Let's Go - Home Depot

Development of a
Management Flight Simulator

by

Daniel Eide Joensen

M.S., Computing Science, University of Copenhagen (1991)
C.S.T., University of Copenhagen (1991)
B.A., Rhetoric, University of Copenhagen (1990)
B.S., Computing Science, University of Copenhagen (1989)

Submitted to Sloan School of Management
in Partial Fulfillment of
the Requirements for the Degree of

Master of Science in Management

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

June 1993

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May 14, 1993

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parents

To

my

support

for

their

with

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and

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Abstract

This thesis documents the process of constructing a management flight simulator. A management flight simulator is a computer program which prompts its user for business decisions and provide immediate performance results as output. During my research assistantship for Dr. Michael S. Scott Morton, Chair of Behavioural and Policy Science, the idea of improving teaching quality though interactive computer supported learning emerged. Dr. Paul Healy supported the idea and proposed a management flight simulator for the Home Depot to enhance the Harvard Business School case. The thesis work primarily consisted of programming as the realism, user friendliness and functionality of the simulator were of top priority. Also, the work was done in a very limited time frame from February through May. This has made some shortcuts necessary.

First, I examine the technological progress that has made the project possible at all. Second, I look into the performance of Home Depot. Third, I go through the construction of the basic management flight simulator. Fourth, I test the simulator. Fifth, I develop an user interface which will ease user interaction with the simulator. Finally, I conclude on the process and outline the implications of the project.

The management flight simulator makes it possible to run the Home Depot as if you were the CEO. This provide an interactive learning experience compressed in time which, together with a lecture and class discussion, can enhance the teaching as well as the learning process. A management flight simulator makes it possible for the teacher to support students who learn better by doing than by discussing, thinking or listening.

Thesis Supervisor: Dr. Paul Healy

Title: Nanyang Technological Senior Professor of Management

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I owe my greatest debt to Professor Paul Healy at MIT Sloan School of Management. His patient support have been unfailing throughout the thesis preparation process. I am equally grateful to Dr. Michael S. Scott Morton who helped conceive the idea and supported me with a Research Assistantship for his Behavioural and Policy Science Chair and the Senior Executives Program. Accordingly, I am indebted to Susan C. Lowance and Judith E. Mason of the Senior Executives Program, and Margaret A. Scoppa of the Behavioural and Policy Science area for providing computer and financial resources. Furthermore, I want to extend my gratitude to professor John Sterman, who agreed to be my thesis reader. He kindly supported my acquisition of MicroWorld's Creator software package and allowed me to use his class notes for System Dynamics. These have deepened my interest in, and understanding of, systems modeling and been invaluable in writing my thesis. Dean William Frank Pounds receives special appreciation for his support in my academic endeavours.

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Thanks go to my family in Denmark and the Faroe Islands — especially to my parents Claudina Fríðbjørg and Stig Eide Joensen — for their support in my overseas pursuit for knowledge.

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1 Introduction

To dare is to lose footing for a moment;
not to dare is to lose yourself.
Søren Kierkegaard 1813-1855

The idea for this thesis originated from the environment of my research assistantship for Professor Michael S. Scott Morton. During the Fall of 1992, Scott Morton and I discussed how organizations use information technology. Our interest soon focused on how information technology affects communication in an organization.

I attended some sessions in the MIT Sloan Senior Executive program. This is a program developed to update experienced managers on current issues in management. Here, I helped with the Peoples Express exercise. The students (managers) read a company background provided ahead of time. They, then, play a computer game, a management flight simulator, which allows them to make business decisions and monitor the effect on annual reports, market share, and so on and so forth.

Professors Paul Healy, Michael S. Scott Morton and I decided on pursuing the construction of a management flight simulation for the Home Depot — a case that Healy has taught in the Senior Executives Program as well as in his 'Financial Statement Analysis' class in the Master's Program. The project was sponsored by Scott Morton's chair in the Behavioural and Policy Science area and the Senior Executives Program.

The major benefits of a management flight simulator are that you are its hands on approach (learning by doing) and that it allows you to observe long term cause-effect relations in a

condensed time period.

The report describes the construction process for the management flight simulator. First, I describe the development of computers which made it possible. I begin with the incredible development hardware. Thereafter, I describe the problems of software development. And finally, I describe system dynamics as a software development and modeling tool.

Second, I look into the background of the Home Depot. I explain how the company started, what it is and what it does. I then explore the major decisions involved in running Home Depot and what its management philosophy is.

Third, I outline the method of the model development. I describe the criteria for the modeling process, the modeling process itself, and how parameter choices were made.

Thereafter, I explain the test phases that the model went through. Next, I go through the construction of the user interface.

Finally, I address the lessons learned during the process. I criticize the methods used and make recommendations on future actions.

The basic research in this thesis takes on two forms: research on the company in order to obtain realistic real-life like results from the model, and, more importantly, determination on which causal relationships drives the company performance on such important parameters as service quality, cash flow performance, and expansion both locally and into new geographic areas.

The report is directed towards students at Master's level in the Management studies at the Massachusetts Institute of Technology and especially towards students participating in System Dynamics and Financial subjects, as well as others with a basic knowledge of Computer Science and Management in general and, in particular, towards people with

problem experience. The report requires no specific computer knowledge. But, it is an advantage, if the reader has a general knowledge of computers and business issues, as well as their terminology.

The game is afoot.

Daniel Eide Joensen
Cambridge, May 14, 1993

2 Computer Development

Key words: Computing, Tools, Computers, Human Insight, Learning and Teaching.

If the automobile and airplane businesses had developed like the computer business, a Rolls-Royce would cost $2.75 and run for 3 million miles on one gallon of gas. And a Boeing 767 would cost just $500 and circle the globe in 20 minutes on five gallons of gas.
Tom Forester [Fore85]

Computers have undergone a tremendous development since the first digital machines were constructed in the wake of the Second World War. This development is historically unmatched by any other technical field. Numerous studies estimate quality-adjusted price indices for computers starting of with Chow's studies [Chow67]. These are later surveyed by Triplett [Trip89] who points out a number of interesting observations.

First, a striking result in table 1 is that the quality-adjusted price index declined every year from 1953 to 1972.

Second, and even more striking, by 1972 a computer's quality adjusted price was roughly 1% of what it cost when computer were first sold on a market in 1953.

Third, the advent of second-generation computers in 1958-1959 set off an accelerated rate of price decreases of about 25% per year. This, in turn, increased dramatically to over 60% when third-generation computers were delivered in 1966. From 1967 to 1970 these price decreases slowed considerably; they then picked up again in 1971-1972 with the introduction of the IBM Model 360 series.

Finally, the average annual growth rate of the quality-adjusted price index for computers during the entire 1953-1972 time period is approximately -27%. This implies that quality-adjusted price decreases in computers over this period occurred at an extraordinary rate.

Table 1: Triplett's Research Price Index for Computers, 1953-1972

Year	Price Index (1965=100)	Annual % Change	Year	Price Index (1965=100)	Annual % Change
1953	1320		1963	183.0	-23.6
1954	1139	-13.7	1964	139.0	-24.2
1955	1010	-11.3	1965	100.0	-27.8
1956	862	-14.7	1966	38.0	-61.5
1957	761	-11.8	1967	26.9	-30.1
1958	689	-9.4	1968	24.3	-9.7
1959	591	-14.2	1969	24.2	-0.4
1960	435	-26.4	1970	23.3	-3.7
1961	332	-23.7	1971	18.1	-22.3
1962	239	-27.9	1972	14.8	-18.2

After 1972, we find almost similar results. The hedonic price study by Cole et al. [Cole86] is particularly interesting. It in turn formed part of the basis of the official computer price index later published by the U.S. Department of Commerce, Bureau of Economic Analysis (BEA) [Cart86]. On the basis of their results, Cole et al. constructed a number of alternative price indices. The primary drivers of computer prices, the indices for processors and intermediate-large scale disk drives, are reproduced in table 2.

The most interesting result is that the traditionally used matched model procedure for accounting for quality change appears to be woefully inadequate. On the other hand, hedonic prices with quality characteristics of speed (MIPS, or millions of IBM 370 equivalent instructions per second) and memory (in MB, or megabytes) for processors, and

speed (Kilobytes per second, which incorporates average seek time, average rotation delay and transfer rate) and capacity for disk drives (MB of storage on the disk drive), gives realistic results.

Table 2: Price Indices for Processors and Disk Drives Based on the Cole et al. Study and New Official Hedonic-Based Price Indices for Computers, 1972-1984

	Processors		Disk Drives		Computers
Year	Matched Model (1982=100)	Hedonic Regression (1982=100)	Matched Model (1982=100)	Hedonic Regression (1982=100)	New Official BEA Price Index (1982=100)
1972	214.1	990.1	201.7	427.4	408.1
1973	214.6	1047.5	200.9	429.5	369.3
1974	219.9	814.8	154.5	345.3	291.1
1975	228.9	792.1	143.4	313.2	265.1
1976	223.6	778.2	134.0	291.5	231.1
1977	183.5	499.0	133.5	150.0	199.7
1978	147.3	262.4	131.1	147.0	169.3
1979	136.4	242.6	107.7	111.0	146.2
1980	115.4	177.2	91.0	96.2	117.5
1981	111.1	112.9	92.9	96.6	107.4
1982	100.0	100.0	100.0	100.0	100.0
1983	89.7	90.1	86.5	54.3	77.1
1984	73.7	77.2	85.1	46.9	68.5
Average Annual Growth Rate (%)	-8.5	-19.2	-6.9	-16.8	-13.8

If we combine the results from table 1 for the 1953-1972 time interval with those of table 2 for 1972-1984, we find that, quality adjusted, computers that cost $531.88 in 1953 cost only $1.00 in 1984. In other words, what would have cost more than half a million dollars in 1953 cost only $1000 in 1984. Moreover, since the calculations in Cole et al. [Cole86] and Cartwright [Cart86] involve only mainframe and minicomputers and exclude personal (micro) computers, I am confident that this price index understates the amount of quality improvement.

The development does not seem to have stopped or slowed down since 1984 but rather to have increased its already surprising pace. Indeed, the life time of a new personal (micro) computer was in 1992 only 10-11 months, while processors lately have ten-doubled their capacity every three years without any significant price increase.

2.1 Computer Software and Computing

To be is to do.
Richard Nixon 1913-

While the development of computer hardware has developed rapidly throughout the history of computers, the development of software is still lagging behind. In many ways producing computer hardware is a science, since it involves controllable manufacturing processes. Software development, however, is an art since it is mostly creative and highly depends on perfection of a skill. The skill of programming a computer is frequently named computing.

At issue is to understand computing. Customarily, when we say 'computing' we mean something that is well defined, an item of a sort. Language misleads us into believing that

we here have something that is just waiting to be described. This is absolutely not the case. Rather, computing involves human purposes and intents, human insights, and man-made tools and techniques.

A tool for computer representation of long-term hard-to-observe effects on systems — that makes it possible to go through an interactive, accelerated process of learning cause-effect relationships — has been developed and refined by Jay Forrester, Peter Senge, John Sterman, et al. at the MIT Sloan School of Management. In the case of The Home Depot, the lessons are how cash flows and timing affects growth opportunities both locally and in new areas. I will apply the tool to The Home Depot to make these lessons from its rapid expansion and tremendous success available in a new form. The tool is called system dynamics.

2.2 System Dynamics and Modeling

If the person in front of me is a used car salesman, then I will act as if I do not see him, because he is likely to harass me if I acknowledge his existence.
Jorge Rufat-Latre [Rufa93]

Most often reality is too complex to grasp in its totality. Accordingly, we are forced to construct simplified representations in our minds as a basis for analyzing and acting in the real world. As a matter of rule, we do not know what the representations actually look like. Researchers in computer science, cognitive science, artificial intelligence, organizational behaviour and in many other fields, however, have built a multitude of more or less formalized meta-representations which can be used to discuss our original representations. All of these models that we keep in our minds are *mental models.*

From a systems perspective, mental models have important limitations. Experiments show

that our mental models do not cope well with specific types of complexity. Situations that involve long delays and dynamic complexity are areas which we cannot model well. Presumably, atavistic mechanisms like reflexes and instincts enable us to react very fast to events — as in threats from a wild animal, fire, or a sudden drop in the long term treasury bond. On the other hand, we are often unable to perceive progressive decay in our environment, or erosion of competitive advantage. Additionally, it is generally accepted that we can only absorb and manipulate a limited amount of information at a time. This limitation is known as bounded rationality after H. Simon, a father of artificial intelligence [Tani87].

Our mental models are only as valid as they are useful. Most of us do not question our models most of the time. We just use them. Fortunately, we have the ability to observe and learn from our actions, and, thereby, to change our models. Testing our models by comparing them to the real world and discussing them with other people is essential to understanding the value of our models.

When we think about the world, we are likely to think of a subject, the actor, and of an object acted upon [Rufa93]. This provides us with a frame that is useful for understanding simple unilateral relations. Much of our world, however, displays more complicated relations. For instance, we have the problem of the chicken and the egg. Chickens, or rather hens, lay eggs that become chickens. Likewise, debt yields expenses, and everything else equal higher expenses yield higher debt. There is no real object. Both entities in the examples are not just actors, but also react to each other. System dynamics calls this uncontrolled growth spiral a positive feedback loop. In figure 1 below, the relation is graphically represented. "S" symbolizes an increasing effect. Expenses and debt will move in the Same direction.

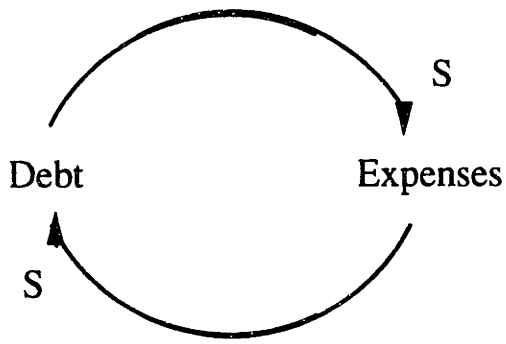

Figure 1: Self-Reinforcing Feedback Loop

Many relations in the real world are not this simple. Rather, they have some kind of external control build into them. An unleveraged company is very attractive to lenders, and might be leveraged until its debt equity ratio reaches the lenders' desired ratio. Figure 2 contains a graphical representation. The mechanism that controls the flow measures the difference between the actual debt equity ratio and the desired ratio. As the actual ratio approaches the desired ratio, the mechanism progressively constrains the flow. Eventually it will reach an equilibrium. The mechanism is called a negative feedback loop. Debt equity ratio and lender willingness to lend modes in Opposite directions.

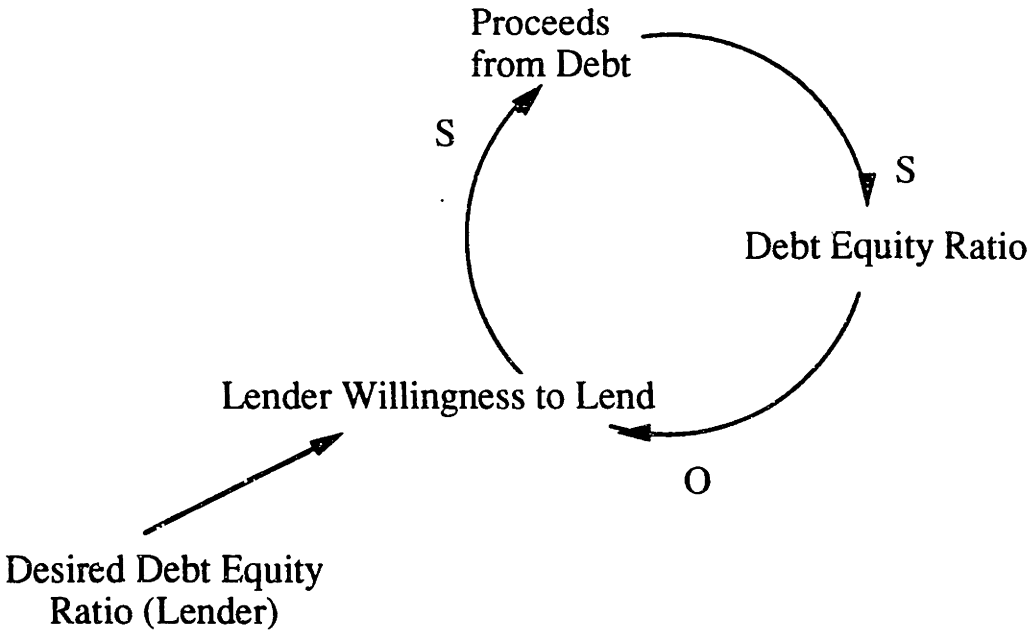

Figure 2: A Balancing Feedback Loop

During the development I have used Ithink™ by High Performance Systems, Inc. This is, to my knowledge, the only software development package specifically directed towards system dynamics. The software development package can manipulate two kinds of entities (primitives) — things and information. Things move physically from one state to another, while information is not stored anywhere and moves instantly. In this respect, Ithink™ takes up the idea from Scandinavian information-theoretical system developments methods. Mats Lundeberg et al. describe analysis of change and system development using "two-string-systems" [Lund78]. In their method, one type of string symbolizes information, while the other symbolizes either things or both things and information. Lundeberg et al. have worked with the ISAC research group on design analysis for information systems. Jørgen Bansler, along with other researchers, develop system development tools under the socio-technical method which also takes people and work environment into account [Bans87].

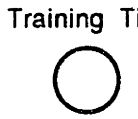

Figure 3: Converter

Ithink's™ two entities present themselves as a Stock and a Converter. Stocks contain things while converters only contain information. Figure 3 graphically represents a converter while figure 4 represents a stock. Information can be send from a stock to a converter or from a converter to another via arrowed lines also known as connectors.

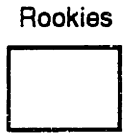

Figure 4: Stock

Things stored in stocks have to flow around in the system via flows. Figure 5 displays a flow. Flows have pipes and regulators. The regulator in figure 5 is labeled "hires". Regulators can receive information from stocks and converters and send information to other converters. In many ways a regulator is a converter that controls a flow. Flows can be uni- or bi-directional. The one in figure 5 is uni-directional from left to right. The fluffy-looking clouds-like things on figure 5 symbolize an unknown stock. These are used when we do not care where a flow comes from, where it goes or when we need an inexhaustible supply.

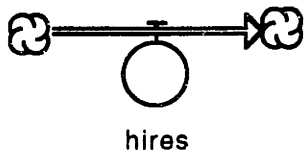

Figure 5: Flow

Combining the four primitives we can model complicated relations. Figure 6 illustrates a

solution to modeling how rookies are hired, trained to get up to speed and then turn into pros. Some pros quit every time period and this information affects the hiring process.

