17.K)
11290 A   R02.K=CLIP(OHF.K,0,MPHF.K,MP17.K)
11300 A   R03.K=CLIP(OM.K,0,MPM.K,MP17.K)
11310 A   R04.K=CLIP(OC.K,0,MPC.K,MP17.K)
11320 A   R05.K=CLIP(OS.K,0,MPS.K,MP17.K)
11330 A   R06.K=CLIP(OB.K,0,MPB.K,MP17.K)
11340 A   BOLD.K=R01.K+R02.K+R03.K+R04.K+R05.K+R06.K-AOLD.K
11350 A   S01.K=CLIP(OHR.K,0,MPHR.K,MP23.K)
11360 A   S02.K=CLIP(OHF.K,0,MPHF.K,MP23.K)
11370 A   S03.K=CLIP(OM.K,0,MPM.K,MP23.K)
11380 A   S04.K=CLIP(OC.K,0,MPC.K,MP23.K)
11390 A   S05.K=CLIP(OS.K,0,MPS.K,MP23.K)
11400 A   S06.K=CLIP(OB.K,0,MPB.K,MP23.K)
11410 A   COLD.K=S01.K+S02.K+S03.K+S04.K+S05.K+S06.K-AOLD.K-BOLD.K
11420 A   T01.K=CLIP(OHR.K,0,MPHR.K,MP27.K)
11430 A   T02.K=CLIP(OHF.K,0,MPHF.K,MP27.K)
11440 A   T03.K=CLIP(OM.K,0,MPM.K,MP27.K)
11450 A   T04.K=CLIP(OC.K,0,MPC.K,MP27.K)
11460 A   T05.K=CLIP(OS.K,0,MPS.K,MP27.K)
11470 A   T06.K=CLIP(OB.K,0,MPB.K,MP27.K)
11480 A   DOLD.K=T01.K+T02.K+T03.K+T04.K+T05.K+T06.K-AOLD.K-BOLD.K-COLD.K
11490 A   U01.K=CLIP(OHR.K,0,MPHR.K,MP29.K)
11500 A   U02.K=CLIP(OHF.K,0,MPHF.K,MP29.K)
11510 A   U03.K=CLIP(OM.K,0,MPM.K,MP29.K)
11520 A   U04.K=CLIP(OC.K,0,MPC.K,MP29.K)
11530 A   U05.K=CLIP(OS.K,0,MPS.K,MP29.K)
11540 A   U06.K=CLIP(OB.K,0,MPB.K,MP29.K)
11550 A   EOLD.K=U01.K+U02.K+U03.K+U04.K+U05.K+U06.K-AOLD.K-BOLD.K-COLD.K-DOLD
11560 X1  .K
11570 A   V01.K=CLIP(OHR.K,0,MPHR.K,MP30.K)
11580 A   V02.K=CLIP(OHF.K,0,MPHF.K,MP30.K)
11590 A   V03.K=CLIP(OM.K,0,MPM.K,MP30.K)
11600 A   V04.K=CLIP(OC.K,0,MPC.K,MP30.K)
11610 A   V05.K=CLIP(OS.K,0,MPS.K,MP30.K)
11620 A   V06.K=CLIP(OB.K,0,MPB.K,MP30.K)
11630 A   FOLD.K=V01.K+V02.K+V03.K+V04.K+V05.K+V06.K-AOLD.K-BOLD.K-COLD.K-DOLD
11640 X1  .K-EOLD.K
11650 A   OHR.K=TABLE(TABOHR,TIME.K,0,300,25)
11660 T   TABOHR=0/1000/1200/2000/2500/1900/1500/1300/1300/2000/1600/1500/1000
11670 A   OHF.K=TABLE(TABOHF,TIME.K,0,300,25)
11680 T  TABOHF=0/7500/8000/8500/9000/7000/10000/12000/10000/8000/7000/5000/50
11690 X   00
11700 A   OM.K=TABLE(TABOM,TIME.K,0,300,25)
11710 T   TABOM=0/7500/8000/8500/9000/7000/10000/12000/10000/8000/7000/5000/50
11720 X   00
11730 A   OC.K=TABLE(TABOC,TIME.K,0,300,25)
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11740 T    TABOC=0/8000/9000/10000/12000/11000/10000/9000/15000/10000/12000/900
11750 X    0/5000
11760 A    OS.K=TABLE(TABOS,TIME.K,0,300,25)
11770 T    TABOS=0/7500/8000/8500/9000/7000/10000/12000/10000/8000/7000/5000/50
11780 X    00
11790 A    OB.K=TABLE(TABOB,TIME.K,0,300,25)
11800 T    TABOB=0/0/2000/3500/4000/3800/3300/2700/3500/3500/3000/500/100
11810 NOTE       E C O N O M I C A L   S E C T O R
11820 NOTE  TOTAL  SALES  REVENUE
11830 3R   AFGR.KL=ASSP.JK*ACFG.K
11840 3R   BFGR.KL=BSSP.JK*BCFG.K
11850 3R   CFGR.KL=CSSP.JK*CCFG.K
11860 3R   DFGR.KL=DSSP.JK*DCFG.K
11870 3R   EFGR.KL=ESSP.JK*ECFG.K
11880 3R   FFGR.KL=FSSP.JK*FCFG.K
11890 3R   QFGR.KL=QSSP.JK*QCFG
11900 3L   AFGRP.K=AFGRP.J+(DT)(AFGR.JK-0)
11910 3L   BFGRP.K=BFGRP.J+(DT)(BFGR.JK-0)
11920 3L   CFGRP.K=CFGRP.J+(DT)(CFGR.JK-0)
11930 3L   DFGRP.K=DFGRP.J+(DT)(DFGR.JK-0)
11940 3L   EFGRP.K=EFGRP.J+(DT)(EFGR.JK-0)
11950 3L   FFGRP.K=FFGRP.J+(DT)(FFGR.JK-0)
11960 3L   QFGRP.K=QFGRP.J+(DT)(QFGR.JK-0)
11970 3N   AFGRP=0
11980 3N   BFGRP=0
11990 3N   CFGRP=0
12000 3N   DFGRP=0
12010 3N   EFGRP=0
12020 3N   FFGRP=0
12030 3N   QFGRP=0
12040 3A   TRSP.K=AFGRP.K+BFGRP.K+CFGRP.K+DFGRP.K+EFGRP.K+FFGRP.K+QFGRP.K
12050 NOTE  TOTAL  DIRECT  PACKAGING  MATERIAL  COST
12060 4R   APGQ.KL=APGQC.K*ACPG.K
12070 4L   APGS.K=APGS.J+(DT)(APGQ.JK-ACPGR.JK)
12080 4N   APGS=0
12090 4R   ACPGR.KL=(AMDP1.JK+AMDP2.JK)*ACPG.K
12100 4L   ACPGP.K=ACPGP.J+(DT)(ACPGR.JK-0)
12110 4N   ACPGP=0
12120 4R   BPGQ.KL=BPGQC.K*BCPG.K
12130 4L   BPGS.K=BPGS.J+(DT)(BPGQ.JK-BCPGR.JK)
12140 4N   BPGS=0
12150 4R   BCPGR.KL=(BMDP1.JK+BMDP2.JK)*BCPG.K
12160 4L   BCPGP.K=BCPGP.J+(DT)(BCPGR.JK-0)
12170 4N   BCPGP=0
12180 4R   CPGQ.KL=CPGQC.K*CCPG.K
12190 4L   CPGS.K=CPGS.J+(DT)(CPGQ.JK-CCPGR.JK)
12200 4N   CPGS=0
12210 4R   CCPGR.KL=(CMDP1.JK+CMDP2.JK)*CCPG.K
12220 4L   CCPGP.K=CCPGP.J+(DT)(CCPGR.JK-0)
12230 4N   CCPGP=0
12240 4R   DPGQ.KL=DPGQC.K*DCPG.K
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12250 4L   DPGS.K=DPGS.J+(DT)(DPGQ.JK-DCPGR.JK)
12260 4N   DPGS=0
12270 4R   DCPGR.KL=(DMDP1.JK+DMDP2.JK)*DCPG.K
12280 4L   DCPGP.K=DCPGP.J+(DT)(DCPGR.JK-0)
12290 4N   DCPGP=0
12300 4R   EPGQ.KL=EPGQC.K*ECPG.K
12310 4L   EPGS.K=EPGS.J+(DT)(EPGQ.JK-ECPGR.JK)
12320 4N   EPGS=0
12330 4R   ECPGR.KL=(EMDP1.JK+EMDP2.JK)*ECPG.K
12340 4L   ECPGP.K=ECPGP.J+(DT)(ECPGR.JK-0)
12350 4N   ECPGP=0
12360 4R   FPGQ.KL=FPGQC.K*FCPG.K
12370 4L   FPGS.K=FPGS.J+(DT)(FPGQ.JK-FCPGR.JK)
12380 4N   FPGS=0
12390 4R   FCPGR.KL=(FMDP1.JK+FMDP2.JK)*FCPG.K
12400 4L   FCPGP.K=FCPGP.J+(DT)(FCPGR.JK-0)
12410 4N   FCPGP=0
12420 4A   TCPGP.K=ACPGP.K+BCPGP.K+CCPGP.K+DCPGP.K+ECPGP.K+FCPGP.K
12430 NOTE  TOTAL  DIRECT  RAW  MATERIAL  COST
12440 5R   ACRMR.KL=ARMF.JK*ACRM.K
12450 5R   BCRMR.KL=BRMF.JK*BCRM.K
12460 5R   CCRMR.KL=CRMF.JK*CCRM.K
12470 5R   DCRMR.KL=DRMF.JK*DCRM.K
12480 5R   ECRMR.KL=ERMF.JK*ECRM.K
12490 5R   FCRMR.KL=FRMF.JK*FCRM.K
12500 5L   ACRMP.K=ACRMP.J+(DT)(ACRMR.JK-0)
12510 5L   BCRMP.K=BCRMP.J+(DT)(BCRMR.JK-0)
12520 5L   CCRMP.K=CCRMP.J+(DT)(CCRMR.JK-0)
12530 5L   DCRMP.K=DCRMP.J+(DT)(DCRMR.JK-0)
12540 5L   ECRMP.K=ECRMP.J+(DT)(ECRMR.JK-0)
12550 5L   FCRMP.K=FCRMP.J+(DT)(FCRMR.JK-0)
12560 5N   ACRMP=0
12570 5N   BCRMP=0
12580 5N   CCRMP=0
12590 5N   DCRMP=0
12600 5N   ECRMP=0
12610 5N   FCRMP=0
12620 5A   TRMCP.K=ACRMP.K+BCRMP.K+CCRMP.K+DCRMP.K+ECRMP.K+FCRMP.K
12630 NOTE  TOTAL  DIRECT  LABOUR  COST
12640 6R   ALCR.KL=ALNP.K*ACWR.K
12650 6R   BLCR.KL=BLNP.K*BCWR.K
12660 6R   CLCR.KL=CLNP.K*CCWR.K
12670 6R   DLCR.KL=DLNP.K*DCWR.K
12680 6R   ELCR.KL=ELNP.K*ECWR.K
12690 6R   FLCR.KL=FLNP.K*FCWR.K
12700 6L   ALCP.K=ALCP.J+(DT)(ALCR.JK-0)
12710 6L   BLCP.K=BLCP.J+(DT)(BLCR.JK-0)
12720 6L   CLCP.K=CLCP.J+(DT)(CLCR.JK-0)
12730 6L   DLCP.K=DLCP.J+(DT)(DLCR.JK-0)
12740 6L   ELCP.K=ELCP.J+(DT)(ELCR.JK-0)
12750 6L   FLCP.K=FLCP.J+(DT)(FLCR.JK-0)
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12760 6N   ALCP=0
12770 6N   BLCP=0
12780 6N   CLCP=0
12790 6N   DLCP=0
12800 6N   ELCP=0
