

THE GAME OF THE COMPUTER INDUSTRY: A CLASSROOM GAME OF COMPETITION SIMULATING THE COMPUTER INDUSTRY FROM 1980 TO 1995

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ABSTRACT

This article introduces a game for classroom use based on a simplified model of the computer industry from 1980 to 1995. It was designed for a four-hour session, in a classroom, with up to thirty participants, but preferably with around sixteen participants.

The model simulates a production capacity that grows faster than demand and therefore leads a change in the strategy from quantity to quality.

The model is very simple to give the students a better view of the possibilities, and yet the possible combinations are so many, that no two games will be the same.

INTRODUCTION

This article introduces a game for classroom use based on a simplified model of the global computer industry from 1980 to 1995.

The game is a translation with minor improvements of the Computers game published in Alves (2001). The original game was published only in Portuguese language. The game has been applied successfully many times in both undergrad, MBA's, EMBA's and executive education courses over the last fourteen years.

The improvements here do clarify some points and resolve some possible low competition issues depending how fast the market grows.

Still the same basic model of a supply that grows faster than demand is used resulting in a game in which the strategy of the players must change from manufacturing as much as possible to manufacturing with the best quality possible. Price of selling is fixed in order to reduce complexity and avoid price wars.

The game rules section was written as an appendix so that it can be printed separately for the participants.

DESIGN GOALS

The main goal of the game is to be applicable in a classroom with minimal infrastructure, and therefore it retains the traditional pen and paper logic, however today we have a more easy access to spreadsheets and projectors, so that, not necessarily, the main game data has to be drawn in a blackboard.

The secondary goal is that it will be a competitive game in

which the competition logic changes along the game from quantity to quality. This is achieved by having a model that permits supply to grow faster than demand.

The tertiary goal is that it can be used in a four hour session with a thirty minutes explanation and a thirty minutes debriefing and three hours of gaming itself. This allows it to be applicable to executive education, MBA, EMBA, graduate, and under-graduation courses.

The quaternary goal is that it has to be fun and engaging, while retaining a reasonable connection with the real world, so the areas of manufacturing, distribution and research are real, the formulas are simple and explicit but close to reality. Cards and dice are used to represent life-like events like market forecast, and research and development, giving a sensation of limited control of events to the participants.

USAGE METHODOLOGY

This game was designed for use in a four-hour session, in a classroom, with up to thirty participants, but preferably with around sixteen participants.

The only materials needed are printed copies of the rules, a blackboard, a printed set of the cards, and at least one six-sided die, but preferably more dice. This makes it a low cost application for any situation. However if a projector and a spreadsheet are available it will be much easier to use.

The participants should preferably have received the rules beforehand, but that is not entirely necessary, since the rules are simple and can be learned while playing.

The facilitator must divide the participants into four to six groups, ideally four groups. Each group can have from two to five participants, ideally four participants. So the number of participants can range from eight to thirty, but with an ideal number of sixteen.

Time usage should be:

- a) Thirty-minutes for groups' setup and game explanation.
- b) Forty to fifty-minutes for the first turn.
- c) Twenty to forty-minutes for subsequent turns.
- d) Thirty to forty-minutes for debriefing.

The number of turns will depend on the speed of the groups for decision-making, but at least four turns should be taken, preferable five turns or more.

The facilitator should answer all questions pertaining to the rules of the game to the best of his or her ability, but never

directly answer question about which strategy to pursue, or what decision to make. If a group is stuck with decision paralysis, that is unable to make a decision, it should do nothing that turn as a penalty for indecision.

Some questions and issues selected for discussion in the debriefing can be advanced with each group as they realize some of the points. However the game rules purposely miss the issue as which is the objective of the game, and who wins, so that this discussion may rise in the debriefing as how to evaluate a company, its assets, sustainability of the profit and future cash flow. So the facilitator must avoid a direct answer to these issues always pointing to the participants that this issue is missing on purpose, and asking them how they think the companies should be compared to each other. Usually only a few groups rise the question and only in the later half of the session.