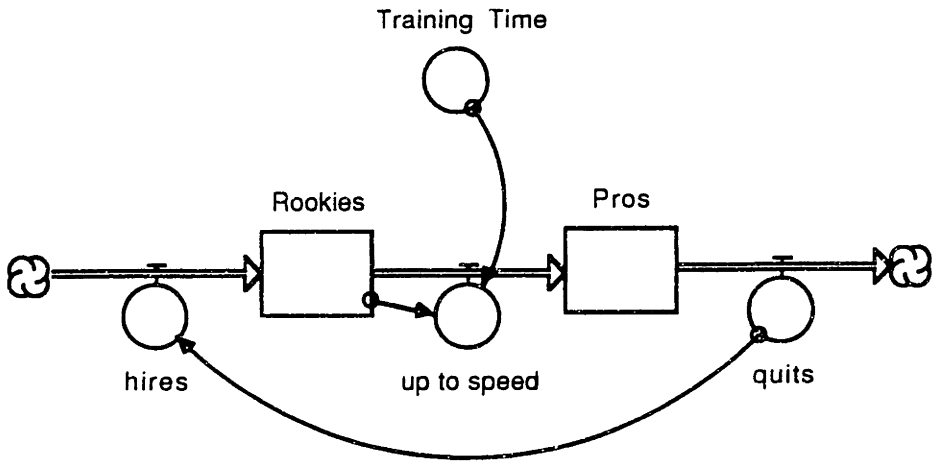

Figure 6: Training Rookies to Become Pros

After looking into the computer revolution that made this possible and the software development package itself, I will now go into Home Depot.

3 Company Background

Key words: Home Depot, Company Background, Case and Home Improvement Market.

At Home Depot
— where low prices are just the beginning.
Home Depot TV Commercial, May 1993

"The difference between a company with a concept and one without is the difference between a stock that sells for 20 times earnings and one that sells for 10 times earnings. The Home Depot is definitely a concept stock [Barr85]"

Thus sounds the introduction to a Harvard Business School case on the Home Depot [Pale88]. What is so special about this company? Well, first, it has experienced incredible growth rates in both revenue and earnings. Second, it forecasts continued strong growth of approximately 30%. Third, it is a warehouse store with retail service. "They also offer unusually helpful customer service ... the only company that has successfully brought off the union of low prices and high prices" [Fort88]. Finally, it still faces potential for geographic growth.

Founded in 1978 in Atlanta, Georgia, The Home Depot is America's largest home center retailer and ranks among the nation's 30 largest retailers, according to Fortune magazine. At the close of fiscal 1991, the Company had 174 full-service, warehouse-style stores in 34 markets in 15 states.

The average Home Depot store is approximately 95,000 square feet, with an additional 10,000 to 20,000 square feet of outside selling area. New stores average approximately 102,000 square feet in size with an additional 10,000 to 20,000 square feet of outside selling area. The stores stock approximately 30,000 different kinds of building materials, home improvement supplies and lawn and garden products.

The Home Depot is widely credited with being a leading innovator in retailing by combining the economies of scale inherent in a warehouse format with a high level of customer service. The Company is also noted for its progressive corporate culture and workplace practices. The Home Depot has a three-part marketing philosophy consisting of low pricing, large merchandise assortment and excellent customer service. Service, by far, is the most important of the three -- as well as the most difficult to execute and for competitors to copy -- since do-it-yourselfers require a high level of guidance while undertaking home improvement projects.

The Home Depot's primary customers are do-it-yourselfers, however, home remodeling contractors, building maintenance professionals and other professional customers are also important market segments.

The Home Depot has been a publicly held company since 1981. Its stock is traded on the New York Stock Exchange (NYSE) under the symbol, "HD," and is included in the Standard & Poor's 500 Index. In 1992, The Home Depot was the biggest non-health gainer on the NYSE.

3.1 Coming Home to the American Dream

The Home Depot still performs marvelously. 1991 was another record-setting year despite the Gulf War, a recession and historic changes in consumer confidence levels and spending habits. While consumers may not buy expensive new cars or designer clothing, or step up to bigger and better homes, they still repair, remodel and improve their existing homes, often their largest personal assets. Consumers also refinance their homes in record numbers to take advantage of the lowest mortgage rates in nearly two decades.

What has endured amid the turmoil seems to be the American Dream of living in, and enjoying, a home that we can call our own. Surveys indicate that almost all Americans want to own a home, and nearly two-thirds already do.

As Bernard Marcus, CEO of The Home Depot puts it: "Why are our homes so dear? We Americans seem to be returning to simpler and more sensible values. We are reaffirming 'hearth, home and family' as the center stage of our lives. Sobered and wiser, we have turned to the things that really matter."

As I see, it the major concern with the Home Depot is whether it has made a plan for succession to its dominating senior management.

In the 1991 annual report the management replies: "We have developed qualified individuals to back up all of our key people, from senior officers to store managers. We continue to train our people as decision makers and entrepreneurs in their own right. This effort will help perpetuate The Home Depot and its operating philosophies."

3.2 The Home Improvement Market

The population of the U.S. is an important driver of the potential size of the total home development market. While legislators, mayors, and the Census Bureau argue over details, the fact remains that our national population has reached a quarter of a billion. That's nearly double what it was at the end of World War II.

Much of that growth came during the 1950's when the Baby Boom combined with post-war immigration to swell the population by 18.5%. The growth rate has been slowing since then: in the Eighties our population increased by about 10%, and in the Nineties we expect to see the first single-digit growth rate since the Great Depression, as female Baby

Boomers grow out of their childbearing years (see table 3).

Table 3: U.S. Population in Thousands

	U.S. Total	South Total	South/U.S.
1970	203,302	62,800	.31
1980	226,546	75,400	.33
1990	249,900	87,200	.35
2000(estimate)	268,266	96,900	.36
Change(1970 - 2000)	+32%	+54%	

Source: U.S. Bureau of the Census, Current Population Report

Slower population growth has important implications for retailers who can no longer count on a burgeoning population to increase their customer headcount. More and more, retailers must win new customers away from the competition. It's a buyer's market, and the retailers who will grow are those who can best anticipate and respond to consumer demands.

Home Depot's stores are almost all in the South, a region which saw great population growth during the Sunbelt migration of the Seventies and early Eighties. No region is completely immune to the current slowdown in population growth rate; however, I believe that Home Depot's heartland will continue to attract migration from regions with harsher climates and higher costs of living. As a result, it will remain one of the fastest growing areas of the country.

I consider the household to be our basic consumer unit, because that's where Home Depot's products are put into use. Since 1970, when the first Baby Boomers began

leaving the nest, the number of U. S. households has grown significantly (see table 4). While the national population increased by 23% over that twenty-year period, the number of households grew by 49%. In Home Depot's current trading area, the number of households grew by an amazing 69% during those years. While the household growth rate will undoubtedly slow during the 1990's, it is projected to outpace the overall population--especially in Home Depot's southern heartland, where there will be nearly 38 million households by the year 2000.

Table 4: U.S. Households in Thousands

	U.S. Total	South Total	South/U.S.
1970	63,450	19,259	.30
1980	80,390	26,487	.33
1990	94,227	32,454	.34
2000(estimate)	105,933	37,883	.36
Change(1970 - 2000)	+67%	+97%	

Source: U.S. Bureau of the Census. Current Population Report. Series P-20 and P-25

The growing number of households represents great market opportunity for Home Depot, in part because we understand the diversity of the growth. In addition to the numerous traditional families formed by Baby Boomers, there has been a huge increase in single person households, single parent households, non-traditional households, and two-worker households. The resulting marketplace for household products is not only larger than it used to be but also more complex.

The archetypal American house is a free-standing one-family dwelling with a garage or (in

the South) a carport. Its front yard is planted with bushes and maybe a few trees: the back yard may be fenced for the kids or the dog, and there's probably some kind of garden producing flowers or those home-grown tomatoes that really taste like tomatoes.

That's the archetype, and for many families in Home Depot's heartland it's also a literal description. But although the needs of such a household may not have changed much since Beaver Cleaver was teething, today's homeowners are satisfying those needs in some very different ways.

Today more than half of all adult females are in the work force, and the number may well reach 60% by the end of the decade. Female Baby Boomers are swelling the work force in record numbers: virtually three-quarters of all women of prime child-bearing age now hold jobs. After having babies, they are more likely to return to their careers than were their mothers.

This social change means that regardless of whether a household includes one, two or more adults, there is probably nobody at home during the day to do the household chores. Instead, adults are appropriating traditional leisure time (weekends and evenings) for the demands of childbearing and home maintenance. They may get help with these responsibilities from a grandparent or other adult not part of the nuclear family. They also get help from modern home care products designed to decrease the drudgery of chores and increase leisure time for the enjoyment of family and home.

Between 1980 and 1990, home center retailing doubled in size from $54 billion to $107 billion in annual sales. That's an annual growth of 7%, compared with only 6.5% growth for retailing in general.

The most important aspect of that growth was the change in who was doing the buying. Throughout the Seventies, building materials were purchased primarily by professional

builders (58% in 1975), and the bulk of their purchases went into new home construction (73% in 1975). As the housing stock built during the post-World War II boom years began to age, more and more building materials were purchased by Do-It-Yourself (DIY) homeowners who needed to repair and update their homes. Manufacturers saw a market opportunity and began to develop product lines catering to weekend handymen and women. Today the DIY market alone is nearly as big as total sales of building materials were just ten years ago.

Among professional builders there has also been a change. While nearly three quarters of their total purchases went into new homes back in 1975, only 57% were destined for new construction in 1990, while 43% went into home repair and home improvement projects. Thus, manufacturers and retailers who were used to dealing with high-volume professional customers have had to adapt to new types of customers and new consumer needs. Price and selection are important, as always; terms and delivery are less so. In-stock, self-service, take-with inventory is now essential, while special orders and "Please allow six weeks for delivery" don't make it.

The Home Improvement Research Institute projects that the home center market will approach $147 billion by 1995. The houses built during the boom years of the 1970's, when annual starts surpassed 2 million, are now about twenty years old. Homeowners are thinking about replacing the roof, buying a new energy efficient water heater, installing new stain resistant carpeting, and getting rid of that tacky gold and avocado sunflower wallpaper that was the last word in home decor when it was hung in 1971.

Table 5: Home Depot's Total Market Potential in Billions

	Contractor		Homeowner		
	New Housing	Repair & Remodel	DIY	Durables	Total
1995 estimate	$60	$48	$99	$43	$250
1990	47	35	72	33	187
1985	40	25	54	29	148
1980	24	16	38	14	92
1975	$22	$ 8	$22	$ 8	$ 60

Source: Monthly Retail Trade, U.S. Department of Commerce, Bureau of the Census; Home Improvement Research Institute; Estimates

Ten years ago, retailing of building materials to newly-defined DIY customers was the domain of lumber yards who were beginning to add expanded lines of hardware to their small offices and showrooms, and of hardware stores who were expanding sales floors to carry some "convenience" assortments of commodity-type items. Power tools were sold by Sears and other mass merchants; decorating items were sold by retailers who focused on one product category such as paint or floor covering and offered deep assortments at full markup.

As the decade unfolded, it became apparent that building material retailing was undergoing a revolution (see table 5). New formats proliferated to take advantage of the rapid growth. The warehouse store with its huge assortments, self-service, and volume-driven profitability gave new meaning to the word "competition." Superstores were born, and drive-through lumber yards were tried. Some retailers attempted to combine different formats while others fought to protect their market niche.

In 1980 the current leader of our industry, Home Depot, had just come into existence and wasn't ranked in Building Supply Home Center's annual list of ten industry giants (see table 6). Yet Home Depot is the oldest of the three warehouse operators now holding down places on that list.

Table 6: Tne Competitive Situation — Top Ten Building Supply and Home Centers in Million Dollars

Rank			Sales		% of 1990 Building
1990	1980	Company	1990	1980	Material Store Sales(*)
1	NA	The Home Depot	$3,815	$ 22	4.1%
2	2	Lowe's	2,833	884	3.0
3	7	Payless Cashways	2,226	316	2.4
4	NM	Builder's Square	1,900	NM	2.0
5	19	Hechinger Co.	1,450	172	1.6
6	NM	Home Club	1,260	NM	1.4
7	1	Wickes Lumber	850	1,300	.9
8	5	Grossman's	810	650	.9
9	30	Menard	800	99	.9
10	6	84 Lumber	$ 785	$ 555	.8%

Source: Building Supply Home Centers Annual Giants Issues. NM = Not Meaningful; NA + Not Available; (*) Based on SIC Code 52

Companies that failed to respond adaptively to change are the ones that have fallen from the list since 1980. Those that responded and evolved, like Home Depot, have grown and prospered.

Despite the phenomenal growth of industry leaders over the past decade, not one has a market share of 5% or more. In fact, the top ten retailers all together have just an 18% shares of the total market. There is still plenty of opportunity for these "giants" to grow, as their marketing efforts result in a greater share of a still-growing total market.

4 Construction of System Dynamics Model

Key words: Model, Cash Flow, Opening Stores and Financing.

It is not possible for a machine to think.
Computers can only deal with zeros and ones.
Only natural things like people and
animals can have intelligence.
Steven L. Tanimoto [Tani87]

Construction of the system dynamics model, the basic management flight simulator is done under a strict set of criteria for model construction, solution to problems and parameter choice. The basic model must be:

- Illustrative
- Simple
- Realistic
- Complete

The primary criterion is that the model is illustrative. The major purpose of constructing the model in the first place is that is can represent the lessons to be learned in a cohesive and persuasive manner.

Second, the model must be simple. We might ask: "is simplicity best or simply the easiest? Is the narrowest path always the holiest?" In this case simplicity is the best. If the model gets too elaborate, it might cloud up the lessons to be learned in an information overflow. This would be another form of the GIGO (garbage in garbage out) phenomena known from computer science.

Third, realism is important in the model. The model does not have to perfectly mirror the

real life Home Depot, that would invalidate the simplicity criterion. Nevertheless, realistic output from the model enhances the trustworthiness of the model.

Finally and least important, the model must be complete. It must in emulate all real life relations between the decision parameters and the output variables.

4.1 Modeling

The overall idea is to model the stock and flows of cash, growth by the opening of new stores both in new areas and in Home Depot's home market and financing of this growth.

Cash is the central account on the balance sheet. All other accounts are in some way connected to cash. My model of the cash flows on the balance sheet is in figure 7.

Proceeds from financing and collections increase the stock of cash. This stock then decreases when accounts payable are paid and when capital expenditures are incurred.

Financing in the form of cash consists of long term debt and equity issuance. The debt is retired on a straight line basis and the outstanding amount results in an interest expense. Financing in the form of leases are treated in a later section.

Collections consist of cash sales and collections of accounts receivable. Credit sales are modeled as a tiny fraction of every sale. Accounts receivable are primarily dependent on last quarter's sale since the collection delay is short.

Accounts payable consists of all expenses including tax. Accounts payable are primarily dependent on last quarter's expenses due to the short delay in payment.

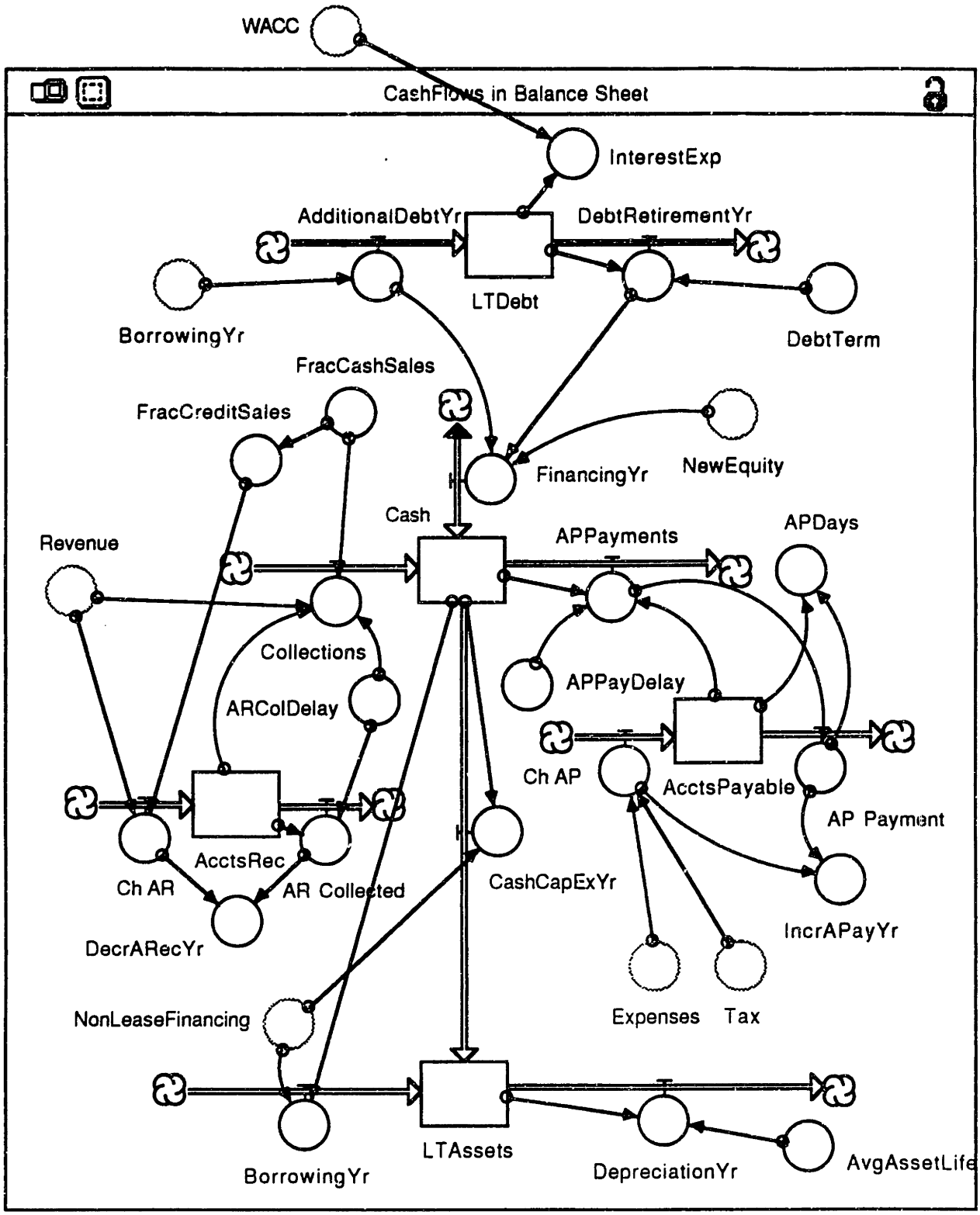

Figure 7: Cash Flows in Balance Sheet

Capital expenditures increase long term assets. A fraction of the capital expenditures are financed with cash while the rest is financed with debt. The cash consists includes proceeds from new equity issuance. Long term assets are depreciated on a straight line basis over their average useful lives.