12810 6N   FLCP=0
12820 6A   TLCP.K=ALCP.K+BLCP.K+CLCP.K+DLCP.K+ELCP.K+FLCP.K
12830 NOTE  INVENTORY  VALUE
12840 7A   AIFN.K=AIAP.K*ACFG.K
12850 7A   BIFN.K=BIAP.K*BCFG.K
12860 7A   CIFN.K=CIAP.K*CCFG.K
12870 7A   DIFN.K=DIAP.K*DCFG.K
12880 7A   EIFN.K=EIAP.K*ECFG.K
12890 7A   FIFN.K=FIAP.K*FCFG.K
12900 7A   QIFN.K=MEAL.K*QCFG
12910 7A   VALFIN.K=AIFN.K+BIFN.K+CIFN.K+DIFN.K+EIFN.K+FIFN.K+QIFN.K
12920 7A   AIFR.K=ARMPF.K*ACRM.K+(ARMPF.K/(TCPL*ACPLP.K))*ACWR.K
12930 7A   BIFR.K=BRMPF.K*BCRM.K+(BRMPF.K/(TCPL*BCPLP.K))*BCWR.K
12940 7A   CIFR.K=CRMPF.K*CCRM.K+(CRMPF.K/(TCPL*CCPLP.K))*CCWR.K
12950 7A   DIFR.K=DRMPF.K*DCRM.K+(DRMPF.K/(TCPL*DCPLP.K))*DCWR.K
12960 7A   EIFR.K=ERMPF.K*ECRM.K+(ERMPF.K/(TCPL*ECPLP.K))*ECWR.K
12970 7A   FIFR.K=FRMPF.K*FCRM.K+(FRMPF.K/(TCPL*FCPLP.K))*FCWR.K
12980 7A   VALFZ.K=AIFR.K+BIFR.K+CIFR.K+DIFR.K+EIFR.K+FIFR.K
12990 7A   AIFS.K=ARMPL.K*ACRM.K
13000 7A   BIFS.K=BRMPL.K*BCRM.K
13010 7A   CIFS.K=CRMPL.K*CCRM.K
13020 7A   DIFS.K=DRMPL.K*DCRM.K
13030 7A   EIFS.K=ERMPL.K*ECRM.K
13040 7A   FIFS.K=FRMPL.K*FCRM.K
13050 7A   VALFR.K=AIFS.K+BIFS.K+CIFS.K+DIFS.K+EIFS.K+FIFS.K
13060 7A   VALIVU.K=VALFIN.K+VALFZ.K+VALFR.K
13070 7A   VALPG.K=APGS.K+BPGS.K+CPGS.K+DPGS.K+EPGS.K+FPGS.K
13080 7A   VALIV.K=VALFIN.K+VALFZ.K+VALFR.K+VALPG.K
13090 NOTE  LONG  TERM  LOAN
13100 8L   BLTL.K=BLTL.J+(DT)(0-CRPLTR.JK)
13110 8N   BLTL=IVOLT
13120 8A   NL.K=YRL*COMPL
13130 8A   IL.K=AINTL/COMPL
13140 8A   INTL.K=BLTL.K*IL.K
13150 8A   V.K=EXP(NL.K*LOGN(1+IL.K))
13160 8A   U.K=(V.K-1)/(IL.K*V.K)
13170 8A   W.K=(IVOLT/U.K)-INTL.K
13180 8A   X.K=PULSE(W.K,X11.K,X11.K)
13190 8A   X11.K=300/COMPL
13200 8A    CRPLT1.K=CLIP(0,X.K,0,BLTL.K)
13210 8R   CRPLTR.KL=CRPLT1.K
13220 8L   TLTDP.K=TLTDP.J+(DT)(CRPLTR.JK-ATBP.JK)
13230 8N   TLTDP=0
13240 8R   ATBP.KL=0
13250 8A   INLTR1.K=PULSE(INTL.K,X11.K,X11.K)
13260 8R   INLTR.KL=INLTR1.K
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13270 8L   TINLTP.K=TINLTP.J+(DT)(INLTR.JK-IATBP.JK)
13280 8N   TINLTP=0
13290 8R   IATBP.KL=0
13300 NOTE     SHORT TERM FINANCING
13310 9A   BCAP.K=CLIP(CASHP.K,0,0,CASHP.K)
13320 9A   RATED.K=RATEY/YRDAY
13330 9A   BBL.K=CLIP(-BCAP.K,BLIMIT,BLIMIT,-BCAP.K)
13340 9R   INTDAY.KL=BBL.K*RATED.K
13350 9L   INTB.K=INTB.J+(DT)(INTDAY.JK-INBLR.JK)
13360 9N   INTB=0
13370 9A   INBLR1.K=PULSE(INTB.K,24,25)
13380 9R   INBLR.KL=INBLR1.K
13390 9L   TINBLP.K=TINBLP.J+(DT)(INBLR.JK-0)
13400 9N   TINBLP=0
13410 NOTE   DEPRECIATION
13420 10R CNEP.KL=0
13430 10L BFAST.K=BFAST.J+(DT)(CNEP.JK-DEPR.JK)
13440 10N BFAST=EEE
13450 10A DEPRA.K=EEE/(LENGTT*COMY)
13460 10A COMY1.K=300/COMY
13470 10R DEPR.KL=PULSE(DEPRA.K,23,COMY1.K)
13480 10L TDEP.K=TDEP.J+(DT)(DEPR.JK-0)
13490 10N TDEP=0
13500 NOTE    TOTAL OVERHEAD ACCRUED FROM HEAD OFFICE
13510 11A TOFOHI.K=PULSE(CTOFOH,23,25)
13520 11R TOFOHR.KL=TOFOHI.K
13530 11L TOFOH.K=TOFOH.J+(DT)(TOFOHR.JK-0)
13540 11N TOFOH=0
13550 NOTE   TOTAL  PRODUCTION  EXPENSES
13560 12R TPRDER.KL=PULSE(CTRODE,23,25)
13570 12L TPRODE.K=TPRODE.J+(DT)(TPRDER.JK-0)
13580 12N TPRODE=0
13590 NOTE   TOTAL  SELLING  EXPENSE
13600 13A TSELI.K=PULSE(CTSLE,23,25)
13610 13R TSELE.KL=TSELI.K
13620 13L TSLE.K=TSLE.J+(DT)(TSELE.JK-0)
13630 13N TSLE=0
13640 NOTE   TOTAL  ADMINSTRATION  EXPENSE
13650 14A TADMI.K=PULSE(CTADE,23,25)
13660 14R TADME.KL=TADMI.K
13670 14L TADE.K=TADE.J+(DT)(TADME.JK-0)
13680 14N TADE=0
13690 NOTE   CASH  FLOW
13700 16R RMIP.KL=(ARMF.JK*ACRM.K)+(BRMF.JK*BCRM.K)+(CRMF.JK*CCRM.K)+(DRMF.JK*
13710 X1  DCRM.K)+(ERMF.JK*ECRM.K)+(FRMF.JK*FCRM.K)
13720 16L APRM.K=APRM.J+(DT)(RMIP.JK-RMCEP.JK)
13730 16N APRM=0
13740 16R RMCEP.KL=APRM.K/DAPRM
13750 16C DAPRM=1
13760 16R PGIP.KL=(APGQC.K*ACPG.K)+(BPGQC.K*BCPG.K)+(CPGQC.K*CCPG.K)+(DPGQC.K*
13770 X1  DCPG.K)+(EPGQC.K*ECPG.K)+(FPGQC.K*FCPG.K)
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13780 16L APPG.K=APPG.J+(DT)(PGIP.JK-PGCEP.JK)
13790 16N APPG=0
13800 16R PGCEP.KL=APPG.K/DAPPG
13810 16C DAPPG=1
13820 16R LCEP.KL=(ALNP.K*ACWR.K)+(BLNP.K*BCWR.K)+(CLNP.K*CCWR.K)+(DLNP.K*DCWR
13830 X1  .K)+(ELNP.K*ECWR.K)+(FLNP.K*FCWR.K)
13840 16R TSAE.KL=TADMI.K+TSELI.K
13850 16R TFIXOH.KL=CRPLT1.K+INLTR1.K+INBLR1.K+TAX3.K+DIV3.K+TOFOHI.K
13860 16L ARP.K=ARP.J+(DT)(TFGR.JK-FGCRP.JK)
13870 16N ARP=0
13880 16R TFGR.KL=(ASSP.JK*ACFG.K)+(BSSP.JK*BCFG.K)+(CSSP.JK*CCFG.K)+(DSSP.JK*
13890 X1  DCFG.K)+(ESSP.JK*ECFG.K)+(FSSP.JK*FCFG.K)+(QSSP.JK*QCFG)
13900 16R FGCRP.KL=DELAY3(TFGR.JK,DARP)
13910 16C DARP=12
13920 16L CASHP.K=CASHP.J+(DT)(FGCRP.JK-RMCEP.JK-LCEP.JK-TPRDER.JK-TSAE.JK-TFI
13930 X1  XOH.JK-PGCEP.JK)
13940 16N CASHP=CASHP1
13950 NOTE  PROFIT AND LOSS
13960 18A GTMP.K=TRSP.K+VALIVU.K-(TRMCP.K+TLCP.K+TCPGP.K+TPRODE.K)
13970 18A NPBT.K=GTMP.K-(TINBLP.K+TDEP.K+TOFOH.K+TADE.K+TINLTP.K+TSLE.K)
13980 18A CNPBT.K=MAX(NPBT.K,0)
13990 18A TTAXA.K=CNPBT.K*TRATE
14000 18A TAX1.K=(AMOUNT*TTAXA.K)-TAXPAY.K
14010 18A TAX2.K=MAX(TAX1.K,0)
14020 18A TAX3.K=PULSE(TAX2.K,24,25)
14030 18R TAX.KL=TAX3.K
14040 18L TAXPAY.K=TAXPAY.J+(DT)(TAX.JK-0)
14050 18N TAXPAY=0
14060 18A DERITX.K=TTAXA.K-TAXPAY.K
14070 18A NPAT.K=NPBT.K-TTAXA.K
14080 18A CNPAT.K=MAX(NPAT.K,0)
14090 18A TDIVA.K=CNPAT.K*DRATE
14100 18A DIV1.K=(AMOUNT*TDIVA.K)-DIVPT.K
14110 18A DIV2.K=MAX(DIV1.K,0)
14120 18A DIV3.K=PULSE(DIV2.K,74,75)
14130 18R DIV.KL=DIV3.K
14140 18L DIVPT.K=DIVPT.J+(DT)(DIV.JK-0)
14150 18N DIVPT=0
14160 18A DIVSPY.K=TDIVA.K-DIVPT.K
14170 18A RETPRF.K=NPAT.K-TDIVA.K
14180 NOTE  LIABILITIES
14190 19A ACPAY.K=APRM.K+APPG.K
14200 19A CURLIB.K=ACPAY.K+DERITX.K+DIVSPY.K
14210 19A SHRCAP.K=PREPSH.K+ORDSH.K
14220 19A PREPSH.K=PRENSH*PRESHP
14230 19A ORDSH.K=ORDNSH*ORDNSP
14240 19A TLLIAB.K=CURLIB.K+BLTL.K+SHRCAP.K+RETPRF.K
14250 NOTE  ASSETS
14260 20A CURAST.K=ARP.K+CASHP.K+VALIV.K
14270 20A FIXAST.K=EEE-TDEP.K
14280 20A TLAST.K=CURAST.K+FIXAST.K
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14290 NOTE       I N P U T   C O N S T A N T S
14300 NOTE                   RAW MATERIAL INPUT CONSTANTS FOR SPECIE "HR"
14310 C    ARR111=385             RAMP / INC. APR.1-APR.24 / DEC. SEPT.7-SEPT.30
14320 C    ARR21=7700             LINEAR PULSE  APR.25-SEPT.6
14330 NOTE                   RAW MATERIAL INPUT CONSTANTS FOR SPECIE "HF"