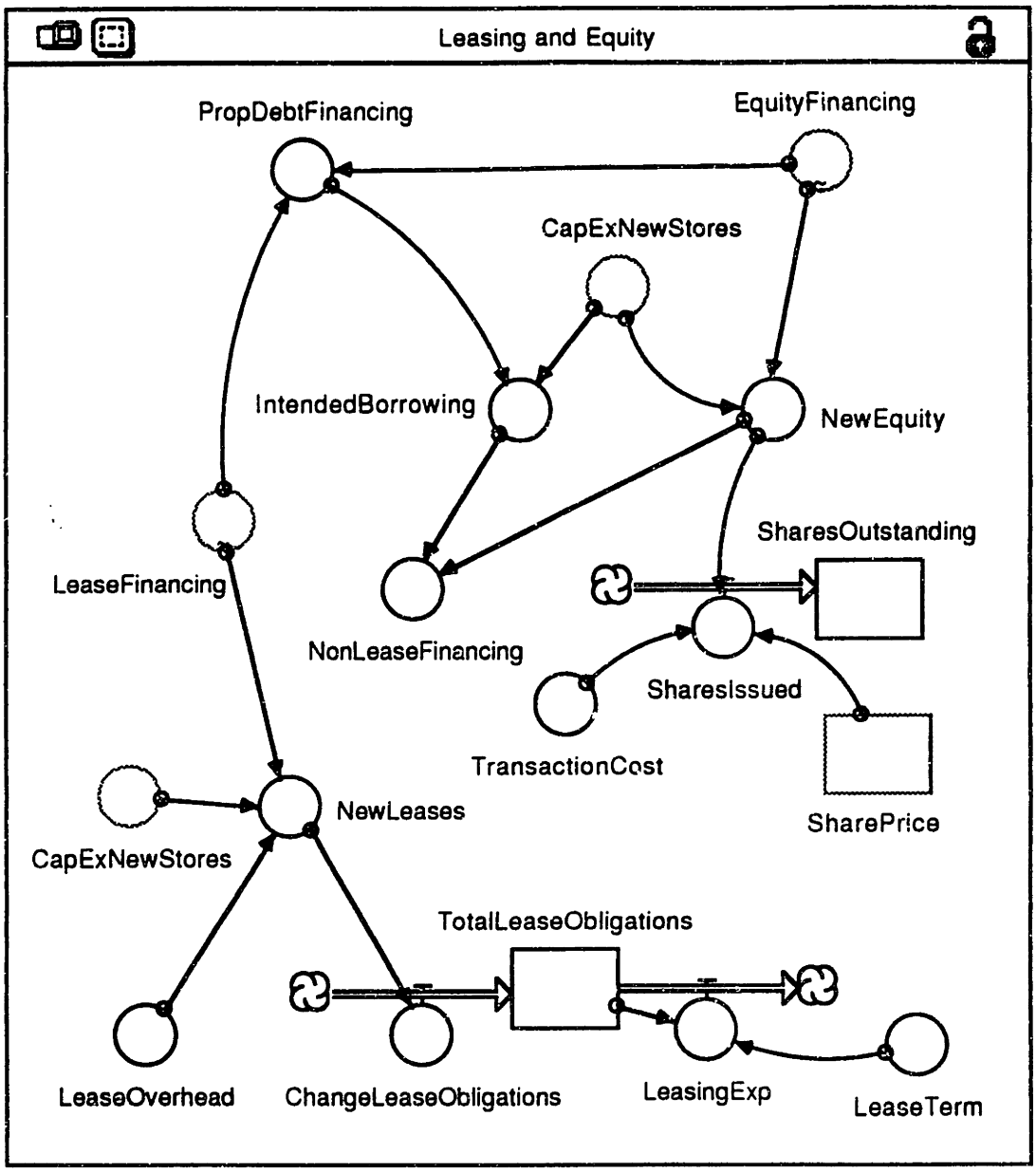

Figure 8: Lease and Equity Financing

Capital expenditures are financed by debt, new equity issuance and leasing (see figure 8). The user of the model provides the fractions financed by equity and leases. This results in amounts of new shares issued at the current share price less a transaction cost and in new lease obligations which are expensed straight line over the term of the lease.

The weighted average cost of capital (WACC) is calculated using the CAPM (Capital Asset Pricing Model) according to the standard method as shown in figure 9.

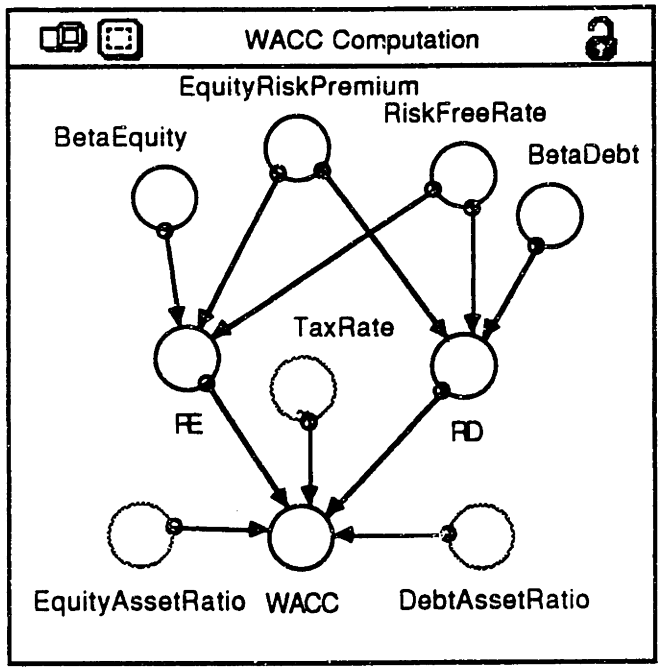

Figure 9: Weighted Average Cost of Capital

Figure 10 illustrates the claculation of total assets, total debt, and equity. On this basis, the sales to assets, debt to assets, equity to asset and return on equity ratios are computed.

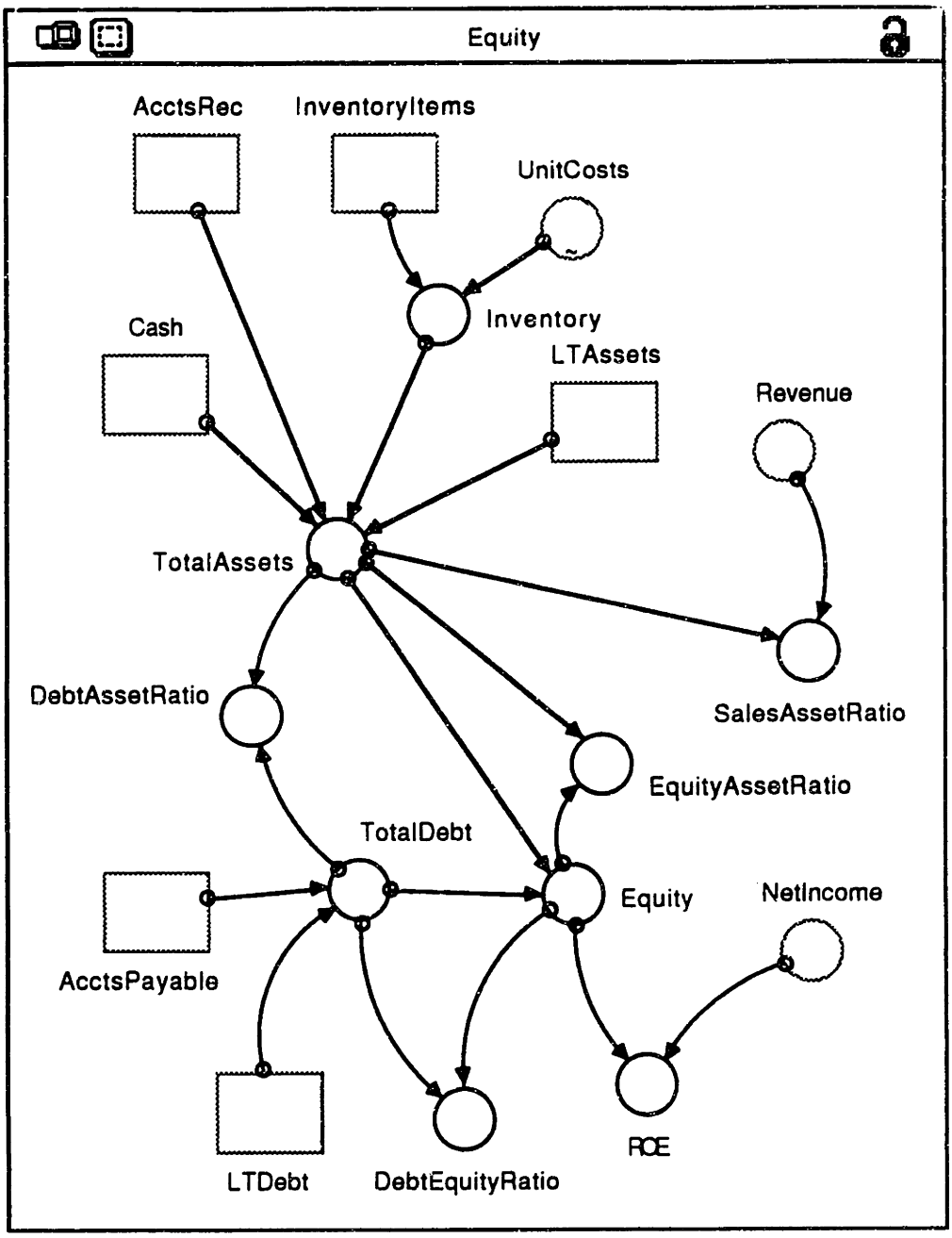

Figure 10: Equity and Debt Asset Ratios

The revenue is the result of units sold at an average price. Figure 11 illustrates the calculation of Net Income. Costs of goods sold (COGS) is a standard price per unit. Interest expense depends on WACC and outstanding debt. Leasing expense is the straight

line expense of outstanding leases.

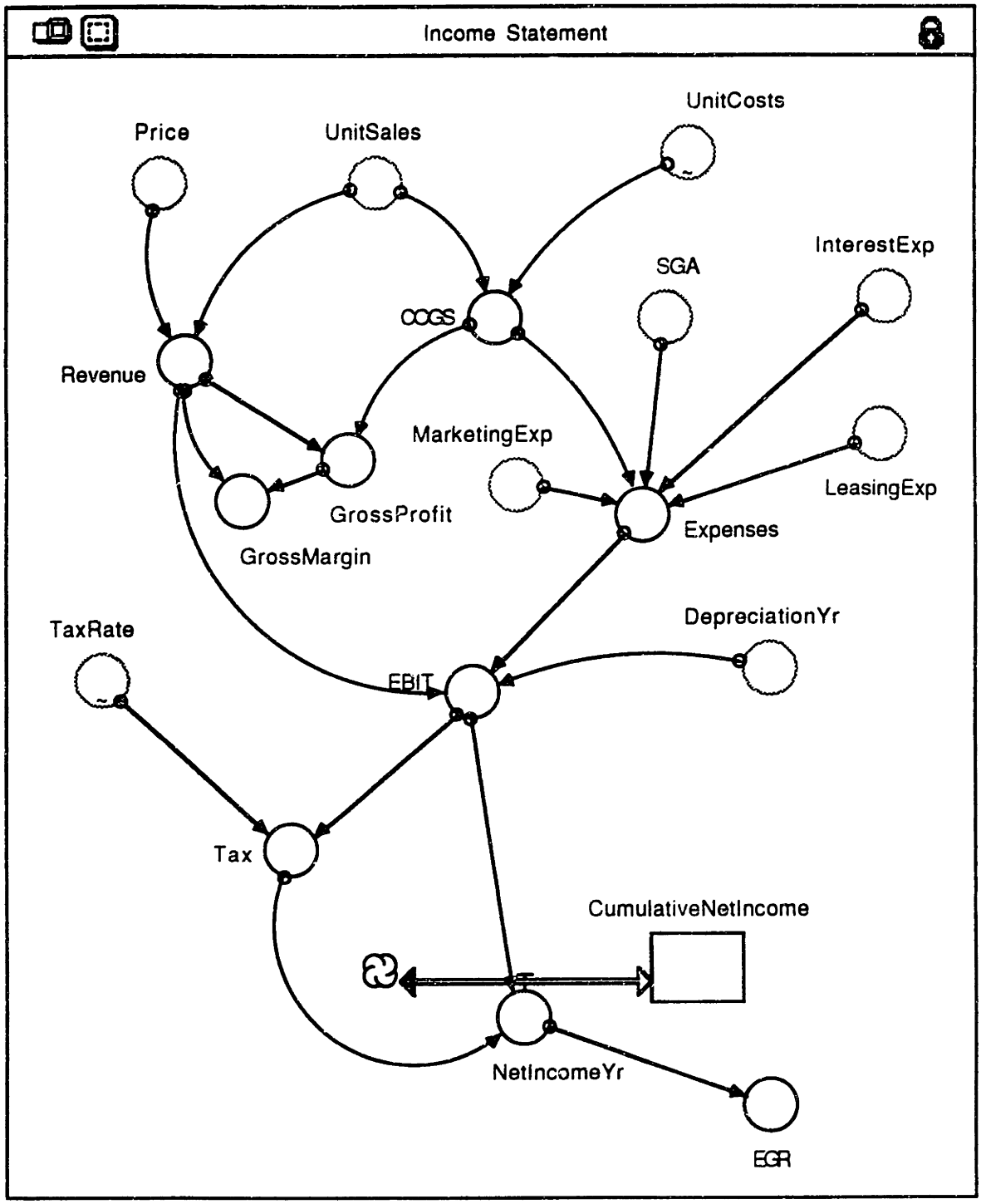

Figure 11: Income Statement

Gross profit and margin, cumulative net income and growth rate, EGR (Earnings Growth Rate) are calculated for reporting in the output window.

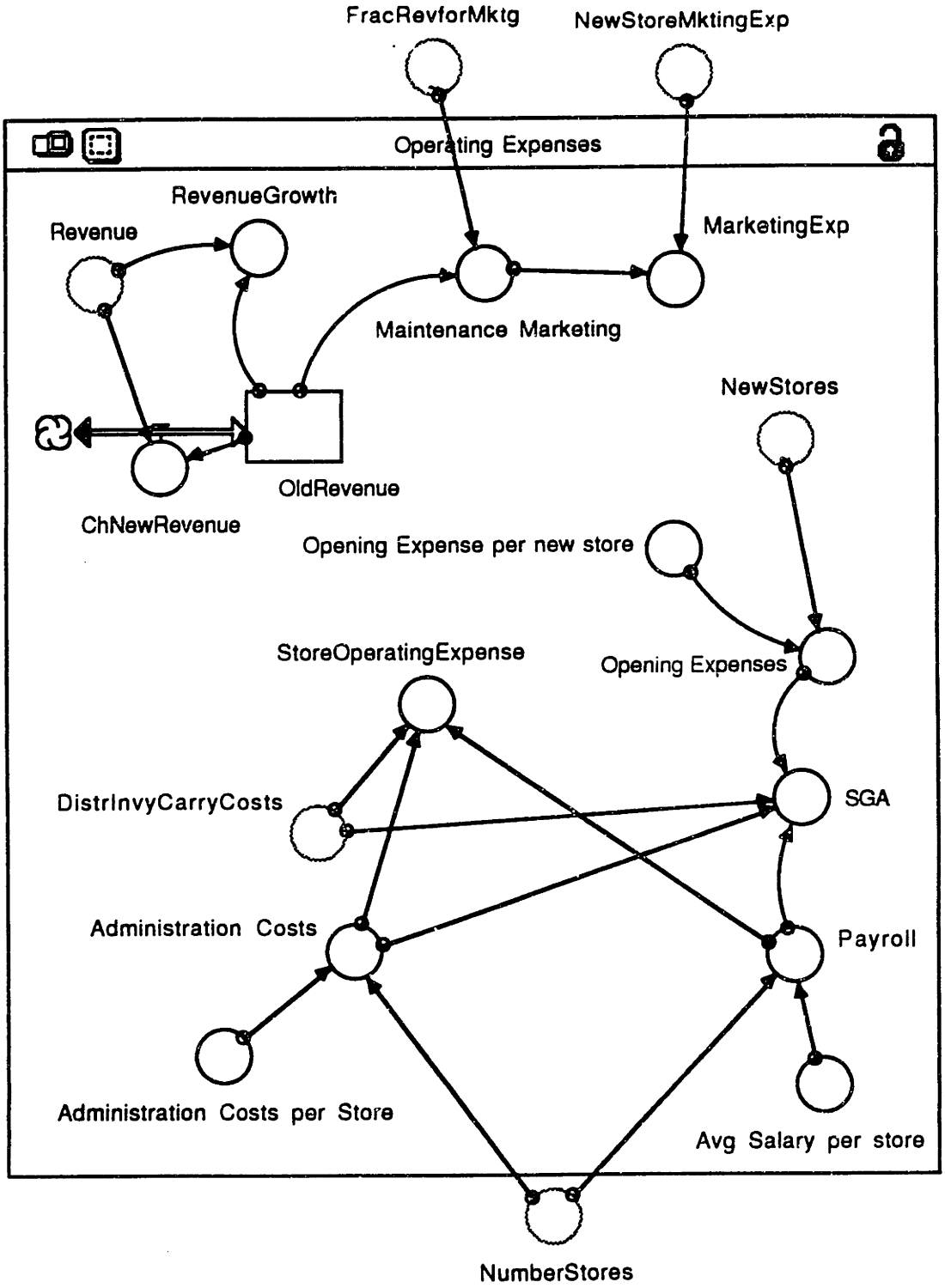

Figure 12: Operating Expenses

Marketing consists of two parts — new store marketing and a fraction of revenue for marketing (see figure 12).

The new store marketing is the expense necessary to get a new store up to the average level of customer awareness. The fraction of revenue represents a maintenance marketing expense.

Sales, general and administrative expenses consists of operating expenses per store and opening expenses per new store. Operating expenses includes delivery and inventory carrying costs, administration costs, and payroll expense. Administration costs and payroll expenses depend on the total number of stores while delivery and inventory carrying costs is related to number of units in inventory.

Inventory are replaced with reorders as symbolized in figure 13. The reordering is done to a simple forecast sales adjusted for the present gap between desired days of inventory and actual days in inventory. Unit costs for reordering depends on the quantity of the reorder.

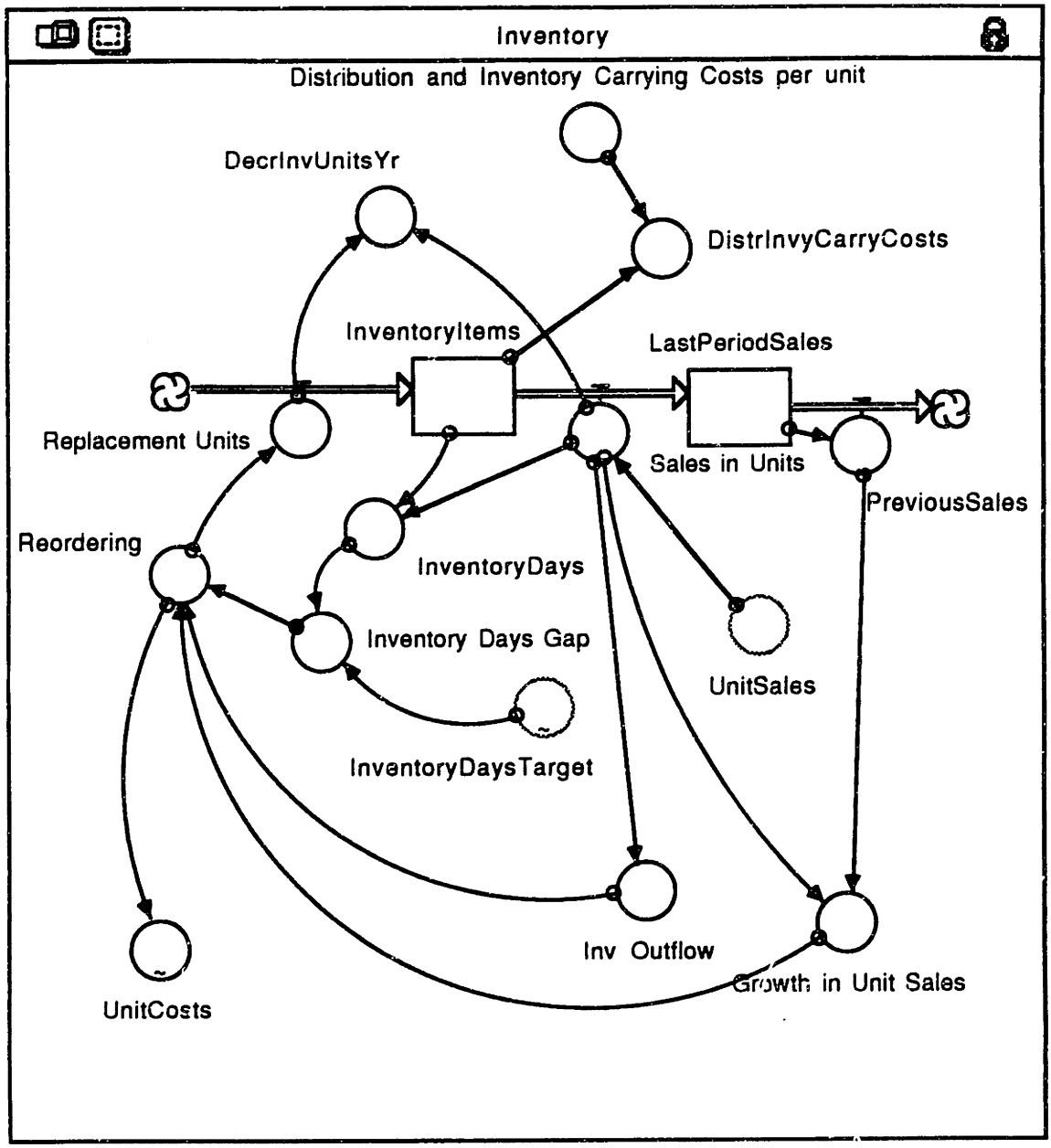

Figure 13: Inventory

Unit sales directly relates to the market share of Home Depot as depicted in figure 14. Market share in turn depends on the relative attractiveness of one unit of merchandise at Home Depot compared with that of the competitor's merchandise. The products are almost perfect substitutes, and their attractiveness is, therefore, the measure of service quality per

dollar of price.

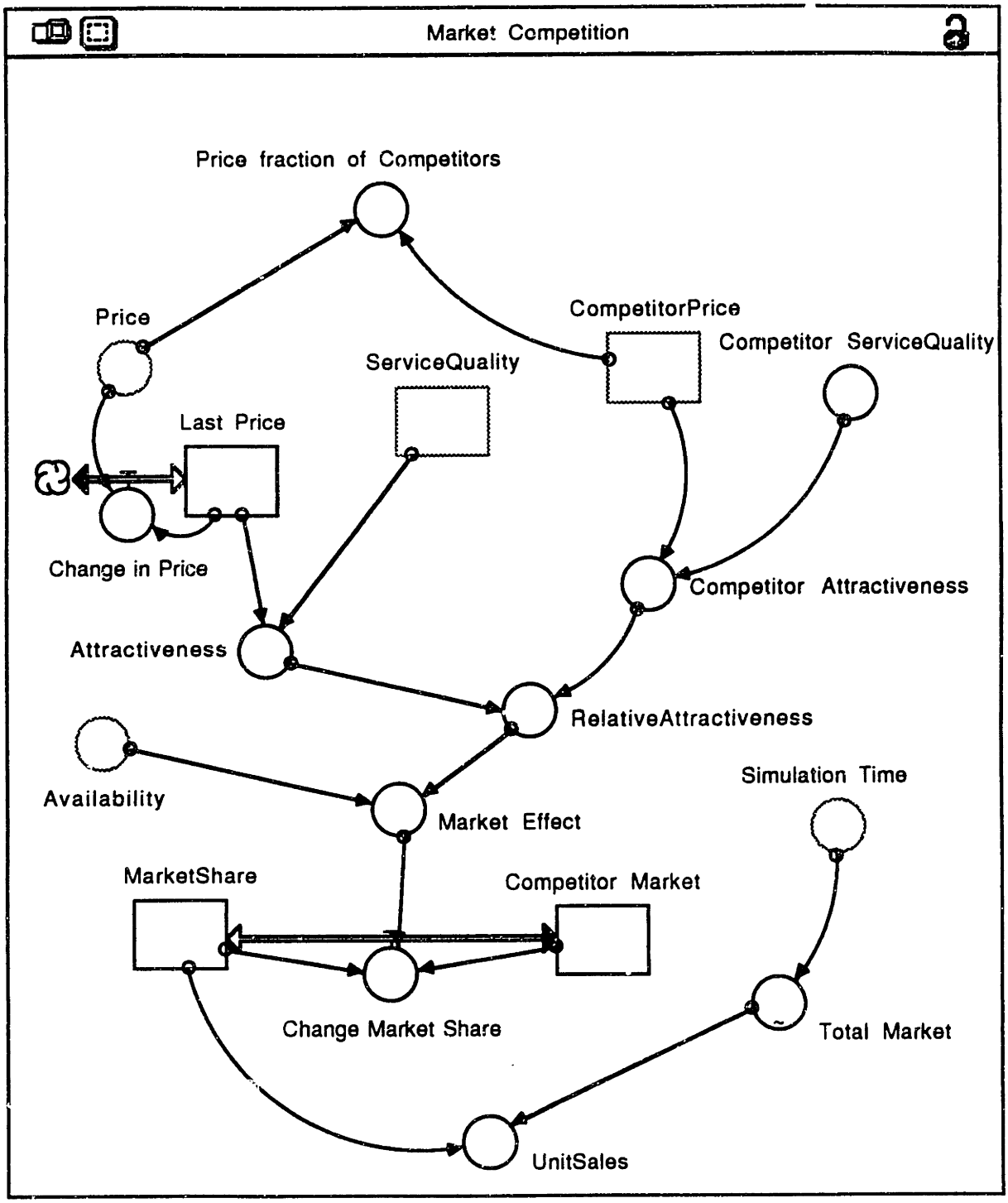

Figure 14: Market Competition

Figure 15 represents the way the intended markup affects the actual markup. The price is

then calculated as total expenses excluding depreciation and tax per item plus actual markup.

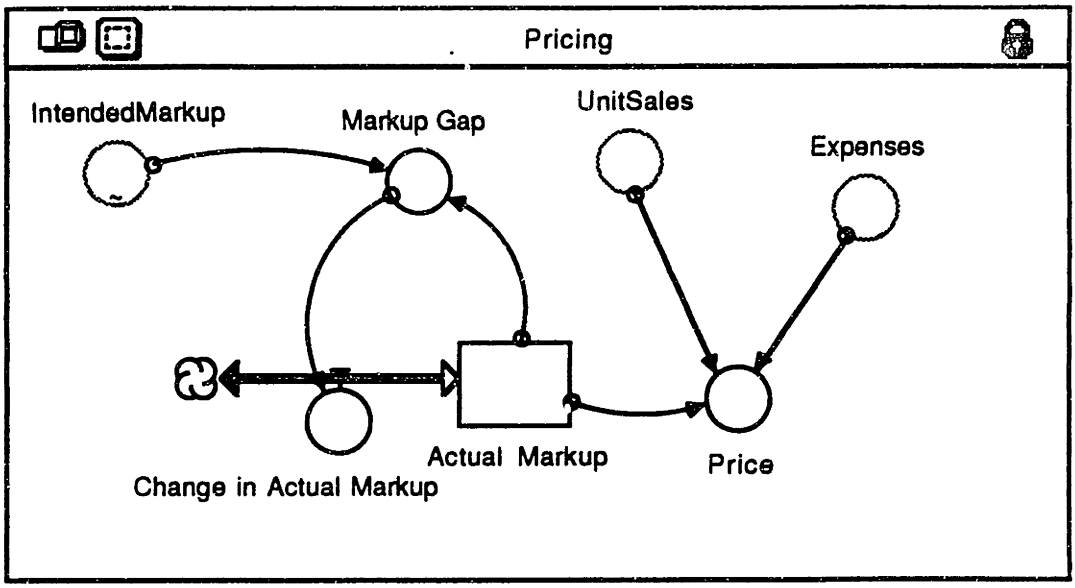

Figure 15: Pricing

The ratio of new stores to the total number of stores determines the change in service quality as outlined in figure 15. If the number of new stores exceeds a specified ratio of the total number of stores (12%), the service quality drops short term. Longer term the service quality increases slowly. Actual service quality is the accumulation of these changes.

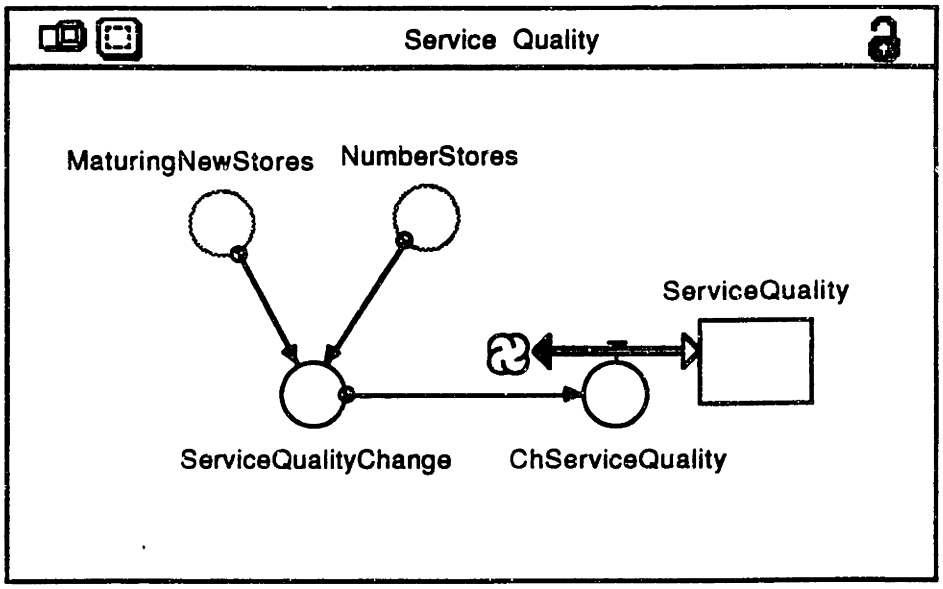

Figure 16: Service quality

Figure 17 shows how the competitor's pricing is modelled as a reactive function of Home Depots pricing. In any given quarter the competitor price will approximate Home Depot's price of the previous quarter. Consequently, a slow decrease in price will maintain a price advantage.

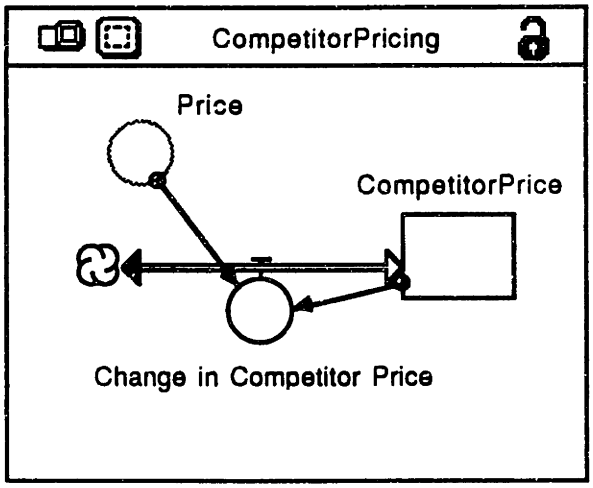

Figure 17: Competitor Pricing

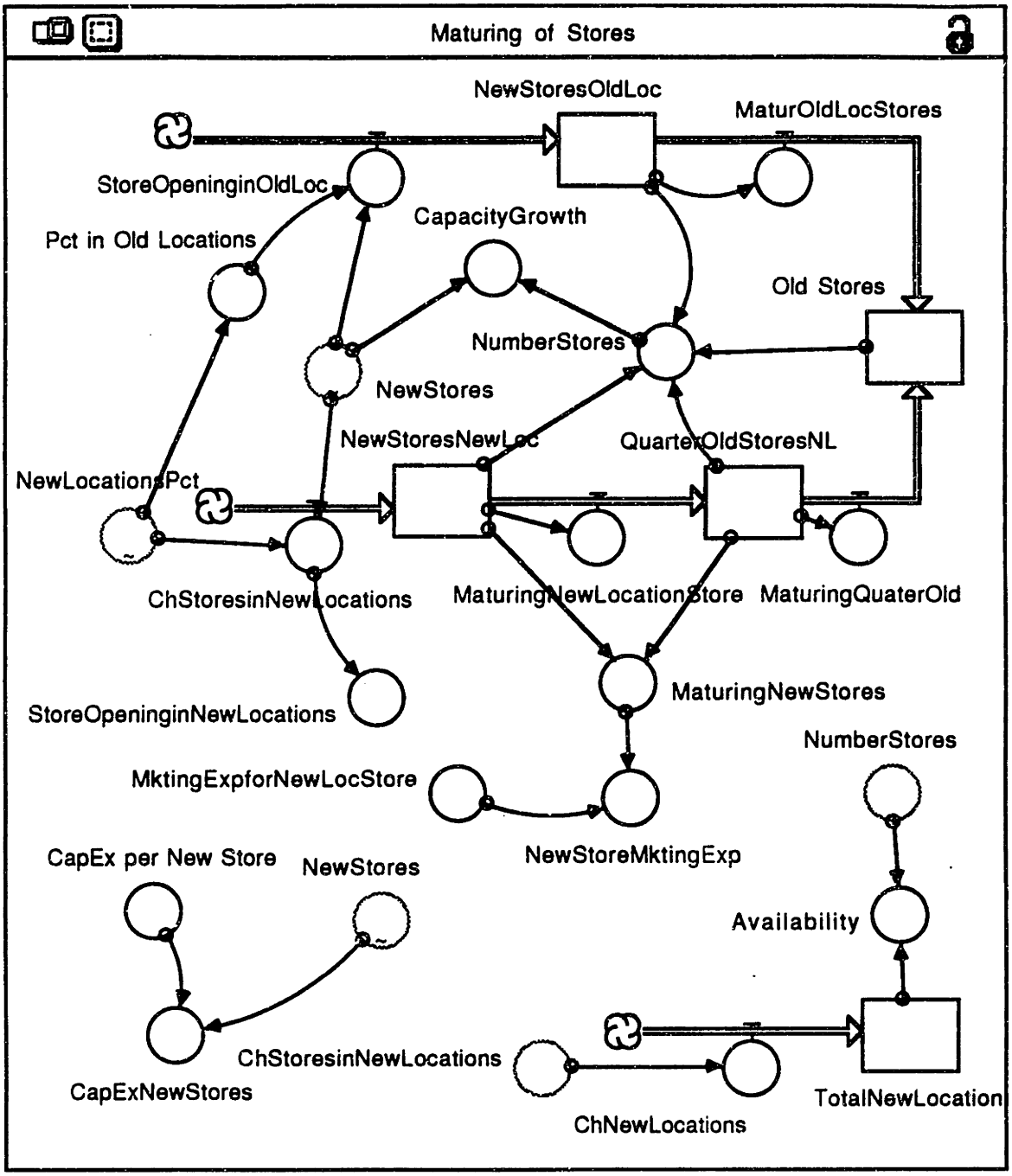

Figure 18: Maturing of Stores

New stores go through an introduction period with increased expenses as modelled in figure 18. New stores in old locations take one quarter to get up to speed, while new stores in new locations take two quarters to get up to speed. New stores in new locations

induce an increased marketing expense in the form of promotional marketing. Capital expenditures are an average expenditure per new store times the total number of new stores. The availability index increases with geographical coverage. In the order of 500 stores where approximately half are in new locations yields an availability index of one. The availability index indicates the market effect of a superior relative attractiveness of the merchandise (see figure 14).

The quarterly cash flow statement can be found in figure 19. Net cash from operations are net income + depreciation + decrease in accounts receivable + decrease in inventory + increase in accounts payable. The net income to sales ratio is calculated for output reporting.

Cash flow to investments consists of capital expenditures. This involves the expenditures financed by debt and equity. Leasing is not reported in the figures.

Cash from financing is the net new debt plus proceeds from equity issuance.

All cash flows are totalled in the variable TotalIncrCash.