14340 C    BRR111=909             RAMP / INC. MAR.1-MAR.24 / DEC. MAY 7-MAY.30
14350 C    BRR21=18180            LINEAR PULSE  MAR.25-MAY 6
14360 C    BRR511=909             RAMP / INC. SEPT.1-SEPT.24 / DEC. NOV.7-NOV.30
14370 C    BRR61=18180            LINEAR PULSE  SEPT.25-NOV.6
14380 NOTE                   RAW MATERIAL INPUT CONSTANTS FOR SPECIE "M"
14390 C    CRR111=1050            RAMP / INC. JUNE 5-JUNE 30 / DEC. OCT.1-OCT.24
14400 C    CRR21=21000            LINEAR PULSE JULY 1-SEPT.30
14410 NOTE                   RAW MATERIAL INPUT CONSTANTS FOR SPECIE "C"
14420 C    DRR111=769             RAMP / INC. APR.1-APR.24 / DEC. SEPT.7-SEPT.30
14430 C    DRR21=15380            LINEAR PULSE  APR.25-SEPT.6
14440 NOTE                   RAW MATERIAL INPUT CONSTANTS FOR SPECIE "S"
14450 C    ERR111=1050            RAMP / INC. JULY 5-JULY 30 / DEC. NOV.1-NOV.24
14460 C    ERR21=21000            LINEAR PULSE AUG.1-OCT.31
14470 NOTE                   RAW MATERIAL INPUT CONSTANT FOR SPECIE "B"
14480 C    FRR11=18000            LINEAR PULSE  SEPT.1-SEPT.30
14490 NOTE                   PRODUCTION CAPACITY CONSTANTS
14500 C    PHR1=40000             PRODUCTION CAPACITY FOR SPECIE "HR"
14510 C    PHF1=60000             PRODUCTION CAPACITY FOR SPECIE "HF"
14520 C    PM1=80000              PRODUCTION CAPACITY FOR SPECIE "M"
14530 C    PC1=60000              PRODUCTION CAPACITY FOR SPECIE "C"
14540 C    PS1=80000              PRODUCTION CAPACITY FOR SPECIE "S"
14550 C    PB1=100000             PRODUCTION CAPACITY FOR SPECIE "B"
14560 C    PHR2=0.00              PERCENTAGE INCREASE OF SPECIE "HR"
14570 C    PHF2=0.00              PERCENTAGE INCREASE OF SPECIE "HF"
14580 C    PM2=0.00               PERCENTAGE INCREASE OF SPECIE "M"
14590 C    PC2=0.00               PERCENTAGE INCREASE OF SPECIE "C"
14600 C    PS2=0.00               PERCENTAGE INCREASE OF SPECIE "S"
14610 C    PB2=0.00               PERCENTAGE INCREASE OF SPECIE "B"
14620 NOTE                   YIELD CONSTANTS
14630 C    YHR1=0.22              YIELD FOR SPECIE "HR"
14640 C    YHF1=0.45              YIELD FOR SPECIE "HF"
14650 C    YM1=1.00               YIELD FOR SPECIE "M"
14660 C    YC1=0.33               YIELD FOR SPECIE "C"
14670 C    YS1=1.00               YIELD FOR SPECIE "S"
14680 C    YB1=0.90               YIELD FOR SPECIE "B"
14690 C    QYLD=0.75              YIELD OF FISH MEAL FROM FISH OFFAL
14700 C    YHR2=0.00              PERCENTAGE INCREASE OF YIELD FOR "HR"
14710 C    YHF2=0.00              PERCENTAGE INCREASE OF YIELD FOR "HF"
14720 C    YM2=0.00               PERCENTAGE INCREASE OF YIELD FOR "M"
14730 C    YC2=0.00               PERCENTAGE INCREASE OF YIELD FOR "C"
14740 C    YS2=0.00               PERCENTAGE INCREASE OF YIELD FOR "S"
14750 C    YB2=0.00               PERCENTAGE INCREASE OF YIELD FOR "B"
14760 C    TYLD=0.10              ADDED YIELD DROP WHEN PROCESSING TRAWED FISH
14770 NOTE                   LABOUR PRODUCTIVITY CONSTANTS
14780 C    LPHR1=410              LABOUR PRODUCTIVITY FOR SPECIE "HR"
14790 C    LPHF1=1300             LABOUR PRODUCTIVITY FOR SPECIE "HF"
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14800 C   LPM1=1600          LABOUR PRODUCTIVITY FOR SPECIE "M"
14810 C   LPC1=640           LABOUR PRODUCTIVITY FOR SPECIE "C"
14820 C   LPS1=1600          LABOUR PRODUCTIVITY FOR SPECIE "S"
14830 C   LPB1=250           LABOUR PRODUCTIVITY FOR SPECIE "B"
14840 C   LPHR2=0.00         INCREASE IN LABOUR PRODUCTIVITY FOR "HR"
14850 C   LPHF2=0.00         INCREASE IN LABOUR PRODUCTIVITY FOR "HF"
14860 C   LPM2=0.00          INCREASE IN LABOUR PRODUCTIVITY FOR "M"
14870 C   LPC2=0.00          INCREASE IN LABOUR PRODUCTIVITY FOR "C"
14880 C   LPS2=0.00          INCREASE IN LABOUR PRODUCTIVITY FOR "S"
14890 C   LPB2=0.00          INCREASE IN LABOUR PRODUCTIVITY FOR "B"
14900 C   CPLP1=10000        LABOUR PRODUCTIVITY FOR FREEZING RAW MATERIAL
14910 C   CPLP2=0.00         INCREASE IN LABOUR PRODUCTIVITY FOR FREEZING
14920 C   TCPL=0.90          LABOUR PRODUCTIVITY PERCENT FOR TRAWED RAW MAT.
14930 NOTE              FINISH PRODUCT PRICE CONSTANTS
14940 C   FPHR1=0.96         FINISH PRODUCT PRICE FOR SPECIE "HR"
14950 C   FPHF1=0.41         FINISH PRODUCT PRICE FOR SPECIE "HF"
14960 C   FPM1=0.15          FINISH PRODUCT PRICE FOR SPECIE "M"
14970 C   FPC1=1.00          FINISH PRODUCT PRICE FOR SPECIE "C"
14980 C   FPS1=0.27          FINISH PRODUCT PRICE FOR SPECIE "S"
14990 C   FPB1=0.72          FINISH PRODUCT PRICE FOR SPECIE "B"
15000 C   FPHR2=0.00         PERCENTAGE INCREASE IN FINISH PRICE SPECIE "HR"
15010 C   FPHF2=0.00         PERCENTAGE INCREASE IN FINISH PRICE SPECIE "HF"
15020 C   FPM2=0.00          PERCENTAGE INCREASE IN FINISH PRICE SPECIE "M"
15030 C   FPC2=0.00          PERCENTAGE INCREASE IN FINISH PRICE SPECIE "C"
15040 C   FPS2=0.00          PERCENTAGE INCREASE IN FINISH PRICE SPECIE "S"
15050 C   FPB2=0.00          PERCENTAGE INCREASE IN FINISH PRICE SPECIE "B"
15060 C   QCFG=.0025         FINISH PRODUCT PRICE FOR FISH MEAL
15070 NOTE              QUANTITY OF PACKAGING MATERIAL CONSTANTS
15080 C   QUAHR=250000       QUANTITY OF PACKAGING MATERIAL FOR SPECIE "HR"
15090 C   QUAHF=425000       QUANTITY OF PACKAGING MATERIAL FOR SPECIE "HF"
15100 C   QUAM=1400000       QUANTITY OF PACKAGING MATERIAL FOR SPECIE "M"
15110 C   QUAC=700000        QUANTITY OF PACKAGING MATERIAL FOR SPECIE "C"
15120 C   QUAS=2000000       QUANTITY OF PACKAGING MATERIAL FOR SPECIE "S"
15130 C   QUAB=460000        QUANTITY OF PACKAGING MATERIAL FOR SPECIE "B"
15140 NOTE              VALUE OF PACKAGING CONSTANTS
15150 C   VPHR1=0.06         VALUE OF PACKAGING MATERIAL FOR SPECIE "HR"
15160 C   VPHF1=0.05         VALUE OF PACKAGING MATERIAL FOR SPECIE "HF"
15170 C   VPM1=0.02          VALUE OF PACKAGING MATERIAL FOR SPECIE "M"
15180 C   VPC1=0.05          VALUE OF PACKAGING MATERIAL FOR SPECIE "C"
15190 C   VPS1=0.03          VALUE OF PACKAGING MATERIAL FOR SPECIE "S"
15200 C   VPB1=0.04          VALUE OF PACKAGING MATERIAL FOR SPECIE "B"
15210 C   VPHR2=0.00         PERCENT INCREASE IN PACKAGING MATERIAL "HR"
15220 C   VPHF2=0.00         PERCENT INCREASE IN PACKAGING MATERIAL "HF"
15230 C   VPM2=0.00          PERCENT INCREASE IN PACKAGING MATERIAL "M"
15240 C   VPC2=0.00          PERCENT INCREASE IN PACKAGING MATERIAL "C"
15250 C   VPS2=0.00          PERCENT INCREASE IN PACKAGING MATERIAL "S"
15260 C   VPB2=0.00          PERCENT INCREASE IN PACKAGING MATERIAL "B"
15270 NOTE              RAW MATERIAL PRICE CONSTANTS
15280 C   RPHR1=0.12         RAW MATERIAL PRICE FOR SPECIE "HR"
15290 C   RPHF1=0.06         RAW MATERIAL PRICE FOR SPECIE "HF"
15300 C   RPM1=0.05          RAW MATERIAL PRICE FOR SPECIE "M"
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15310 C    RPC1=0.135            RAW MATERIAL PRICE FOR SPECIE "C"
15320 C    RPS1=0.05             RAW MATERIAL PRICE FOR SPECIE "S"
15330 C    RPB1=0.35             RAW MATERIAL PRICE FOR SPECIE "B"
15340 C    RPHR2=0.00            PERCENT INCREASE IN RM COST FOR "HR"
15350 C    RPHF2=0.00            PERCENT INCREASE IN RM COST FOR "HF"
15360 C    RPM2=0.00             PERCENT INCREASE IN RM COST FOR "M"
15370 C    RPC2=0.00             PERCENT INCREASE IN RM COST FOR "C"
15380 C    RPS2=0.00             PERCENT INCREASE IN RM COST FOR "S"
15390 C    RPB2=0.00             PERCENT INCREASE IN RM COST FOR "B"
15400 NOTE                  LABOUR COST CONSTANTS
15410 C    LCHR1=32.00           LABOUR COST FOR SPECIE "HR"
15420 C    LCHF1=32.00           LABOUR COST FOR SPECIE "HF"
15430 C    LCM1=32.00            LABOUR COST FOR SPECIE "M"
15440 C    LCC1=32.00            LABOUR COST FOR SPECIE "C"
15450 C    LCS1=32.00            LABOUR COST FOR SPECIE "S"
15460 C    LCB1=32.00            LABOUR COST FOR SPECIE "B"
15470 C    LCHR2=0.00            PERCENT INCREASE IN LABOUR "HR"
15480 C    LCHF2=0.00            PERCENT INCREASE IN LABOUR "HF"
15490 C    LCM2=0.00             PERCENT INCREASE IN LABOUR "M"
15500 C    LCC2=0.00             PERCENT INCREASE IN LABOUR "C"
15510 C    LCS2=0.00             PERCENT INCREASE IN LABOUR "S"
15520 C    LCB2=0.00             PERCENT INCREASE IN LABOUR "B"
15530 NOTE                  FREEZING CAPACITY CONSTANTS
15540 C    TFVC1=100000          FREEZER CAPACITY
15550 C    TFVC2=0.00            PERCENTAGE INCREASE IN FREEZING CAPACITY
15560 NOTE                  LONG TERM LOAN CONSTANTS
15570 C    IVOLT=1000000         INITIAL VALUE OF LONG TERM LOAN
15580 C    YRL=35                LENGTH OF LOAN IN YEARS
15590 C    COMPL=2               NUMBER OF PAYMENTS PER YEAR
15600 C    AINTL=.10             INTEREST RATE PER YEAR
15610 NOTE                  SHORT TERM FINANCING CONSTANTS
15620 C    RATEY=.1075           BANK INTEREST RATE PER YEAR
15630 C    YRDAY=300             NUMBER OF DAYS IN COMPANY YEAR
15640 C    BLIMIT=250000         LIMIT BANK WILL COVER COMPANY CHEQUES
15650 NOTE                  DEPRECIATION CONSTANTS
15660 C    EEE=1100000           INITIAL VALUE OF FIXED ASSETS
15670 C    COMY=12               FIXED ASSETS DEPRECIATED MONTHLY
15680 C    LENGTT=15             NUMBER OF YEARS FIXED ASSETS DEPRECIATED
15690 NOTE                  MONTHLY OVERHEAD EXPENSE CONSTANTS
15700 C    CTOFOH=4750           MONTHLY HEAD OFFICE OVERHEAD
15710 C    CTRODE=22000          MONTHLY PRODUCTION EXPENSE
15720 C    CTSLE=15000           MONTHLY SELLING EXPENSE
15730 C    CTADE=7300            MONTHLY ADMINSTRATION EXPENSE
15740 NOTE                  SHARE CONSTANTS
15750 C    PRENSH=500            NUMBER OF PREFERENCE SHARES
15760 C    PRESHP=150.00         PRICE PER PREFERENCE SHARE
15770 C    ORDNSH=2500           NUMBER OF ORDINARY SHARES
15780 C    ORDNSP=70.00          PRICE PER ORDINARY SHARE
15790 NOTE                  OTHER CONSTANTS
15800 C    TSS=20000             SHIPPING RATE
15810 C    TBBB=1000000          TOTAL COLD STORAGE CAPACITY
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15820 C    ALFA=0.2                ORDER ADJUSTMENT COEFFICIENT
15830 C    CASHP1=150000           INITIAL CASH
15840 C    TRATE=0.49              TAX RATE
15850 C    DRATE=0.10              DIVIDEND RATE
15860 C    AMOUNT=0.75             PERCENT OF TAX AND DIVIDEND TO BE PAID MONTHLY
15870 C    NDFI=2                  SELECTED MULTIPLIER FOR BUYING RAW MATERIAL
15880 NOTE      E C O N O M I C  AND  M A N A G E M E N T  PERFORANCE  RATIOS
15890 NOTE                         GROSS PROFIT RATIO
15900 S    GPR.K=GTMP.K/TRSP1.K
15910 A    TRS1.K=CLIP(CONST,TRSP.K,0,TRSP.K)
15920 C    CONST=9000000000
15930 NOTE                         OPERATING RATIO
15940 S    OPR.K=(TRSP.K-GTMP.K)/TRSP1.K
15950 NOTE                         EXPENSE RATIO
15960 S    EXR.K=(TINBLP.K+TOFOH.K+TADE.K+TINLTP.K+TSLE.K)/TRSP1.K
15970 NOTE                         NET PROFIT RATIO
15980 S    NPBTR.K=NPBT.K/TRSP1.K
15990 NOTE                         RETURN ON CAPITAL RATIO
16000 S    ROCER.K=NPBT.K/CURAS1.K
16010 A    CURAS1.K=CLIP(CONST,CURAST.K,0,CURAST.K)
16020 NOTE                         RETURN ON TOTAL ASSETS
16030 S    ROTASR.K=RETPRF.K/TLAST1.K
16040 A    TLAST1.K=CLIP(CONST,TLAST.K,0,TLAST.K)
16050 SPEC  DT=1/LENGTH=300/PRTPER=6/PLTPER=10
16060 PRINT 1)AFGRP/2)ACRMP/3)ALCP/4)ACPGP/5)TRSP/6)GTMP/7)NPBT/9)SHRCAP/10)EE
16070 X      E/11)MPHR/12)GPR
16080 PRINT 1)BFGRP/2)BCRMP/3)BLCP/4)BCPGP/5)VALIVU/6)TINBLP/7)TTAXA/9)BLTL/10
16090 X      )TDEP/11)MPHF/12)OPR
16100 PRINT 1)CFGRP/2)CCRMP/3)CLCP/4)CCPGP/5)TRMCP/6)TDEP/7)TDIVA/9)RETPRF/10)
16110 X      BFAST/11)MPM/12)EXR
16120 PRINT 1)DFGRP/2)DCRMP/3)DLCP/4)DCPGP/5)TLCP/6)TOFOH/7)RETPRF/9)ACPAY/10)
16130 X      CASHP/11)MPC/12)NPBTR
16140 PRINT 1)EFGRP/2)ECRMP/3)ELCP/4)ECPGP/5)TCPGP/6)TADE/9)DERITX/10)ARP/11)M
16150 X      PS/12)ROCER
16160 PRINT 1)FFGRP/2)FCRMP/3)FLCP/4)FCPGP/5)TPRODE/6)TINLTP/9)DIVSPY/10)VALIV
16170 X       /11)MPB/12)ROTASR
16180 PRINT 1)QFGRP/2)TRMCP/3)TLCP/4)TCPGP/5)GTMP/6)TSLE/9)CURLIB/10)CURAST
16190 PRINT 1)TRSP/6)NPBT/9)TLLIAB/10)TLAST
16200 PLOT  CASHP=C
16210 PLOT  TABHR=F,TABHF=H,TABM=M,TABC=C,TABS=S,TABB=B
16220 RUN    BASIC
READY
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APPENDIX "C"