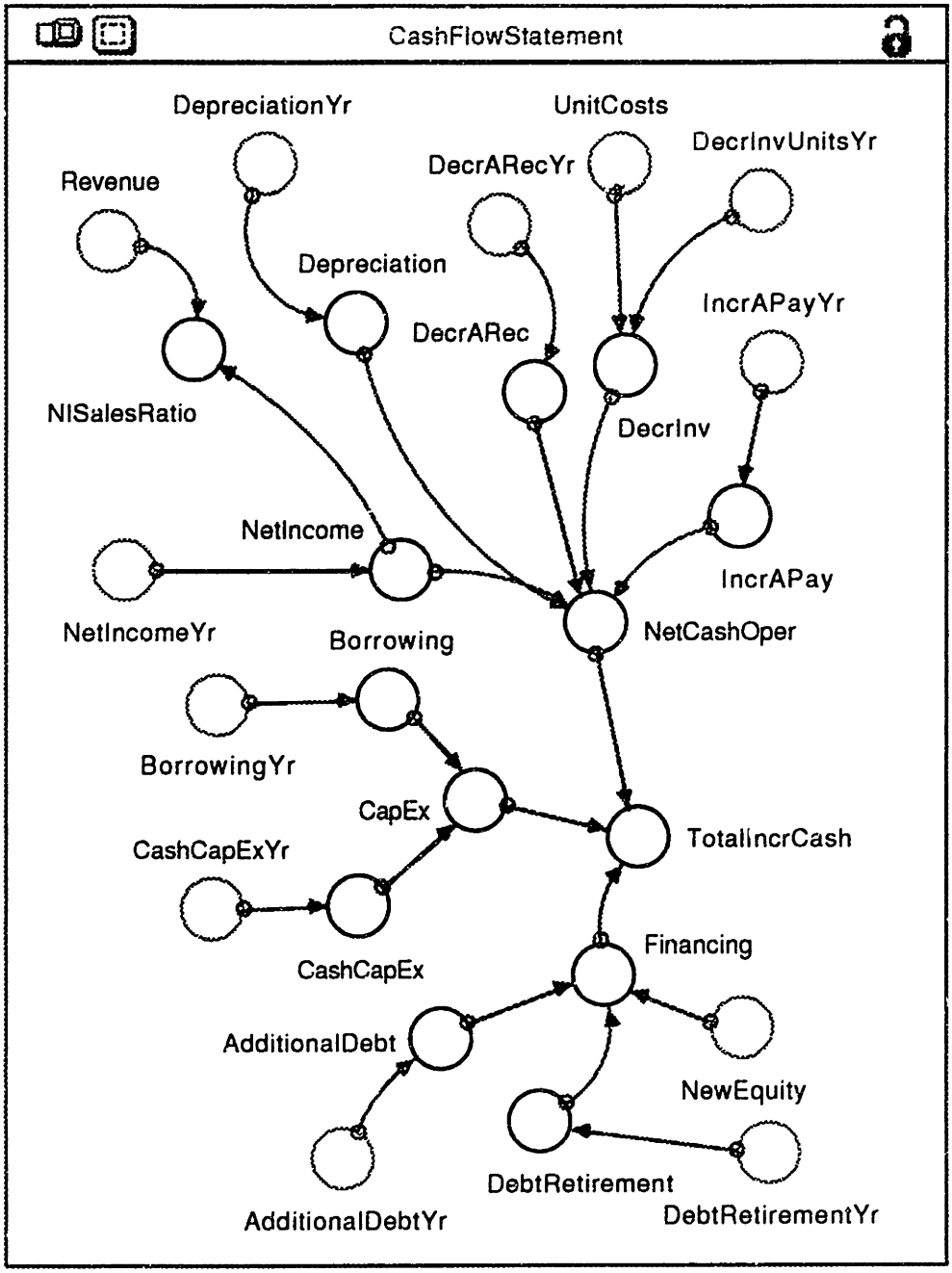

Figure 19: Cash Flow Statement

As a measurement of the success rate of management, the market value of the firm is reported in output. The calculation is illustrated in figure 20. The market value is the number of outstanding shares times the share price.

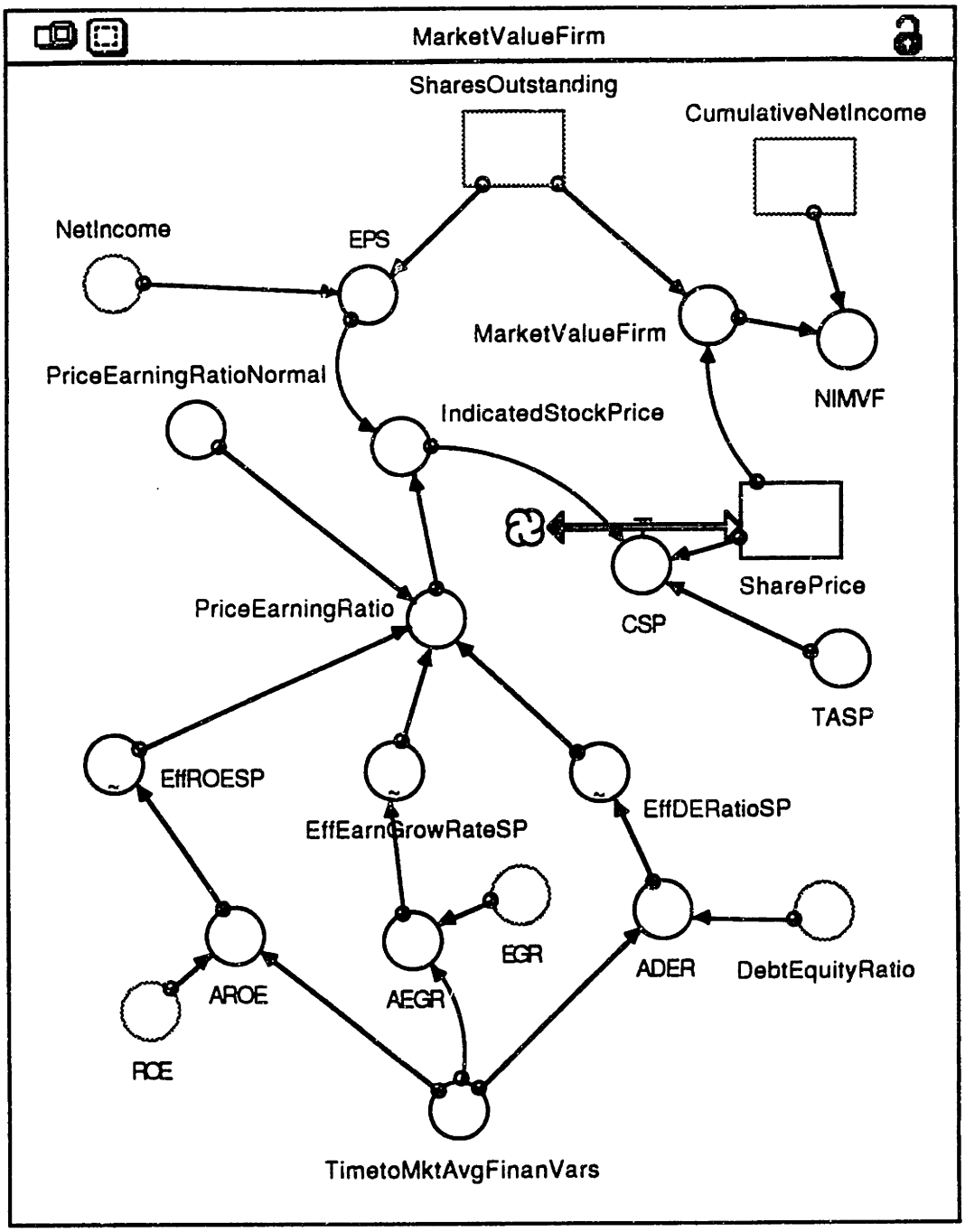

Figure 20: Market Value of Firm

The share price is constructed on the basis of a time-lagged indicated stock price which calculates as price earnings ratio times earnings per share (EPS). The price earnings ratio is the normal market price earnings ratio of 10 increased by growth rate potential (AEGR)

adjusted for average return on equity (AROE) and average debt equity ratio (ADER).

For output purposes the cumulative net income is added to the market value of the firm in the variable NIMVF.

Finally, the model includes an input display providing a base case scenario. This is shown in figure 21. The base case will suggest values to all input parameters during model execution.

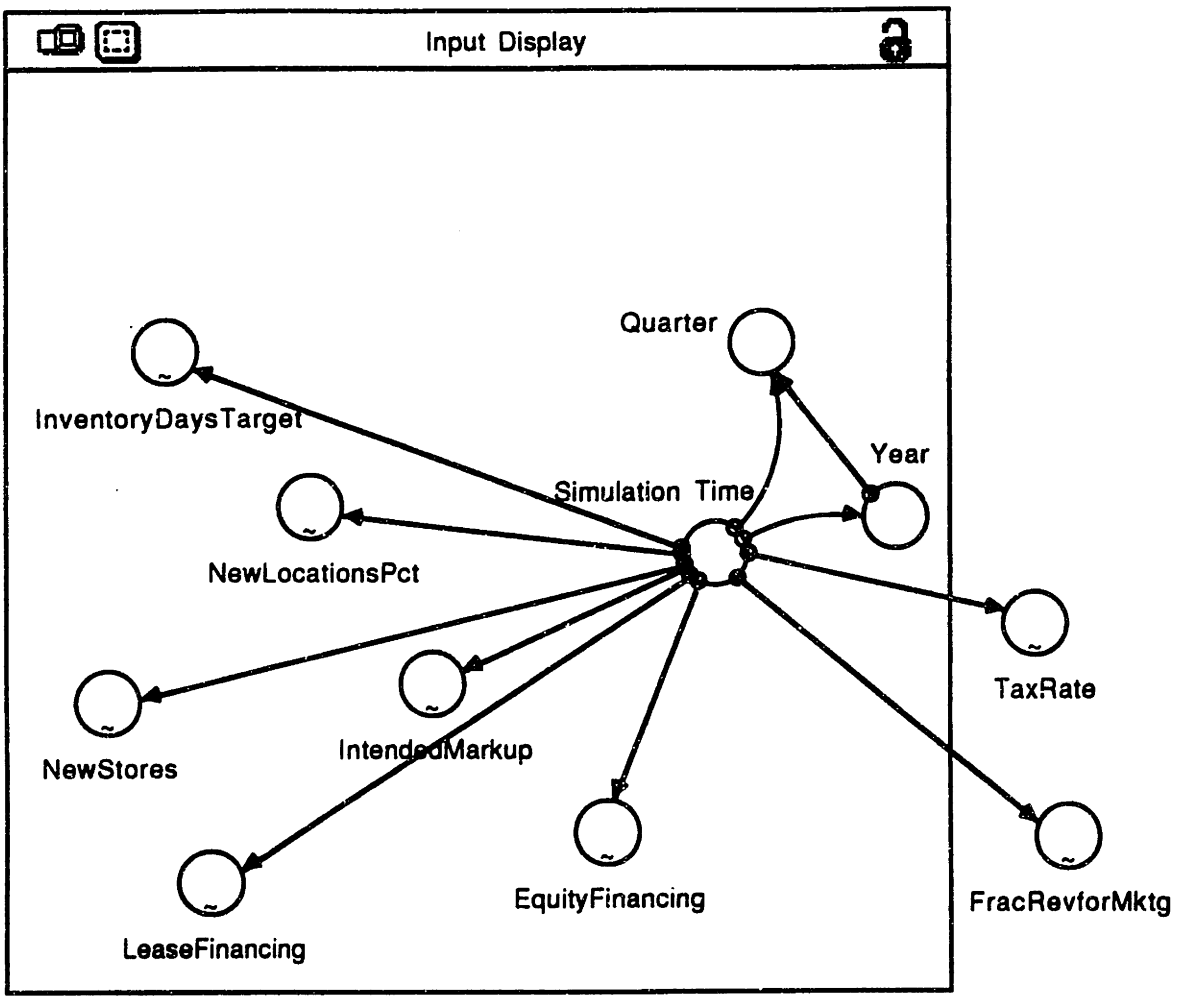

Figure 21: Input to model

4.2 Parameter Choices

Since the model is so large and complex that it would be too extensive to go into all parameter choices, I will only go into the key parameters. I will go through the figures 7 through 21 as presented above.

All prices are in 1986 terms. Throughout the program I ignore inflation, which makes it easier to compare results from different quarters.

In figure 7, the company's buildings, furniture, fixtures and equipment are depreciated using the straight-line method over the estimated useful lives of the assets. Improvements to leased premises are amortized on the straight-line method over the life of the lease or the useful life of the improvement, whichever is shorter. The Company's property and equipment is depreciated using the following estimated useful lives:

	Life
Buildings	20-45 years
Furniture, fixtures and equipment	5-20 years
Leasehold improvements	8-25 years

The cost in excess of the fair value of net assets acquired is being amortized on a straight-line basis over 40 years. The cost of purchased software and associated consulting fees is amortized on a straight-line basis over periods ranging from three to five years. I have calculated an average useful life of 11 years on the basis of the 1985 annual report.

The accounts receivable delay is one quarter. The accounts payable delay is also one quarter.

Initial values for all stocks are taken from the annual report from 1985. The tax rate is a

constant 46% over the time period.

I consider all highly liquid investments purchased with a maturity of three months or less to be cash equivalents.

Figure 8's transaction costs for issuance of new equity is estimated at 2%, while lease overhead is assessed to 225%. This means that the total payments on the lease will be 3.25 times the cost when financed by cash. The lease term is 20 years.

Beta of equity is 1.3 and beta of debt is .2 in figure 9.

The opening expense per new store in figure 12 is $1.8 million which primarily consist of inventory investment and training. Administration costs per store amounts to $15,000 per quarter. Average salary per store is $120,000 per quarter.

Distribution and inventory carrying costs in figure 13 are $ 1.00 per unit per quarter.

In figure 14 the initial market share is the estimated market share of 1.00% from the 1985 annual report.

Site acquisition and construction for a new store, as represented in figure 18, required $6.6 million in 1986.

Finally, the time for the market to react to financial information in figure 20 is set to one quarter. This is relatively slow because of imperfections in information flow.

Total market size in numbers of purchases is given in the market analysis, and is not a part of the modeling.

5 Test of System Dynamics Model

Key words: Test, Borderline Cases and Reliability.

Do you not know there comes a midnight hour when
everyone has to throw off his mask?
Do you think you can slip away a little before
midnight in order to avoid this?
Søren Kierkegaard 1813-1855

The general approach to testing a software program is that the code must be MECE — Mutually Exclusive and Collectively Exhaustive. However, in this case we are not looking at a rocket control system, but at a management flight simulator. This results in the following three phased test strategy:

- User test
- External test
- Internal test

A user test consists of a few runs using realistic user data. Its purpose is to check that the software reacts sensibly to the user interaction at the very top level. This stage was completed without problems.

The external test is more rigorous. In the external test, borderline cases of inputs are tried in a controlled combinatory experiment where predictions of the outputs are tested. I performed several hundred tests without discovering any flaws or being surprised by the software.

An internal test is extremely thorough. The basic idea is to test all parts of the software under borderline cases and to follow all flows of data and program executing within the software. I only performed this on the most complex parts of the software. Here I did find

some inefficiencies. However, none were faults and the inefficiencies did not need corrective action.

I tested the model according to all of the above criteria and found it without significant errors or misrepresentations.

6 Construction of User Interface

Key words: User Interface, Friendliness, User Errors, Input and Output Windows.

Cogito, ergo sum.
René Descartes 1596-1650

Constructing the user interface is the most important part of the software development process. Indeed, I thought through the most important elements before even starting the programming. The user interface served as the communications link between software and the user and must prompt the user for input in an easily understandable way and represent all output distinct and legibly. As such I narrowed the criteria for the user interface down to the following properties:

- User friendliness
- Presentation of relevant reports and graphs
- Prompt for intuitively understandable parameters
- Detection of user errors

The most important property of any software program is its user friendliness. The software can be brilliantly programmed, solve previously unsolvable problems, be efficient and valuable in many ways, but if the user interface is less than perfect it will always diminish the potential user group. Also, it must be easy to get started using the software. This either requires previous knowledge of the users or easily read and informative manuals and tutorials.

The management flight simulator must present relevant reports and graphs of financial and market research data that are easy to access, read and understand.

Furthermore, the software must somehow prompt the user for input. It is easy to fool the user into providing useless or wrong data. This must be avoided at any cost. Prompts for intuitively understandable parameters are essential to usefulness of the software. If the user does not understand what data to provide and when, he or she will be likely to fulfill the GIGO (garbage in garbage out) inference.

Likewise, the input section of the user interface must be able to catch the worst user errors. For instance, the user should not be allowed to decide to finance 1.1 (110%) of his or her capital expenses with debt. If this kind of error can be caught before the simulator process them, response time for the program goes down. The user can immediately correct his or her error and try again.

All these criteria and properties make my choice of user interface easy. The Peoples' Express management flight simulator was programmed with the MicroWorld Creator™ user interface tool. Using this tool I can expect the users to have gone through the Peoples' Express exercise using the software and, thus, be familiar with the functions of the software. In this case, the introduction to the game can be done by assigning the Harvard Business School case and make a short briefing that enhances the differences between the two management flight simulators.

6.1 Input and Output Windows

Having chosen the user interface software development tool the interface is almost defined. In any case the user will be faced with a cockpit as in figure 22. The cockpit consists of three parts. The top part labeled decisions is the input window. The middle and bottom part designated reports and graphs are output variables.

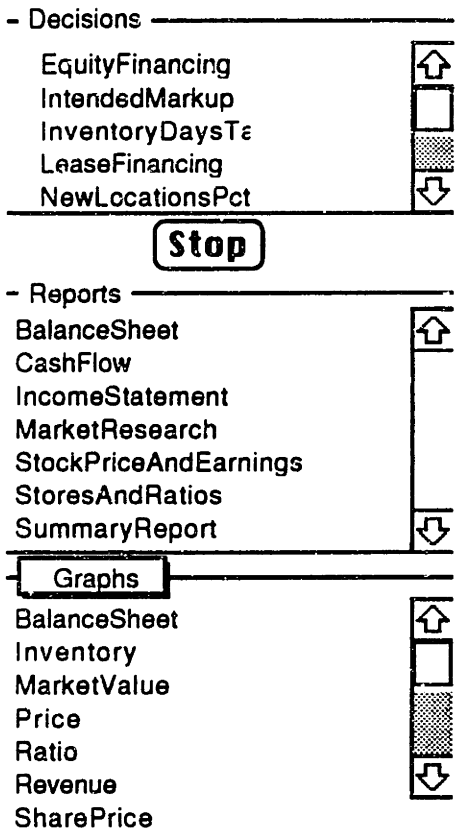

Figure 22: Management Flight Simulator Cockpit

In the input window the user can scan back and forward using the white bar and arrows on the right side of the box. In the box we have six decision parameters of which only five can be seen at any time. The six parameters are:

- Equity financing
- Intended markup
- Inventory days target
- Lease financing

- New locations percentage
- New stores

"Equity financing" denotes the fraction of financing for capital expenses that comes from issuance of new equity.