KEY FOR MODEL SYMBOLS

ARMPL	Fresh Raw Material Inventory - Production Line	"A"	- LB
BRMPL	" " " " " "	"B"	"
CRMPL	" " " " " "	"C"	"
DRMPL	" " " " " "	"D"	"
ERMPL	" " " " " "	"E"	"
FRMPL	" " " " " "	"F"	"

ARMPF	Frozen Raw Material Inventory - Production Line	"A"	- LB
BRMPF	" " " " " "	"B"	"
CRMPF	" " " " " "	"C"	"
DRMPF	" " " " " "	"D"	"
ERMPF	" " " " " "	"E"	"
FRMPF	" " " " " "	"F"	"

AIAP	Finished Inventory - Production Line	"A"	- LB
BIAP	" " " "	"B"	"
CIAP	" " " "	"C"	"
DIAP	" " " "	"D"	"
EIAP	" " " "	"E"	"
FIAP	" " " "	"F"	"
MEAL	Fish Meal Inventory		- LB

APPPP	Finished Goods Sold To Date - Production Line	"A"	- LB
BPPPP	" " " " " " "	"B"	"
CPPPP	" " " " " " "	"C"	"
DPPPP	" " " " " " "	"D"	"
EPPPP	" " " " " " "	"E"	"
FPPPP	" " " " " " "	"F"	"
QPPPP	Fish Meal Sold To Date		- LB

ARMF	Raw Material Buying Rate - Production Line	"A"	- LB
BRMF	" " " " " "	"B"	"
CRMF	" " " " " "	"C"	"
DRMF	" " " " " "	"D"	"
ERMF	" " " " " "	"E"	"
FRMF	" " " " " "	"F"	"

AERML	Raw Material Not Bought	- Production Line	"A"	- LB
BERML	" " " "	" "	"B"	"
CERML	" " " "	" "	"C"	"
DERML	" " " "	" "	"D"	"
EERML	" " " "	" "	"E"	"
FERML	" " " "	" "	"F"	"

AORDB	Unfilled Order Inventory	- Production Line	"A"	- LB
BORDB	" " "	" "	"B"	"
CORDB	" " "	" "	"C"	"
DORDB	" " "	" "	"D"	"
EORDB	" " "	" "	"E"	"
FORDB	" " "	" "	"F"	"

AFF1	Cold Storage Capacity	- Production Line	"A"	- LB
BFF1	" " "	" "	"B"	"
CFF1	" " "	" "	"C"	"
DFF1	" " "	" "	"D"	"
EFF1	" " "	" "	"E"	"
FFF1	" " "	" "	"F"	"
TBBB	Total Plant Cold Storage Capacity			- LB

AMWP	Raw Material Available	- Production Line	"A"	- LB/day
BMWP	" " "	" "	"B"	"
CMWP	" " "	" "	"C"	"
DMWP	" " "	" "	"D"	"
EMWP	" " "	" "	"E"	"
FMWP	" " "	" "	"F"	"

AYLD	Yield of Finished Product From R.M.	- Production Line	"A"	-
BYLD	" " " " " " "	" "	"B"	
CYLD	" " " " " " "	" "	"C"	
DYLD	" " " " " " "	" "	"D"	
EYLD	" " " " " " "	" "	"E"	
FYLD	" " " " " " "	" "	"F"	
QYLD	Yield of Fish Meal From Fish Offal			
TYLD	Additional Yield Drop When Processing Thawed Fish			

AALP	Production	Planned	For	Fresh	Raw	Material	- Production	Line	"A"	- LB/day
BALP	"	"	"	"	"	"	"	"	"B"	"
CALP	"	"	"	"	"	"	"	"	"C"	"
DALP	"	"	"	"	"	"	"	"	"D"	"
EALP	"	"	"	"	"	"	"	"	"E"	"
FALP	"	"	"	"	"	"	"	"	"F"	"

AALLP	Production	Planned	For	Frozen	Raw	Material	- Production	Line	"A"	- LB /day
BALLP	"	"	"	"	"	"	"	"	"B"	"
CALLP	"	"	"	"	"	"	"	"	"C"	"
DALLP	"	"	"	"	"	"	"	"	"D"	"
EALLP	"	"	"	"	"	"	"	"	"E"	"
FALLP	"	"	"	"	"	"	"	"	"F"	"

AFCA1	Freezer	Capacity	For	Processing	Fresh	R.M.	- Production	Line	"A"	- LB /day
BFCA1	"	"	"	"	"	" "	"	"	"B"	"
CFCA1	"	"	"	"	"	" "	"	"	"C"	"
DFCA1	"	"	"	"	"	" "	"	"	"D"	"
EFCA1	"	"	"	"	"	" "	"	"	"E"	"
FFCA1	"	"	"	"	"	" "	"	"	"F"	"

ALL1	Freezer	Capacity	For	Round	Raw	Material	- Production	Line	"A"	- LB/day
BLL1	"	"	"	"	"	"	"	"	"B"	"
CLL1	"	"	"	"	"	"	"	"	"C"	"
DLL1	"	"	"	"	"	"	"	"	"D"	"
ELL1	"	"	"	"	"	"	"	"	"E"	"
FLL1	"	"	"	"	"	"	"	"	"F"	"

ASAP	Freezer	Capacity	For	Previously	Thawed	R.M.	- Production	Line	"A"	- LB/day
BSAP	"	"	"	"	"	" "	"	"	"B"	"
CSAP	"	"	"	"	"	" "	"	"	"C"	"
DSAP	"	"	"	"	"	" "	"	"	"D"	"
ESAP	"	"	"	"	"	" "	"	"	"E"	"
FSAP	"	"	"	"	"	" "	"	"	"F"	"

AMDP1	Fresh	Raw	Material	Processing	Rate	- Production	Line	"A"	- LB/day
BMDP1	"	"	"	"	"	"	"	"B"	"
CMDP1	"	"	"	"	"	"	"	"C"	"
DMDP1	"	"	"	"	"	"	"	"D"	"
EMDP1	"	"	"	"	"	"	"	"E"	"
FMDP1	"	"	"	"	"	"	"	"F"	"
FMEAL		Fish Meal Processing Rate							- LB

AFNP	Raw	Material	Freezing	Rate	- Production	Line	"A"	- LB/day
BFNP	"	"	"	"	"	"	"B"	"
CFNP	"	"	"	"	"	"	"C"	"
DFNP	"	"	"	"	"	"	"D"	"
EFNP	"	"	"	"	"	"	"E"	"
FFNP	"	"	"	"	"	"	"F"	"

AMDP2	Frozen	Raw	Material	Processing	Rate	- Production	Line	"A"	- LB/day
BMDP2	"	"	"	"	"	"	"	"B"	"
CMDP2	"	"	"	"	"	"	"	"C"	"
DMDP2	"	"	"	"	"	"	"	"D"	"
EMDP2	"	"	"	"	"	"	"	"E"	"
FMDP2	"	"	"	"	"	"	"	"F"	"

ASSP	Finished	Inventory	Shipping	Rate	- Production	Line	"A"	- LB/day
BSSP	"	"	"	"	"	"	"B"	"
CSSP	"	"	"	"	"	"	"C"	"
DSSP	"	"	"	"	"	"	"D"	"
ESSP	"	"	"	"	"	"	"E"	"
FSSP	"	"	"	"	"	"	"F"	"
QSSP	"	"	"	"	For Fish Meal			- LB

AMDP3Q	Raw	Material	Spoiled	- Production	Line	"A"	- LB/day
BMDP3Q	"	"	"	"	"	"B"	"
CMDP3Q	"	"	"	"	"	"C"	"
DMDP3Q	"	"	"	"	"	"D"	"
EMDP3Q	"	"	"	"	"	"E"	"
FMDP3Q	"	"	"	"	"	"F"	"

ALNP	Production	Labour	Required	- Production	Line	"A"	- Workers	
BLNP	"	"	"	"	"	"B"	"	
CLNP	"	"	"	"	"	"C"	"	
DLNP	"	"	"	"	"	"D"	"	
ELNP	"	"	"	"	"	"E"	"	
FLNP	"	"	"	"	"	"F"	"	
TLNP	Total Production Labour Required						- "	

ACPLP	Production	Labour	Productivity	- Production	Line	"A"	- LB/	Day
BCPLP	"	"	"	"	"	"B"	"	"
CCPLP	"	"	"	"	"	"C"	"	"
DCPLP	"	"	"	"	"	"D"	"	"
ECPLP	"	"	"	"	"	"E"	"	"
FCPLP	"	"	"	"	"	"F"	"	"
CPLP	Labour Productivity For Freezing Round R.M.						"	"
TCPL	Labour Productivity Percentage For Thawed R.M.						"	"

ACFG	Finished	Product	Price	- Production	Line	"A"	- $/LB
BCFG	"	"	"	"	"	"B"	"
CCFG	"	"	"	"	"	"C"	"
DCFG	"	"	"	"	"	"D"	"
ECFG	"	"	"	"	"	"E"	"
FCFG	"	"	"	"	"	"F"	"

APGQC	Quantity	of	Packaging	Material	- Production	Line	"A"	- LB
BPGQC	"	"	"	"	"	"	"B"	"
CPGQC	"	"	"	"	"	"	"C"	"
DPGQC	"	"	"	"	"	"	"D"	"
EPGQC	"	"	"	"	"	"	"E"	"
FPGQC	"	"	"	"	"	"	"F"	"

ACPG	Value	of	Packaging	Material	- Production	Line	"A"	- $/LB
BCPG	"	"	"	"	"	"	"B"	"
CCPG	"	"	"	"	"	"	"C"	"
DCPG	"	"	"	"	"	"	"D"	"
ECPG	"	"	"	"	"	"	"E"	"
FCPG	"	"	"	"	"	"	"F"	"