"Intended markup" identifies the target average markup on gross profit. As is the case in most organizations, the target markup is not necessarily the same as the actual markup. Furthermore, there is a time delay in adjusting the markup.

"Inventory days target" labels the current target for average days in inventory. This is very difficult to adjust in real life operations and the time lagged effect is an important part of the total effect from this parameter.

"Lease financing" is the fraction of financing for capital expenses that comes from leasing instead of buying.

"New locations percentage" specifies the percentage of new stores opened in the next quarter that will be outside Home Depot's home area.

"New stores" designates the total number of stores to be opened within the next quarter.

The output windows in figure 22 shows balance sheets, cash flows, income statements, market research, stock price, earnings, store information, financial ratios and a summary report. The actual structure of the output reports can be found in appendix 2.

7 Conclusion

God keeps me from ever completing anything.
This whole book is but a draft — nay, but
the draft of a draft. Oh, Time, Strength,
Cash and Patience.
Herman Melville 1819-1891

I have presented the development of a functioning management flight simulator for the Home Depot, which covers the most important aspects of the Harvard Business School (HBS) case by Palepu [Pale88]. The simulator can function as one of the basic elements in teaching the lessons of growth and cash flow constraints that can be observed in the expansion of Home Depot. However, I believe that the way the model was constructed and the most important parameter and modeling choices should be presented after the simulation (game playing) session, since the model after all only represents a subjective view on the case, the lessons and the company.

Rules are for the obedience of fools
and guidance of wise men.
Unknown

I have presented what I believe to be the main features of interest from the development, with brief commentaries on their relevance, usefulness, and completeness. This report may be used as a teacher's introduction to the model.

However, the report is too extensive and too technical to have value as introductory reading to a class that will use the model.

The model does not cover all aspects of Home Depot. Personnel, for instance, is not treated in detail, but made implicit in the number of stores. Therefore, the model will not reflect reality to detail. Nevertheless, or rather because of its simplicity, the model illustrates the lessons.

The method of model development has allowed me to fairly reflects the lessons of Home Depot. The method resulted in stepwise refinements from a simple representation until all important aspects of Home Depot were included in the model. The parameter choices were made based on analysis of financial statements, market research and the HBS case. At the same time, the focus of the representation was to illustrate the lessons in a simple environment rather than to simulate reality in detail. More time would allow me both to illustrate the lessons and to more precisely simulate the real-life situation.

I will continue to work on a tutorial guide to the management flight simulator with Dr. Paul Healy. This will allow him and other interested professors to use the simulator along with the case when teaching the lessons of Home Depot.

8 Postscript

Play it again Sam
Humphrey Bogart in "Casablanca"

Thus, the last report of the Master's Program in Management at Massachusetts Institute of Technology, the Master's Thesis itself has endeth.

In this thesis, I have tried to document an understanding of the main practical problems in implementing a management flight simulator, as required in the work description of the thesis.

But, beside this documentation the thesis has been interesting viewed from other criteria. It has been exciting to get insight into the receiver's perspective — to really appreciate how the users of the flight simulator might approach it.

Finally, I will point out that the writing of a thesis has, in a way that I think that even however many lectures cannot compare with, given me an insight into the problems in implementing educational simulation systems. Thereby, it has once again been proven that practice surpasses theory by far concerning efficient learning and educational value.

Opus est finis et nunc est bibendum.

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Appendices

Appendix 1: Ten Year Selected Financial and Operational Highlights

THE HOME DEPOT, INC. AND SUBSIDIARIES

Amounts in thousands, except where noted

	5 Year Annual Compound Growth Rate	10 Year Annual Compound Growth Rate
Statement of earnings data		
Net sales	38.4%	58.4%
Earnings before taxes	53.1	70.0
Net earnings	59.8	70.3
Net earnings per share ($)(2)	46.1	61.4
Weighted average number of shares(2)	9.1	6.9
Gross margin - % to sales	-	-
Store selling and operating - % to sales	-	-
Pre-opening - % to sales	-	-
General and administrative - % to sales	-	-
Net interest income (expense) - % to sales	-	-
Earnings before taxes - % to sales	-	-
Net earnings - % to sales	-	-
Balance sheet data and financial ratios		
Total assets	44.8%	64.9%
Working capital	46.9	60.5
Merchandise inventories	31.7	50.3
Net property and equipment	49.3	80.1
Long-term debt	18.3	53.4
Stockholders' equity	59.7	78.3
Book value per share ($)(2)	47.9	66.1
Long-term debt to equity - %	-	-
Current ratio	-	-
Inventory turnover	-	-
Return on average equity - %	-	-
Statement of cash flows data		
Depreciation and amortization	43.2%	76.7%
Capital expenditures	52.5	67.5
Cash dividends per share ($)(2)	-	-
Customer and store data		
Number of states	16.5%	22.3%
Number of stores	23.7	36.1
Square footage at year-end	27.8	41.6
Change in square footage - %	-	-
Average square footage per store	-	-
Number of customer transactions	33.9	54.3
Average sale per transaction ($)	3.4	2.7
Number of employees	33.5	45.7

	5 Year Annual Compound Growth Rate	10 Year Annual Compound Growth Rate
Other data		
Net sales increase - %	-	-
Average total company weekly sales	38.4%	58.4%
Weighted average weekly sales per operating store	12.3	13.0
Comparable store sales increase - %(3)	-	-
Weighted average sales per square foot ($)(3)	8.6	8.6
Advertising expense - % to sales	-	-

	1991	1990(1)
Statement of earnings data		
Net sales	$5,136,674	$3,815,356
Earnings before taxes	396,120	259,828
Net earnings	249,150	163,428
Net earnings per share ($)(2)	1.20	.90
Weighted average number of shares(2)	207,999	181,253
Gross margin - % to sales	28.1	27.9
Store selling and operating - % to sales	18.1	18.2
Pre-opening - % to sales	.3	.4
General and administrative - % to sales	2.3	2.4
Net interest income (expense) - % to sales	.3	(.1)
Earnings before taxes - % to sales	7.7	6.8
Net earnings - % to sales	4.8	4.3
Balance sheet data and financial Ratios		
Total assets	$2,510,292	$1,639,503
Working capital	623,937	300,867
Merchandise inventories	662,257	509,022
Net property and equipment	1,254,774	878,730
Long-term debt	270,575	530,774
Stockholders' equity	1,691,212	683,402
Book value per share ($)(2)	8.01	3.86
Long-term debt to equity - %	16.0	77.7
Current ratio	2.17:1	1.73:1
Inventory turnover	6.1x	6.0x
Return on average equity - %	18.5	27.6
Statement of cash flows data		
Depreciation and amortization	$ 52,283	$ 34,358
Capital expenditures	432,198	400,205
Cash dividends per share ($)(2)	.11	.07
Customer and store data		
Number of states	15	12
Number of stores	174	145
Square footage at year-end	16,480	13,278
Change in square footage - %	24.1	27.4
Average square footage per store	95	92
Number of customer transactions	146,221	112,464
Average sale per transaction ($)	35.13	33.92
Number of employees	28,000	21,500

	1991	1990(1)
Other data		
Net sales increase - %	34.6	38.3
Average total company weekly sales	$ 98,782	$ 71,988
Weighted average weekly sales per operating store	633	566
Comparable store sales increase - %(3)	11	10
Weighted average sales per square foot ($)(3)	348	322
Advertising expense - % to sales	.7	.9

	1989	1988	1987
Statement of earnings data			
Net sales	$2,758,535	$1,999,514	$1,453,657
Earnings before taxes	182,015	125,833	95,586
Net earnings	111,954	76,753	54,086
Net earnings per share ($)(2)	.63	.44	.33
Weighted average number of shares(2)	177,705	172,988	161,981
Gross margin - % to sales	27.8	27.0	27.8
Store selling and operating - % to sales	18.3	17.8	18.1
Pre-opening - % to sales	.3	.4	.3
General and administrative - % to sales	2.5	2.4	2.6
Net interest income (expense) - % to sales	(.1)	(.1)	(.2)
Earnings before taxes - % to sales	6.6	6.3	6.6
Net earnings - % to sales	4.1	3.8	3.7
Balance sheet data and financial ratios			
Total assets	$1,117,534	$ 699,179	$ 528,270
Working capital	273,851	142,806	110,621
Merchandise inventories	381,452	294,274	211,421
Net property and equipment	514,440	332,416	244,503
Long-term debt	302,901	107,508	52,298
Stockholders' equity	512,129	382,938	320,559
Book value per share ($)(2)	2.97	2.26	1.93
Long-term debt to equity - %	59.1	28.1	16.3
Current ratio	1.94:1	1.74:1	1.75:1
Inventory turnover	5.9x	5.8x	5.4x
Return on average equity - %	25.2	21.6	21.1
Statement of cash flows data			
Depreciation and amortization	$ 21,107	$ 14,673	$ 10,646
Capital expenditures	204,972	105,123	89,235
Cash dividends per share ($)(2)	.05	.03	.02

	1989	1988	1987
Customer and store data			
Number of states	12	10	8
Number of stores	118	96	75
Square footage at year-end	10,424	8,216	6,161
Change in square footage - %	26.9	33.4	27.6
Average square footage per store	88	86	82
Number of customer transactions	84,494	64,227	48,073
Average sale per transaction ($)	32.65	31.13	30.24
Number of employees	17,500	13,000	9,100
Other data			
Net sales increase - %	38.0	37.6	43.7
Average total company weekly sales	$ 53,049	$ 38,452	$ 27,955
Weighted average weekly sales per operating store	515	464	418
Comparable store sales increase - %(3)	13	13	18
Weighted average sales per square foot ($)(3)	303	282	265
Advertising expense - % to sales	1.1	1.5	2.0

	1986	1985	1984(1)
Statement of earnings data			
Net sales	$1,011,462	$700,729	$432,779
Earnings before taxes	47,073	11,619	26,252
Net earnings	23,873	8,219	14,122
Net earnings per share ($)(2)	.18	.06	.11
Weighted average number of shares(2)	134,562	127,817	128,093
Gross margin - % to sales	27.5	25.9	26.4
Store selling and operating - % to sales	18.7	19.2	17.2
Pre-opening - % to sales	.3	1.1	.4
General and administrative - % to sales	2.7	2.9	3.0
Net interest income (expense) - % to sales	(1.1)	(1.2)	.3
Earnings before taxes - % to sales	4.7	1.7	6.1
Net earnings - % to sales	2.4	1.2	3.3
Balance sheet data and financial ratios			
Total assets	$ 394,741	$380,193	$249,364
Working capital	91,076	106,451	100,110
Merchandise inventories	167,115	152,700	84,046
Net property and equipment	168,981	160,816	73,577
Long-term debt	116,907	199,943	117,942
Stockholders' equity	163,042	89,092	80,214
Book value per share ($)(2)	1.13	.70	.63
Long-term debt to equity - %	71.7	224.0	147.0
Current ratio	1.85:1	2.27:1	3.22:1
Inventory turnover	4.6x	4.1x	4.2x
Return on average equity - %	20.3	9.7	19.3

	1986	1985	1984(1)
Statement of cash flows data			
Depreciation and amortization	$ 8,697	$ 5,193	$ 2,368
Capital expenditures	52,363	99,767	50,769
Cash dividends per share ($)(2)	-	-	-
Customer and store data			
Number of states	7	7	6
Number of stores	60	50	31
Square footage at year-end	4,828	4,001	2,381
Change in square footage - %	20.6	68.0	64.3
Average square footage per store	80	80	77
Number of customer transactions	34,020	23,324	14,256
Average sale per transaction ($)	29.73	30.04	30.36
Number of employees	6,600	5,400	4,000
Other data			
Net sales increase - %	44.3	61.9	68.9
Average total company weekly sales	19,451	$ 13,476	$ 8,166
Weighted average weekly sales per operating store	355	343	366
Comparable store sales increase - %(3)	7	2	14
Weighted average sales per square foot ($)(3)	230	223	247
Advertising expense - % to sales	2.4	3.2	2.5

	1983	1982
Statement of earnings data		
Net sales	$256,184	$117,645
Earnings before taxes	18,986	9,870
Net earnings	10,261	5,315
Net earnings per share ($)(2)	.08	.05
Weighted average number of shares(2)	125,724	112,557
Gross margin - % to sales	27.3	28.4
Store selling and operating - % to sales	17.0	16.5
Pre-opening - % to sales	.9	.4
General and administrative - % to sales	2.9	3.3
Net interest income (expense) - % to sales	.9	.2
Earnings before taxes - % to sales	7.4	8.4
Net earnings - % to sales	4.0	4.5

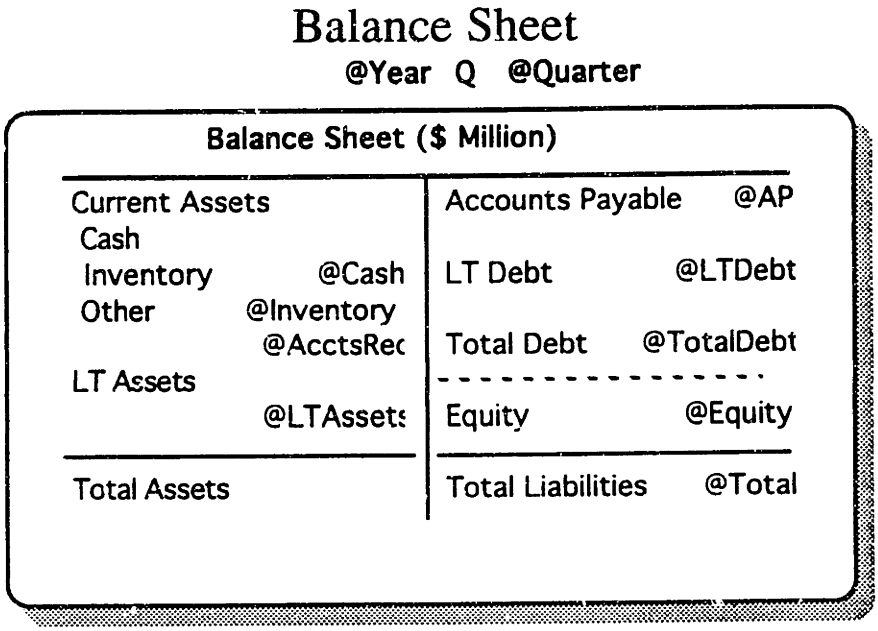
	1983	1982
Balance sheet data and financial ratios		
Total assets	$105,230	$ 33,014
Working capital	49,318	12,901
Merchandise inventories	58,712	17,575
Net property and equipment	21,129	5,954
Long-term debt	4,384	236
Stockholders' equity	65,278	18,354
Book value per share ($)(2)	.52	.32
Long-term debt to equity - %	6.7	1.3
Current ratio	2.43:1	1.92:1
Inventory turnover	4.9x	5.8x
Return on average equity - %	24.5	45.1
Statement of cash flows data		
Depreciation and amortization	$ 903	$ 389
Capital expenditures	16,081	2,883
Cash dividends per share ($)(2)	-	-
Customer and store data		
Number of states	4	2
Number of stores	19	10
Square footage at year-end	1,449	696
Change in square footage - %	108.2	37.3
Average square footage per store	76	70
Number of customer transactions	8,479	4,164
Average sale per transaction ($)	30.21	28.25
Number of employees	2,400	1,100
Other data		
Net sales increase - %	117.8	128.3
Average total company weekly sales	$ 4,927	$ 2,262
Weighted average weekly sales per operating store	360	281
Comparable store sales increase - %(3)	31	47
Weighted average sales per square foot ($)(3)	245	210
Advertising expense - % to sales	2.9	2.6

(1) Fiscal years 1990 and 1984 consisted of 53 weeks, all other years reported consisted of 52 weeks.

(2) All per share and share data have been adjusted for a three-for-two stock split-up effected in the form of a dividend in June 1991.

(3) Adjusted to reflect the first 52 weeks of the 53-week fiscal year in 1990.