ACRM	Raw Material Price		- Production Line	"A"	-	$/LB
BCRM	" " "		" "	"B"		"
CCRM	" " "		" "	"C"		"
DCRM	" " "		" "	"D"		"
ECRM	" " "		" "	"E"		"
FCRM	" " "		" "	"F"		"

AOLD	Daily Market Orders	- Production Line	"A"	-	LB /day
BOLD	" " "	" "	"B"		"
COLD	" " "	" "	"C"		"
DOLD	" " "	" "	"D"		"
EOLD	" " "	" "	"E"		"
FOLD	" " "	" "	"F"		"

ACWR	Daily Labour Cost	- Production Line	"A"	-	$/WORKER
BCWR	" " "	" "	"B"		"
CCWR	" " "	" "	"C"		"
DCWR	" " "	" "	"D"		"
ECWR	" " "	" "	"E"		"
FCWP	" " "	" "	"F"		"

MPHR	Profit Margin For Species	"HR"	-	$/LB
MPHF	" " " "	"HF"		"
MPM	" " " "	"M"		"
MPC	" " " "	"C"		"
MPS	" " " "	"S"		"
MPB	" " " "	"B"		"

MP9	SpeciesWith Highest Profit Margin
MP17	" " Second Highest Profit Margin
MP23	" " Third " " "
MP27	" " Fourth " " "
MP29	" " Fifth " " "
MP30	" " Sixth " " "

TABHR	Species	"HR"	Raw	Material	Available	- LB /day
TABHF	"	"HF"	"	"	"	"
TABM	"	"M"	"	"	"	"
TABC	"	"C"	"	"	"	"
TABS	"	"S"	"	"	"	"
TABB	"	"B"	"	"	"	"

PHR	Species	"HR"	Production	Capacity	- LB/DAY
PHF	"	"HF"	"	"	"
PM	"	"M"	"	"	"
PC	"	"C"	"	"	"
PS	"	"S"	"	"	"
PB	"	"B"	"	"	"

YHR	Yield	For	Species	"HR"	-
YHF	"	"	"	"HF"	
YM	"	"	"	"M"	
YC	"	"	"	"C"	
YS	"	"	"	"S"	
YB	"	"	"	"B"	

LPHR	Labour	Productivity	For	Species	"HR"	- LB/DAY
LPHF	"	"	"	"	"HF"	"
LPM	"	"	"	"	"M"	"
LPC	"	"	"	"	"C"	"
LPS	"	"	"	"	"S"	"
LPB	"	"	"	"	"B"	"

FPHR	Finished	Product	Price	For	Species	"HR"	- $/LB
FPHF	"	"	"	"	"	"HF"	"
FPM	"	"	"	"	"	"M"	"
FPC	"	"	"	"	"	"C"	"
FPS	"	"	"	"	"	"S"	"
FPB	"	"	"	"	"	"B"	"

QPHR	Quantity	of	Packaging	Material	For	Species	"HR"	- LB
QPHF	"	"	"	"	"	"	"HF"	"
QPM	"	"	"	"	"	"	"M"	"
QPC	"	"	"	"	"	"	"C"	"
QPS	"	"	"	"	"	"	"S"	"
QPB	"	"	"	"	"	"	"B"	"

VPHR	Value	of	Packaging	Material	For	Species	"HR"	- $/LB
VPAF	"	"	"	"	"	"	"HF"	"
VPM	"	"	"	"	"	"	"M"	"
VPC	"	"	"	"	"	"	"C"	"
VPS	"	"	"	"	"	"	"S"	"
VPB	"	"	"	"	"	"	"B"	"

RPHR	Raw	Material	Cost	For	Species	"HR"	- $/LB
RPHF	"	"	"	"	"	"HF"	"
RPM	"	"	"	"	"	"M"	"
RPC	"	"	"	"	"	"C"	"
RPS	"	"	"	"	"	"S"	"
RPB	"	"	"	"	"	"B"	"

LCHR	Labour	Cost	For	Species	"HR"	- $/DAY
LCHF	"	"	"	"	"HF"	"
LCM	"	"	"	"	"M"	"
LCC	"	"	"	"	"C"	"
LCS	"	"	"	"	"S"	"
LCB	"	"	"	"	"B"	"

TABOHR	Daily	Market	Orders	For	Species	"HR"	- LB/day
TABOHF	"	"	"	"	"	"HF"	"
TABOM	"	"	"	"	"	"M"	"
TABOC	"	"	"	"	"	"C"	"
TABOS	"	"	"	"	"	"S"	"
TABOB	"	"	"	"	"	"B"	"

AFGR	Daily Sales Revenue	- Production Line	"A"	-	$/day
BFGR	" " "	" "	"B"		"
CFGR	" " "	" "	"C"		"
DFGR	" " "	" "	"D"		"
EFGR	" " "	" "	"E"		"
FFGR	" " "	" "	"F"		"
QFGR	" " "	For Fish Meal			"

AFGRP	Accumulated Sales Revenue	- Production Line	"A"	-	$
BFGRP	" " "	" "	"B"		"
CFGRP	" " "	" "	"C"		"
DFGRP	" " "	" "	"D"		"
EFGRP	" " "	" "	"E"		"
FFGRP	" " "	" "	"F"		"
QFGRP	" " "	For Fish Meal			"
TRSP	Total Sales Revenue				

APGQ	Daily Cost of Packaging Material Bought	- Production Line	"A"	-	$ /day
BPGQ	" " " " " "	" "	"B"		"
CPGQ	" " " " " "	" "	"C"		"
DPGQ	" " " " " "	" "	"D"		"
EPGQ	" " " " " "	" "	"E"		"
FPGQ	" " " " " "	" "	"F"		"

APGS	Inventory Value of Packaging Material	- Production Line	"A"	-	$
BPGS	" " " " "	" "	"B"		"
CPGS	" " " " "	" "	"C"		"
DPGS	" " " " "	" "	"D"		"
EPGS	" " " " "	" "	"E"		"
FPGS	" " " " "	" "	"F"		"

ACPGP	Value of Packaging Material used	- Production Line	"A"	-	$
BCPGP	" " " " "	" "	"B"		"
CCPGP	" " " " "	" "	"C"		"
DCPGP	" " " " "	" "	"D"		"
ECPGP	" " " " "	" "	"E"		"
FCPGP	" " " " "	" "	"F"		"
TCPGP	Total Value of Packaging material Used				"

ACRMR	Daily Cost of Raw Material	- Production Line	"A"	- $/day
BCRMR	" " " " "	" "	"B"	"
CCRMR	" " " " "	" "	"C"	"
DCRMR	" " " " "	" "	"D"	"
ECRMR	" " " " "	" "	"E"	"
FCRMR	" " " " "	" "	"F"	"

ACRMP	Accumulating Cost of Raw Material	- Production Line	"A"	- $
BCRMP	" " " " "	" "	"B"	"
CCRMP	" " " " "	" "	"C"	"
DCRMP	" " " " "	" "	"D"	"
ECRMP	" " " " "	" "	"E"	"
FCRMP	" " " " "	" "	"F"	"
TRMCP	Total Cost of Raw Material			"

ALCR	Daily Direct Labour Cost	- Production Line	"A"	- $/day
BLCR	" " " "	" "	"B"	"
CLCR	" " " "	" "	"C"	"
DLCR	" " " "	" "	"D"	"
ELCR	" " " "	" "	"E"	"
FLCR	" " " "	" "	"F"	"

ALCP	Accumulating Direct Labour Cost	- Production Line	"A"	- $
BLCP	" " " "	" "	"B"	"
CLCP	" " " "	" "	"C"	"
DLCP	" " " "	" "	"D"	"
ELCP	" " " "	" "	"E"	"
FLCP	" " " "	" "	"F"	"
TLCP	Total Direct Labour Cost			"

AIFN	Finished Goods Inventory Value	- Production Line	"A"	- $
BIFN	" " " "	" "	"B"	"
CIFN	" " " "	" "	"C"	"
DIFN	" " " "	" "	"D"	"
EIFN	" " " "	" "	"E"	"
FIFN	" " " "	" "	"F"	"
QIFN	Fish Meal Inventory Value			"

AIFR	Frozen Raw Material Inventory Value - Production Line "A"	- $
BIFR	" " " " " " " "B"	"
CIFR	" " " " " " " "C"	"
DIFR	" " " " " " " "D"	"
EIFR	" " " " " " " "E"	"
FIFR	" " " " " " " "F"	"

AIFS	Fresh Raw Material Inventory Value - Production Line "A"	- $
BIFS	" " " " " " " "B"	"
CIFS	" " " " " " " "C"	"
DIFS	" " " " " " " "D"	"
EIFS	" " " " " " " "E"	"
FIFS	" " " " " " " "F"	"