Appendix 2: Output Reports from the User Interface



Cash Flow Statement

@Year Q @Quarter

Cash Flow Statement ($ Million/Quarter)	
Net Earnings	@NetIncome
Depreciation	@Depreciation
Decr. Receivables	@DecrARec
Decr. Inventory	@DecrInv
Incr. Payables	@IncrAPay
Cash from Operations	@NetCashOper
Capital Expenses	@CapEx
Cash from Investment	@CapEx
Long Term Borrowing	@AdditionalDebt
Principal Repayment	@DebtRetirement
Proceed from C/S Sales	@NewEquity
Cash from Financing	@Financing
Total Incr. in Cash	@TotalIncrCash

Income Statement

@Year Q @Quarter

Income Statement ($ Million/Quarter)	
Revenues	@Revenue
COGS	@COGS
Gross Profit	@GrossProfit
SGA	@SGA
Marketing	@MarketingExp
Leasing	@LeasingExp
Depreciation	@Depreciation
Interest	@InterestExp
EBIT	@EBIT
Tax	@Tax
Net Income	@NetIncome

Market Research

@YearQ @Quarter

	Home Depot	Competitors
Price ($/purchase)	@Price	@CompetitorPrice
Reported Service Quality	@SerQ	1.00

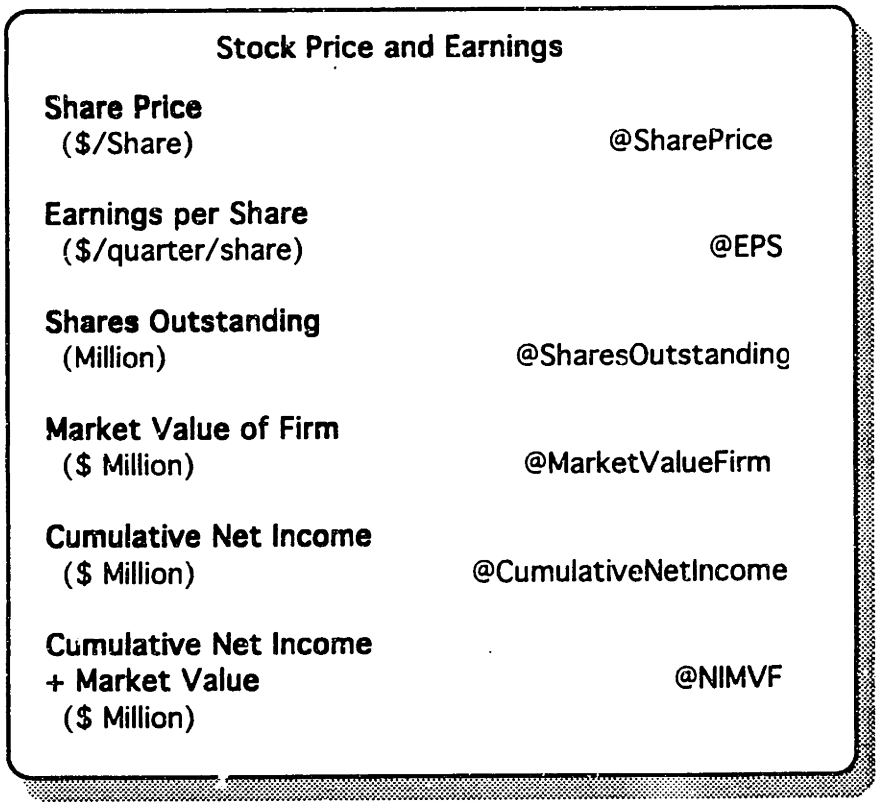
Home Depot Revenue Growth Rate (%/quarter) @RevenueGrowth

Market Share (Fraction) @MarketShare

Marketing Expenditures ($ Million/quarter) @MarketingExp

Stock Price and Earnings

@Year Q @Quarter

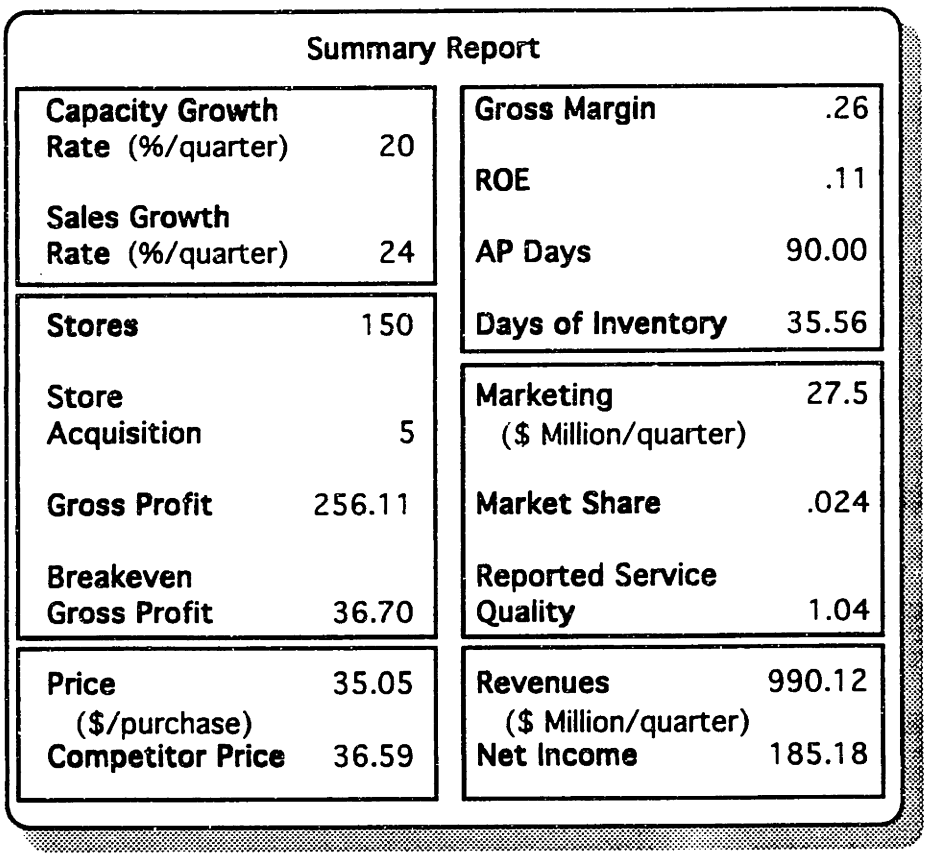


Stores and Ratios

	@YearQ @Quarter
Stores	@NumberStores
Store Opening (New Stores/Quarter)	@NewStores
New Stores in New Areas	@StOpenNewLo
Inventory ($ Millions)	@Inventory
Days in Inventory	@InventoryDays
Cost of Store Operations ($ Millions/Quarter)	@StoreOperExp
Accounts Payable Days	@APDays
Gross Margin	@GrossMargin
Sales/Assets	@SalesAssetRatic
ROE	@ROE
Net Income/Sales	@NISalesRatio

Summary Report

1994 Q 3



Appendix 3: Import File for MicroWorld Creator™

```
; This is the equation file for the Home Depot Management Flight Simulator system using
  equations written with iThink™ (a trademark of High Performance Systems) (v. 4)
;
; Copyright ©1993 by Daniel Eide Jousen.
;
; Equations
;
FORMAT %8.2          ;two decimals
;
insert ITHINK "equations19"
;
; Input Section
;
D NewStores
BL NewStores = 0 ;Lower bound

D NewLocationsPct
BL NewLocationsPct = 0 ;Lower bound
BU NewLocationsPct = 1 ;Upper bound

D LeaseFinancing
BL LeaseFinancing = 0 ;Lower bound
BU LeaseFinancing = 1 ;Upper bound

D EquityFinancing
BL EquityFinancing= 0 ;Lower bound
BU EquityFinancing = (1 - LeaseFinancing) ;Upper bound

D IntendedMarkup
BL IntendedMarkup= -0.5 ;Lower bound
BU IntendedMarkup= 2 ;Upper bound

D InventoryDaysTarget
BL InventoryDaysTarget = 30 ;Lower bound
BU InventoryDaysTarget = 90 ;Upper bound

;DL "Decisions"
;C minProd = 0
;C maxProd = 1000
;D Production
;BL Production = minProd
;BU Production  = maxProd

;DL "Permanent Decisions"
;DP InitInventory
;
```

```
; Output Section

P Price = []Price, Competitorprice
P Stores = [0,90]NewStores, NumberStores
P Inventory = []InventoryDaysTarget, InventoryDays
P Revenue = []Revenue []NetIncome
P BalanceSheet = [0,200]Cash, LTAssets / LongTermAssets, AcctsPayable, LTDebt /
  LongTermDebt, Equity
P Ratio = [0,0.5]SalesAssetRatio [0,.2]ROE, NISalesRatio / NetIncomeSalesRatio
P SharePrice = [0,10]SharePrice
P MarketValue = [0,50]MarketValueFirm, CumulativeNetIncome, NIMVF /
  CumulativeNetIncomeAndMarketValueFirm

FORMAT %4.0 Year, Quarter, NewStores, NumberStores,
  StoreOpeningInNewLocations, RevenueGrowth,CapacityGrowth, APDays,
  InventoryDays, InventoryDaysTarget        ;Integer
FORMAT %0.3 MarketShare          ;Three Digit Fraction
```

Appendix 4: Ithink™ Equations

CashFlows in Balance Sheet

AcctsPayable(t) = AcctsPayable(t - dt) + (Ch_AP - AP_Payment) * dt
INIT AcctsPayable = 32.356 { Accounts Payable ($Millions) }
INFLOWS:
Ch_AP = Pulse(Expenses+Tax,0,.25) {Change in Accounts Payable ($Millions/qtr)}
OUTFLOWS:
AP_Payment = Pulse(APPayments/4,0,.25) { Accounts Payable Payment ($Millions/qtr) }

AcctsRec(t) = AcctsRec(t - dt) + (Ch_AR - AR_Collected) * dt
INIT AcctsRec = 9.365 {Accounts Receivable ($Millions) }
INFLOWS:
Ch_AR = Pulse(FracCreditSales*Revenue,0,.25) {Increase in Accounts Receivable ($Millions/qtr) }
OUTFLOWS:
AR_Collected = Pulse(AcctsRec/ARColDelay,0,.25) {Accounts Receivable Collected ($Millions/qtr) }

Cash(t) = Cash(t - dt) + (Collections + FinancingYr - APPayments - CashCapExYr) * dt
INIT Cash = 52.062 { Cash Balance ($Millions) }
INFLOWS:
Collections = Pulse((AcctsRec/ARColDelay)+(FracCashSales*Revenue),0,.25) { Cash Collections ($Millions/qtr) }
FinancingYr = Pulse(NewEquity+AdditionalDebtYr-DebtRetirementYr,0,.25) {Net Cash from Financing ($Millions/qtr)}
OUTFLOWS:
APPayments = Pulse(MIN(AcctsPayable/APPayDelay,Cash),0,.25) { Cash Payments ($Millions/qtr) }
CashCapExYr = Pulse(MIN(NonLeaseFinancing,Cash),0,.25) {Capital Expenditures from Cash ($Millions/qtr)}

LTAssets(t) = LTAssets(t - dt) + (CashCapExYr + BorrowingYr - DepreciationYr) * dt
INIT LTAssets = 73.577 {Long Term Assets ($Millions)}
INFLOWS:
CashCapExYr = Pulse(MIN(NonLeaseFinancing,Cash),0,.25) {Capital Expenditures from Cash ($Millions/qtr)}
BorrowingYr = Pulse(MAX(NonLeaseFinancing-Cash,0),0,.25) {Capital Expenditures from Borrowing ($Millions/qtr)}
OUTFLOWS:
DepreciationYr = Pulse(LTAssets/AvgAssetLife,0,.25) {Depreciation ($Millions/qtr)}

```
LTDebt(t) = LTDebt(t - dt) + (AdditionalDebtYr - DebtRetirementYr) * dt
  INIT LTDebt = 117.942 { Long Term Debt ($Millions) }
        INFLOWS:
        AdditionalDebtYr = Pulse(BorrowingYr,0,0.25) { Additional Debt ($Millions/qtr)
        }
        OUTFLOWS:
        DebtRetirementYr = Pulse(LTDebt/DebtTerm,0,.25) { Debt Retirement
        ($Millions/qtr) }

APDays = AcctsPayable/AP_Payment*360 {Average Accounts Payable Days}
APPayDelay = 1 { Accounts Payable Delay (qtr) }
ARColDelay = 1 {Accounts Receivable Delay (qtr)}
AvgAssetLife = 73577000/7813000*4 {Average Asset Life (years)}
DebtTerm = 20 { Average Term of Debt (qtrs) }
DecrARecYr = AR_Collected-Ch_AR {Net Decrease in Accounts Receivables
  ($Millions/qtr)}
FracCashSales = 1-(15799000-7170000)/(700729000-432779000) { Faction of Cash
  Sales (dimensionless)}
FracCreditSales = 1-FracCashSales{Fraction of Credit Sales (dimensionless) }
IncrAPayYr = Ch_AP-AP_Payment {Increase in Accounts Payable ($Millions/qtr)}
InterestExp = LTDebt*WACC {Interest Expense ($Millions/qtr) }
```

CashFlowStatement

```
AdditionalDebt = AdditionalDebtYr/4 { Additional Debt ($Millions/qtr) }
Borrowing = BorrowingYr/4 {Capital Expenditures from Borrowing ($Millions/qtr)}
CapEx = CashCapEx+Borrowing {Capital Expenses ($Millions/qtr)}
CashCapEx = CashCapExYr/4 {Capital Expenditures from Cash ($Millions/qtr)}
DebtRetirement = -DebtRetirementYr/4 { Debt Retirement ($Millions/qtr) }
DecrARec = DecrARecYr/4 {Decrease in Accounts Receivables ($Millions/qtr)}
DecrInv = DecrInvUnitsYr*UnitCosts/4 {Decrease in Inventory ($Millions/qtr)}
Depreciation = DepreciationYr/4 {Depreciation ($Millions/qtr)}
Financing = AdditionalDebt+DebtRetirement+NewEquity {Financing ($Millions/qtr)}
IncrAPay = IncrAPayYr/4 {Increase in Accounts Payables ($Millions/qtr)}
NetCashOper = NetIncome+Depreciation+DecrARec+DecrInv+IncrAPay {Net Cash Flow
  from Operations ($Millions)}
NetIncome = NetIncomeYr/4 {Net Income ($Millions/qtr)}
NISalesRatio = NetIncome/Revenue {Net Income to Sales Ratio}
TotalIncrCash = NetCashOper+CapEx+Financing {Total Increment in Cash and Cash
  Equivalents ($Millions/qtr)}
```

CompetitorPricing

```
CompetitorPrice(t) = CompetitorPrice(t - dt) + (Change_in_Competitor_Price) * dt
  INIT CompetitorPrice = 50 {Competitor Price}
        INFLOWS:
        Change_in_Competitor_Price = Price-CompetitorPrice {Competitor price
        adjustment}
```

Equity

```
DebtAssetRatio = TotalDebt/TotalAssets {Debt Asset Ratio}
DebtEquityRatio = TotalDebt/Equity {Debt Equity Ratio}
Equity = TotalAssets-TotalDebt {Book Equity ($Millions)}
EquityAssetRatio = Equity/TotalAssets {Equity Asset Ratio}
```

Inventory = InventoryItems*UnitCosts {Value of Total Inventory ($Millions)}
ROE = NetIncome/Equity {Return on Equity}
SalesAssetRatio = Revenue/TotalAssets {Sales Asset Ratio}
TotalAssets = Cash+Inventory+AcctsRec+LTAssets {Total Assets ($Millions)}
TotalDebt = AcctsPayable+LTDebt {Liabilities ($Millions)}

Income Statement

CumulativeNetIncome(t) = CumulativeNetIncome(t - dt) + (NetIncomeYr) * dt
INIT CumulativeNetIncome = 0 { Cumulative Net Income ($Millions/qtr) }
INFLOWS:
NetIncomeYr = pulse(EBIT-Tax,0,.25) { Net Income ($Millions/qtr) annualized for pulzing }

COGS = UnitSales*UnitCosts {Cost of Goods Sold ($Millions/qtr)}
EBIT = Revenue-Expenses-DepreciationYr {EBIT ($Millions/qtr)}
EGR = 4*TREND(NetIncomeYr,4,0)
Expenses = COGS+SGA+InterestExp+MarketingExp+LeasingExp {expenses ($Millions/qtr)}
GrossMargin = GrossProfit/Revenue {Gross Margin}
GrossProfit = Revenue-COGS {($Millions/qtr)}
Revenue = Price*UnitSales {Revenue ($Millions/qtr) }
Tax = MAX(0,EBIT*TaxRate) {Tax Expense ($Millions/qtr)}

Input Display

Quarter = 4*(Simulation_Time-Year)+1 {Quarter}
Simulation_Time = TIME
Year = INT(Simulation_Time) {Year}
EquityFinancing = GRAPH(Simulation_Time { Capital Expenditures From Equity })
(1984, 0.25), (1984, 0.25), (1984, 0.25), (1985, 0.25), (1985, 0.25), (1985, 0.25), (1986, 0.25), (1986, 0.25), (1986, 0.25), (1986, 0.25), (1986, 0.25), (1987, 0.25), (1987, 0.25), (1987, 0.25), (1988, 0.25), (1988, 0.25), (1988, 0.25), (1988, 0.25), (1988, 0.25), (1989, 0.25), (1989, 0.25), (1989, 0.25), (1990, 0.25), (1990, 0.25), (1990, 0.2), (1990, 0.2), (1990, 0.2), (1991, 0.2), (1991, 0.2), (1991, 0.2), (1992, 0.2), (1992, 0.2), (1992, 0.2), (1992, 0.2), (1992, 0.2), (1993, 0.2), (1993, 0.2), (1993, 0.2), (1994, 0.2), (1994, 0.2), (1994, 0.2)
IntendedMarkup = GRAPH(Simulation_Time { Intended Markup on Costs of Sales })
(1984, 0.25), (1984, 0.25), (1984, 0.25), (1985, 0.25), (1985, 0.25), (1985, 0.25), (1986, 0.25), (1986, 0.25), (1986, 0.25), (1986, 0.25), (1986, 0.25), (1987, 0.25), (1987, 0.25), (1987, 0.25), (1988, 0.25), (1988, 0.25), (1988, 0.25), (1988, 0.25), (1988, 0.25), (1989, 0.25), (1989, 0.25), (1989, 0.25), (1990, 0.25), (1990, 0.25), (1990, 0.25), (1990, 0.25), (1990, 0.25), (1991, 0.25), (1991, 0.3), (1991, 0.3), (1992, 0.3), (1992, 0.3), (1992, 0.3), (1992, 0.3), (1992, 0.3), (1993, 0.3), (1993, 0.3), (1993, 0.3), (1994, 0.3), (1994, 0.3), (1994, 0.3)
InventoryDaysTarget = GRAPH(Simulation_Time {Target inventory days})
(1984, 30.0), (1984, 30.0), (1984, 30.0), (1985, 30.0), (1985, 30.0), (1985, 30.0), (1986, 30.0), (1986, 30.0), (1986, 30.0), (1986, 30.0), (1986, 30.0), (1987, 30.0), (1987, 30.0), (1987, 30.0), (1988, 30.0), (1988, 30.0), (1988, 30.0), (1988, 30.0), (1988, 30.0), (1989, 30.0), (1989, 30.0), (1989, 30.0), (1990, 30.0), (1990, 30.0), (1990, 30.0), (1990, 30.0), (1990, 30.0), (1991, 30.0), (1991, 30.0), (1991, 30.0), (1992, 30.0), (1992, 30.0), (1992, 30.0), (1992, 30.0), (1992, 30.0), (1993, 30.0), (1993, 30.0), (1993, 30.0), (1994, 30.0), (1994, 30.0), (1994, 30.0)

LeaseFinancing = GRAPH(Simulation_Time { Capital Expenditures From Leases })
(1984, 0.25), (1984, 0.25), (1984, 0.25), (1985, 0.25), (1985, 0.25), (1985, 0.25), (1986, 0.25), (1986, 0.25), (1986, 0.25), (1986, 0.25), (1986, 0.25), (1987, 0.25), (1987, 0.25), (1987, 0.25), (1988, 0.25), (1988, 0.25), (1988, 0.25), (1988, 0.25), (1988, 0.25), (1989, 0.25), (1989, 0.25), (1989, 0.25), (1990, 0.25), (1990, 0.25), (1990, 0.25), (1990, 0.25), (1990, 0.25), (1991, 0.25), (1991, 0.25), (1991, 0.25), (1992, 0.25), (1992, 0.25), (1992, 0.27), (1992, 0.27), (1992, 0.27), (1993, 0.27), (1993, 0.27), (1993, 0.27), (1994, 0.27), (1994, 0.27), (1994, 0.27)

NewLocationsPct = GRAPH(Simulation_Time { Percentage of New Stores in New Locations })
(1984, 0.22), (1984, 0.22), (1984, 0.215), (1985, 0.215), (1985, 0.195), (1985, 0.15), (1986, 0.16), (1986, 0.55), (1986, 0.68), (1986, 0.795), (1986, 0.825), (1987, 0.88), (1987, 0.765), (1987, 0.705), (1988, 0.665), (1988, 0.62), (1988, 0.56), (1988, 0.48), (1988, 0.395), (1989, 0.3), (1989, 0.26), (1989, 0.21), (1990, 0.17), (1990, 0.165), (1990, 0.155), (1990, 0.155), (1990, 0.15), (1991, 0.12), (1991, 0.11), (1991, 0.105), (1992, 0.095), (1992, 0.095), (1992, 0.085), (1992, 0.065), (1992, 0.06), (1993, 0.06), (1993, 0.025), (1993, 0.02), (1994, 0.00), (1994, 0.00), (1994, 0.00)

NewStores = GRAPH(Simulation_Time { New stores decided to open per quarter })
(1984, 3.00), (1984, 3.00), (1984, 3.00), (1985, 3.00), (1985, 4.00), (1985, 5.00), (1986, 5.00), (1986, 5.00), (1986, 2.00), (1986, 2.00), (1986, 3.00), (1987, 3.00), (1987, 3.00), (1987, 4.00), (1988, 4.00), (1988, 4.00), (1988, 5.00), (1988, 5.00), (1988, 5.00), (1989, 6.00), (1989, 5.00), (1989, 5.00), (1990, 6.00), (1990, 6.00), (1990, 6.00), (1990, 7.00), (1990, 7.00), (1991, 7.00), (1991, 7.00), (1991, 7.00), (1992, 7.00), (1992, 8.00), (1992, 0.00), (1992, 0.00), (1992, 0.00), (1993, 1.00), (1993, 8.00), (1993, 8.00), (1994, 8.00), (1994, 8.00), (1994, 9.00)

Inventory

InventoryItems(t) = InventoryItems(t - dt) + (Replacement_Units - Sales_in_Units) * dt
INIT InventoryItems = 4 {Millions of Items in Inventory}
INFLOWS:
Replacement_Units = Reordering {Reorders (Millions Units)}
OUTFLOWS:
Sales_in_Units = Pulse(UnitSales,0,.25) {Unit Sales (Millions units/qtr)}

LastPeriodSales(t) = LastPeriodSales(t - dt) + (Sales_in_Units - PreviousSales) * dt
INIT LastPeriodSales = 2.4 {Last periods sales (Millions Units)}
INFLOWS:
Sales_in_Units = Pulse(UnitSales,0,.25) {Unit Sales (Millions units/qtr)}
OUTFLOWS:
PreviousSales = Pulse(LastPeriodSales,0,.25) {Previous Sales (Millions Units)}

DecrInvUnitsYr = Sales_in_Units-Replacement_Units {Decrease in Inventory Units Millions/qtr}

Distribution_and_Inventory_Carrying_Costs_per_unit = 1 {Distribution and Inventory Carrying Costs per unit ($/unit)}

DistrInvyCarryCosts = InventoryItems*Distribution_and_Inventory_Carrying_Costs_per_unit {Distribution and Inventory Carrying Costs ($Millions/qtr)}

Growth_in_Unit_Sales = Sales_in_Units/PreviousSales-1 {Growth in Unit Sales}

InventoryDays = InventoryItems/Sales_in_Units*360 {Average Days in Inventory}

Inventory_Days_Gap = InventoryDaysTarget/InventoryDays-1 { Place right hand side of equation here... }

```
Inv_Outflow = Sales_in_Units {Outflow Millions}
Reordering = Inv_Outflow*(1+1.5*Growth_in_Unit_Sales)*(1+Inventory_Days_Gap/2)
  {Reorders Millions}
UnitCosts = GRAPH(Reordering {Unit Costs ($/unit)})
  (0.00, 35.2), (10.0, 32.4), (20.0, 30.6), (30.0, 28.8), (40.0, 26.4), (50.0, 24.0),
  (60.0, 20.4), (70.0, 20.4), (80.0, 20.4), (90.0, 20.6), (100, 20.6)
```

Leasing and Equity

```
SharesOutstanding(t) = SharesOutstanding(t - dt) + (SharesIssued) * dt
  INIT SharesOutstanding = 1 {Million Shares Outstanding}
       INFLOWS:
       SharesIssued = NewEquity/SharePrice*(1-TransactionCost) {Millions Shares
       Issues}

TotalLeaseObligations(t) = TotalLeaseObligations(t - dt) + (ChangeLeaseObligations -
  LeasingExp) * dt
  INIT TotalLeaseObligations = 0 {Total Lease Obligations ($Millions)}
       INFLOWS:
       ChangeLeaseObligations = Pulse(NewLeases,0,.25) {Change in Lease Obligations
       ($Millions)}
       OUTFLOWS:
       LeasingExp = Pulse(TotalLeaseObligations/LeaseTerm,0,.25) {Quarterly Lease
       Expense ($Millions)}

IntendedBorrowing = PropDebtFinancing*CapExNewStores {Debt Financing ($Million)}
LeaseOverhead = 2.25 {Percentage Lease Overhead}
LeaseTerm = 80 {Lease Term (qtr)}
NewEquity = EquityFinancing*CapExNewStores {New Equity Financing ($Million)}
NewLeases = LeaseFinancing*CapExNewStores*(1+LeaseOverhead) {New Lease
  Obligations ($Millions)}
NonLeaseFinancing = IntendedBorrowing+NewEquity {NonLeaseFinancing ($Millions)}
PropDebtFinancing = 1-LeaseFinancing-EquityFinancing{ Proportion of debt for new
  financing (dimensionless) }
TransactionCost = .02 {Equity Issuing Costs Percentage}
```

Market Competition

```
Competitor_Market(t) = Competitor_Market(t - dt) + (- Change_Market_Share) * dt
  INIT Competitor_Market = .9 {Competitor Market Share}
       OUTFLOWS:
       Change_Market_Share = IF (Market_Effect > 0) THEN
       Competitor_Market*Market_Effect ELSE MarketShare*Market_Effect {Change in
       Market Share}

Last_Price(t) = Last_Price(t - dt) + (Change_in_Price) * dt
  INIT Last_Price = 35
       INFLOWS:
       Change_in_Price = Price-Last_Price
```

MarketShare(t) = MarketShare(t - dt) + (Change_Market_Share) * dt
  INIT MarketShare = .01 {Home Depot Market Share}
      INFLOWS:
      Change_Market_Share = IF (Market_Effect > 0) THEN Competitor_Market*Market_Effect ELSE MarketShare*Market_Effect {Change in Market Share}

Attractiveness = ServiceQuality/Last_Price { Attractiveness }
Competitor_Attractiveness = Competitor_ServiceQuality/CompetitorPrice {Competitor Attractiveness}
Competitor_ServiceQuality = 1 {Average Competitors' Service Quality}
Market_Effect = Availability*(RelativeAttractiveness-1) {Change in Market Change}
Price_fraction_of_Competitors = Price/CompetitorPrice { Price Fraction of Competitors Price }
RelativeAttractiveness = Attractiveness/Competitor_Attractiveness {Relative Attractiveness}
UnitSales = MarketShare*Total_Market {Unit Sales (Million units/qtr)}
Total_Market = GRAPH(Simulation_Time {Total Unit Sales Millions/qtr})
  (1984, 70.0), (1984, 90.0), (1984, 120), (1985, 140), (1985, 160), (1985, 180), (1986, 220), (1986, 260), (1986, 275), (1986, 285), (1986, 325), (1987, 365), (1987, 405), (1987, 415), (1988, 430), (1988, 440), (1988, 480), (1988, 490), (1988, 525), (1989, 540), (1989, 560), (1989, 570), (1990, 585), (1990, 600), (1990, 615), (1990, 625), (1990, 640), (1991, 645), (1991, 660), (1991, 680), (1992, 705), (1992, 715), (1992, 725), (1992, 745), (1992, 755), (1993, 775), (1993, 790), (1993, 805), (1994, 825), (1994, 845), (1994, 880)

MarketValueFirm
SharePrice(t) = SharePrice(t - dt) + (CSP) * dt
  INIT SharePrice = IndicatedStockPrice {Share Price($/share)}
      INFLOWS:
      CSP = (IndicatedStockPrice-SharePrice)/TASP

ADER = SMTH1(DebtEquityRatio,TimetoMktAvgFinanVars)
AEGR = SMTH1(EGR,TimetoMktAvgFinanVars)
AROE = SMTH1(ROE,TimetoMktAvgFinanVars)
EPS = 4*NetIncome/SharesOutstanding {EPS ($/share/year)}
IndicatedStockPrice = EPS*PriceEarningRatio
MarketValueFirm = SharesOutstanding*SharePrice {Market Value of Firm ($Million)}
NIMVF = MarketValueFirm+CumulativeNetIncome {Market Value of Firm and Cumulative Net Income=Value Generation ($Million)}
PriceEarningRatio =
  PriceEarningRatioNormal*EffROESP*EffEarnGrowRateSP*EffDERatioSP
PriceEarningRatioNormal = 10
TASP = 20
TimetoMktAvgFinanVars = 8
EffDERatioSP = GRAPH(ADER)
  (0.00, 0.9), (0.25, 0.95), (0.5, 1.00), (0.75, 0.95), (1.00, 0.9), (1.25, 0.85), (1.50, 0.8), (1.75, 0.75), (2.00, 0.7)
EffEarnGrowRateSP = GRAPH(AEGR)
  (-0.5, 0.5), (-0.4, 0.6), (-0.3, 0.7), (-0.2, 0.8), (-0.1, 0.9), (-5.09e-17, 1.00), (0.1, 1.10), (0.2, 1.20), (0.3, 1.25), (0.4, 1.27), (0.5, 1.30), (0.6, 1.30), (0.7, 1.30)

EffROESP = GRAPH(AROE)
(0.00, 0.1), (0.0556, 1.00), (0.111, 1.85), (0.167, 2.60), (0.222, 3.25), (0.278, 3.75), (0.333, 3.85), (0.389, 3.95), (0.444, 4.00), (0.5, 4.00)

Maturing of Stores

NewStoresNewLoc(t) = NewStoresNewLoc(t - dt) + (ChStoresinNewLocations - MaturingNewLocationStore) * dt
INIT NewStoresNewLoc = 0 { Number of new stores in new locations}
INFLOWS:
ChStoresinNewLocations = pulse(NewStores*NewLocationsPct,0,.25) { New Store Opening in New Locations}
OUTFLOWS:
MaturingNewLocationStore = pulse(NewStoresNewLoc,0,.25) {Maturing of new location stores}

NewStoresOldLoc(t) = NewStoresOldLoc(t - dt) + (StoreOpeninginOldLoc - MaturOldLocStores) * dt
INIT NewStoresOldLoc = 9 { Number of new stores in old locations }
INFLOWS:
StoreOpeninginOldLoc = pulse(NewStores*Pct_in_Old_Locations,0,.25) { New Store Opening in Old Locations}
OUTFLOWS:
MaturOldLocStores = Pulse(NewStoresOldLoc,0,.25) {Maturing of old location stores}

Old_Stores(t) = Old_Stores(t - dt) + (MaturOldLocStores + MaturingQuaterOld) * dt
INIT Old_Stores = 10 { Old Stores }
INFLOWS:
MaturOldLocStores = Pulse(NewStoresOldLoc,0,.25) {Maturing of old location stores}
MaturingQuaterOld = pulse(QuarterOldStoresNL,0,.25) {Maturing of new location stores}

QuarterOldStoresNL(t) = QuarterOldStoresNL(t - dt) + (MaturingNewLocationStore - MaturingQuaterOld) * dt
INIT QuarterOldStoresNL = 0 {One Quarter Old Stores in New Locations}
INFLOWS:
MaturingNewLocationStore = pulse(NewStoresNewLoc,0,.25) {Maturing of new location stores}
OUTFLOWS:
MaturingQuaterOld = pulse(QuarterOldStoresNL,0,.25) {Maturing of new location stores}

TotalNewLocation(t) = TotalNewLocation(t - dt) + (ChNewLocations) * dt
INIT TotalNewLocation = 0 {Total number of stores in new locations}
INFLOWS:
ChNewLocations = ChStoresinNewLocations {New Store Opening in New Locations}

Availability = 2*(TotalNewLocation/NumberStores)*NumberStores/500 {Availability Index}
CapacityGrowth = (NewStores/(NumberStores-NewStores))*100 {Percentage Capacity

Growth}
CapExNewStores = NewStores*CapEx_per_New_Store { Total Capital Expenses for New Stores ($Million) }
CapEx_per_New_Store = 5.5 {Capital Expense per New Store ($Millions/store)}
MaturingNewStores = NewStoresNewLoc+QuarterOldStoresNL {Maturing Stores in New Locations}
MktingExpforNewLocStore = 1 {Marketing Expense for New Location Store ($Millions/qtr)}
NewStoreMktingExp = MktingExpforNewLocStore*MaturingNewStores { Total Marketing for New Location Stores ($Millions) }
NumberStores = NewStoresOldLoc+Old_Stores+NewStoresNewLoc+QuarterOldStoresNL {Total number of stores}
Pct_in_Old_Locations = 1-NewLocationsPct { Percentage of New Stores in Old Locations}
StoreOpeninginNewLocations = ChStoresinNewLocations/4 {Quarterly Store Openings in New Locations}

Operating Expenses

OldRevenue(t) = OldRevenue(t - dt) + (ChNewRevenue) * dt
INIT OldRevenue = 1 {Revenue this quarter ($Millions/qtr)}
INFLOWS:
ChNewRevenue = Revenue-OldRevenue {Transfer of Revenue this period ($Millions/qtr)}

Administration_Costs = NumberStores*Administration_Costs_per_Store {Administration Costs ($Millions/qtr)}
Administration_Costs_per_Store = .015 {Administration Costs per Store ($Millions/qtr)}
Avg_Salary_per_store = .12 {Average Salary per Store ($Millions/qtr)}
Maintenance_Marketing = FracRevforMktg*OldRevenue {Maintenance Marketing Expense ($Millions/qtr)}
MarketingExp = Maintenance_Marketing+NewStoreMktingExp {Marketing Expense ($Millions/qtr)}
Opening_Expenses = Opening_Expense_per_new_store*NewStores {New stores opening expenses excl. marketing ($Millions/qtr)}
Opening_Expense_per_new_store = 1.8
Payroll = Avg_Salary_per_store*NumberStores {Payroll ($Millions/qtr)}
RevenueGrowth = (Revenue/OldRevenue-1)*100 {Percentage Growth in Revenue}
SGA = Payroll+Administration_Costs+DistrInvyCarryCosts+Opening_Expenses {SGA ($Millions/qtr)}
StoreOperatingExpense = DistrInvyCarryCosts+Payroll+Administration_Costs {Store Operating Expense ($Millions/qtr)}

Pricing

Actual_Markup(t) = Actual_Markup(t - dt) + (Change_in_Actual_Markup) * dt
INIT Actual_Markup = .30 {Actual Markup}
INFLOWS:
Change_in_Actual_Markup = Markup_Gap/2 {Change in Actual Markup(dimensionless)}

Markup_Gap = IntendedMarkup-Actual_Markup {Gap between actual Markup and Intended Markup (dimensionless) }

Price = Expenses/UnitSales*(1+Actual_Markup) {Price ($/Purchase) }

Service Quality

ServiceQuality(t) = ServiceQuality(t - dt) + (ChServiceQuality) * dt
  INIT ServiceQuality = 1 {Service Quality}
    INFLOWS:
    ChServiceQuality = ServiceQualityChange/4 {Change in Service Quality}

ServiceQualityChange = (.12-MaturingNewStores/NumberStores) {Change in Service Quality}

WACC Computation

BetaDebt = .20 {Estimated Beta of Debt}
BetaEquity = 1.3 {Historic Equity Beta}
EquityRiskPremium = .08 {Market Premium of Equity over Risk Free Rate (historic arithmetic average)}
RD = (RiskFreeRate-.01)+BetaDebt*EquityRiskPremium {Debt Interest Rate}
RE = (RiskFreeRate-.01)+BetaEquity*EquityRiskPremium {Equity Discount Rate}
RiskFreeRate = .06 {Long Term Government Bond Rate}
WACC = EquityAssetRatio*RE+DebtAssetRatio*RD*(1-TaxRate) {Weighted Average Cost of Capital}

Not in a sector

FracRevforMktg = GRAPH(Simulation_Time{Marketing Expense as Fraction of Revenues (dimensionless)})
(1984, 0.05), (1984, 0.05), (1984, 0.05), (1985, 0.05), (1985, 0.05), (1985, 0.05),
(1986, 0.05), (1986, 0.05), (1986, 0.05), (1986, 0.05), (1986, 0.05), (1987, 0.05),
(1987, 0.05), (1987, 0.05), (1988, 0.05), (1988, 0.05), (1988, 0.05), (1988, 0.05),
(1988, 0.05), (1989, 0.05), (1989, 0.05), (1989, 0.05), (1990, 0.05), (1990, 0.05),
(1990, 0.05), (1990, 0.05), (1990, 0.05), (1991, 0.05), (1991, 0.05), (1991, 0.05),
(1992, 0.05), (1992, 0.05), (1992, 0.05), (1992, 0.05), (1992, 0.05), (1993, 0.05),
(1993, 0.05), (1993, 0.05), (1994, 0.05), (1994, 0.05), (1994, 0.05)
TaxRate = GRAPH(Simulation_Time)
(1984, 0.46), (1984, 0.46), (1984, 0.46), (1985, 0.46), (1985, 0.46), (1985, 0.46),
(1986, 0.46), (1986, 0.46), (1986, 0.46), (1986, 0.46), (1986, 0.46), (1987, 0.46),
(1987, 0.46), (1987, 0.46), (1988, 0.46), (1988, 0.46), (1988, 0.46), (1988, 0.46),
(1988, 0.46), (1989, 0.46), (1989, 0.46), (1989, 0.46), (1990, 0.46), (1990, 0.46),
(1990, 0.46), (1990, 0.46), (1990, 0.46), (1991, 0.46), (1991, 0.46), (1991, 0.46),
(1992, 0.46), (1992, 0.46), (1992, 0.46), (1992, 0.46), (1992, 0.46), (1993, 0.46),
(1993, 0.46), (1993, 0.46), (1994, 0.46), (1994, 0.46), (1994, 0.46)