VALFIN	Inventory Value of All Finished Goods	- $
VALFZ	" " " " Frozen Raw Material	"
VALFR	" " " " Fresh Raw Material	"
VALPG	" " " " Packaging Material	"
VALIV	Total Inventory Value	"
VALIVU	Total Inventory Value Excluding Packaging Material	"

BLTL	Long Term Bank Balance	- $
IVOLT	Initial Long Term Bank Loan Value	"
YRL	Life of The Long Term Bank Loan	YEARS
AINTL	Interest Rate Per Year on Long Term Loan	%
COMPL	Number of Loan Payments Per Year	
CRPLTR	Principal Paid on Loan Each Payment	$/6 months
TLTDP	Total Principal Paid on Long Term Loan to Date	$
INLTR	Interest Paid on Loan Each Payment	"/6 months
TINLTP	Total Interest Paid on Long Term Loan to Date	$

BCAP	Short Term Financing Loan Value	- $
RATED	Short Term Financing Daily Interest Rate	"/day
BLIMIT	Maximum Value of Short Term Financing	$
INBLR	Monthly Interest Paid on Short Term Financing	"/month
TINBLP	Total Interest Paid on Short Term Financing to Date	$

BFAST	Value of Depreciable Assets	- $
EEE	Initial Value of Depreciable Assets	"
LENGTT	Length of Life Assets Are Depreciated	yrs.
DEPR	Depreciation Rate of Assets	$/month
TDEP	Total Depreciation to Date	$

TOFOHR	Monthly Overhead Accrued From Head Office	- $/month
TOFOH	Total Overhead Accrued From Head Office to Date	$
TPRDER	Monthly Production Expense	$/month
TPRODE	Total Production Expense to Date	$
TSELE	Monthly Selling Expense	$/month
TSLE	Total Selling Expense to Date	$
TADME	Monthly Administration Expense	$/month
TADE	Total Administration Expense to Date	

APRM	Daily Raw Material Accounts Payable	- $/day
RMCEP	Daily Raw Material Cost Expenditure	"
APPG	Daily Packaging Material Accounts Payable	"
PGCEP	Daily Packaging Material Cash Expenditure	"
LCEP	Daily Labour Cash Expenditure	"
TPRDER	Daily Production Overhead Cash Expenditure	"
TSAE	Daily Selling and Adminstration O/H Cash Expenditure	"
TFIXOH	Daily Cash Expenditures of Other Fixed Overheads	"
ARP	Cash Receivables	$
FGCRP	Daily Finished - Goods Cash Receipts	$ /day
CASHP	Daily Cash Balance on Hand or in Bank	"
CASHP1	Initial Cash	$

GTMP	Gross Trading Marginal Profit	- $
NPBT	Net Profit Before Taxes	"
TAX	Monthly Taxes Paid to Date	"/month
TAXPAY	Total Taxes Paid to Date	$
DERITX	Difference Between Taxes Required to Pay and Paid	"
NPAT	Net Profit After Taxes	"
DIV	Quarterly Dividends Paid	"/qtr.
DIVPT	Total Dividends Paid	$
TDIVA	Total Dividends Required to Pay	"
DIVSPY	Difference Between Dividends Required to Pay and Paid	"
RETPRF	Total Retained Earnings	"

ACPAY	Accounts Payable	- $
CURLIB	Current Liabilities	"
PRENSH	Number of Preference Shares	
PRESHP	Unit Value of Preference Shares	"
ORDNSH	Number of Ordinary Shares	
ORDSH	Unit Value of Ordinary Shares	"
PREPSH	Total Value of Preference Shares	"
ORDSH	Total Value of Ordinary Shares	"
SHRCAP	Total Value of All Shares	"
TLLIAB	Total Liabilities	"

CURAST	Current Assets	- $
FIXAST	Fixed Assets	"
TLAST	Total Assets	"

GPR	Gross Profit Ratio
OPR	Operating Ratio
EXR	Expense Ratio
NPBTR	Net Profit Ratio
ROCER	Return on Capital Ratio
ROTASR	Return on Total Assets

APPENDIX "D"

Forecasting

The forecasting technique commonly used for short-term and medium-term planning is the adaptive forecasting technique known as exponential smoothing or the Box-Jenkins method. The basic exponential smoothing formula is:

FORECAST = A X DEMAND + (1-A) X PREVIOUS FORECAST

where A is a constant for the given product or range of products being forecasted. For example, suppose our last forecast was 85, and the demand 70 and A = 0.25; then the new forecast is 0.25 X 70 + 0.75 X 85 = 81.25.

Note that the basic exponential smoothing formula can be expressed as:

FORECAST = PREVIOUS FORECAST + A (DEMAND - PREVIOUS FORECAST)

In this form, the second term is an error term which is made use of in calculating the new forecast, hence the "adoptiveness" of the formula. The smoothing out effect is illustrated in Figure D.1, as seen, the forecasts do not closely follow the more violent swings in the demand or sales figures; they give a type of average figure.

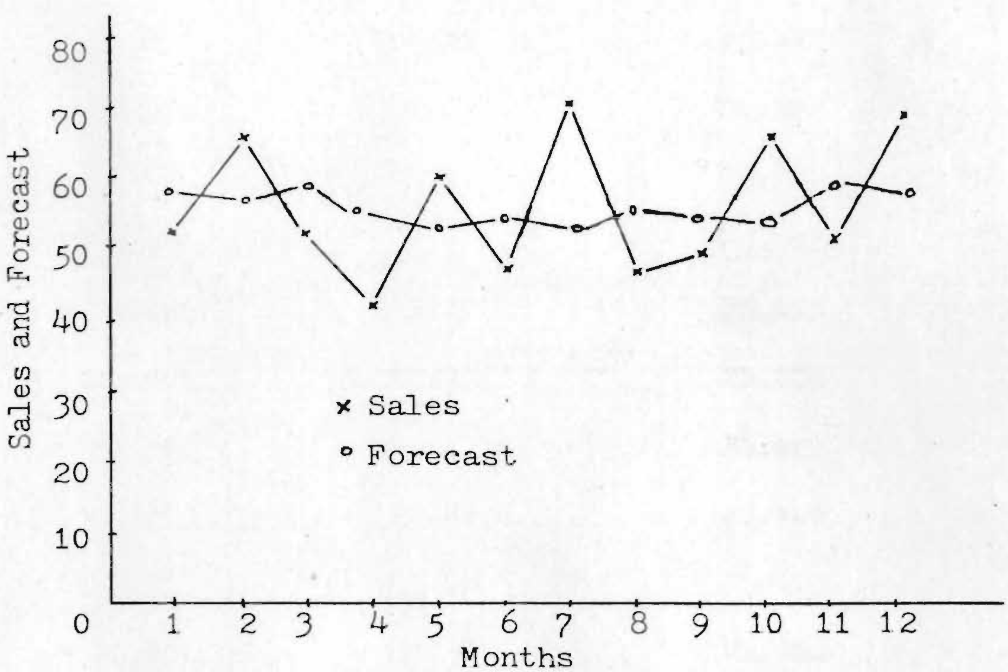

Figure D.1 Exponential Smoothing Example

APPENDIX "E"

THE SYSTEM DYNAMIC EQUATIONS AND COMPUTER PRINT-OUT OF A SIMPLE RESERVOIR MODEL

```
00010 * A SIMPLE RESEVOIR MODEL
00020 R  R1.KL=75000
00030 L  L1.K=L1.J+(DT)(R1.JK-R2.JK)
00040 N  L1=100000
00050 R  R2.KL=A2.K
00060 A  A2.K=L1.K*P1
00070 C  P1=0.80
00080 PRINT 2)R1/4)L1/6)R2
00090 SPEC DT=0.01/LENGTH=15/PRTPER=1/PLTPER=0
00100 RUN BASIC
READY
```

PAGE 1   RUN-BASIC   A SIMPLE RESEVOIR MODEL

TIME	R1	L1	R2
E+00	E+03	E+03	E+03
.0	75.000	100.00	80.000
1.	75.000	96.55	77.238
2.	75.000	95.00	76.001
3.	75.000	94.31	75.447
4.	75.000	94.00	75.199
5.	75.000	93.86	75.087
6.	75.000	93.80	75.038
7.	75.000	93.77	75.016
7.999	75.000	93.76	75.006
8.999	75.000	93.75	75.001
9.999	75.000	93.75	75.000
10.999	75.000	93.75	75.000
11.999	75.000	93.75	75.000
12.999	75.000	93.75	75.000
13.999	75.000	93.75	75.000
14.999	75.000	93.75	75.000