The game has a trend to monopoly and after turn four or five some groups may want to merge. The rule does not prohibit that and therefore it permit by omission. The facilitator may allow or not depending on his or her will. The suggestion is to allow for the game to remain competitive, but never suggest that beforehand. Always force them into reach this conclusion by themselves stimulating to think beyond the rules set, or to think what would happen in the real world. Smart students will reach the conclusion that merging is the only way to remain competitive.

DEBRIEFING

The game is a mean to an end, which is learning through experience, so to consolidate this learning a debriefing is necessary at the end of the session. The participants will probably keep talking about the game afterwards but it's important to give them a closure at the end of the session.

The facilitator may discuss whatever he or she finds necessary and important given the purpose of the course but some suggestions are made here.

- a) The first question to address is which company won the game, since it's not explained anywhere on the rules on purpose. The facilitator should induce them to think how much each company is worth, or by how much money they would buy each company, or how much money each company will get in the future. The concepts behind those questions are valuation, future cash flow and assets evaluation. They must understand that cash is not the only asset here, and the assets will have some value in the future, but this value is not fixed and different evaluations may exist.
- b) Other possible line of discussion is about the game dynamics that represents the game and its relation to the strategies. Since the model is built in such a way that supply will overrun demand in three to four turns the strategy will have to shift from manufacturing the biggest quantity to manufacturing the best quality possible. This is clearly related to Porter (1980) generic strategies of Cost leadership and differentiation.
- c) Derived line of thought is the trend to monopoly and the mergers. The players will feel the need to merger but some

groups may reach this conclusion while others not. In fact the game doesn't disallow to work together. The rules just don't say anything in favor or against. They can even make joint research and development or license someone else's technology or even other more complex deals as the facilitator allows. This is a good way to talk about cooperation, complimentary companies, and network competition. It's even possible to play a second time with that in mind and the game will be much more competitive.

- d) Another possibility is group dynamics in terms of decision, or how they made their decisions during the game and how they felt time pressure, incomplete information, decision trees, group synergy or conflict, how they dealt with the competition, the deals and betrayals.
- e) The computer industry itself can be a line of debate as well as which other industries could be similarly simulated. The game is of course a simplification of reality but it has enough elements to make a good experience even though it doesn't simulate all aspects, and some equations are imperfect from the economic point of view. The companies will naturally develop a multinational company with manufacturing where it's cheaper, distributing where there is demand and making research and development (R&D) where it's also cheaper. Normally they will manufacture in Asia, sell in Europe, Japan and USA and make R&D in one single region where the "silicon valley effect" is achieved.
- f) R&D can be another topic for discussion. The uncertainty model of R&D that makes its result impossible to predict as well as the diseconomy of scale contained in the formulae, and how real is the fact that R&D can not be totally controlled. Many companies with lesser investment achieve better breakthroughs than others with large breakthroughs.
- g) Also possible is to discuss the simplifications on the model like the absence of logistical and maintenance costs as well fixed prices. These factors are basically there to simplify the game and make it more manageable and easier to learn. But it can be argued that for computers the logistical and maintenance costs are low compared to overall price, and in fact the price is actually the margin of profit and not the price per se.
- h) A final line of discussion is the rise of emerging economies, as the manufacturing is off-shored to Asia. It could be argued that after 1995 when the game ends the demand would grow in those markets faster than in Europe and USA. Therefore a new set of demand cards would be necessary.

COMMENTS

This model tries to simulate the effects of a global multinational company operating in a changing environment. The costs are such that manufacturing is best concentrated in the low cost countries. Distribution needs to follow the market and is naturally distributed worldwide, but more concentrated in the large markets of Europe, USA and Japan. Research and development is cheaper in USA, Europe and Japan, but the first place to get a R&D center becomes cheaper than the others and so it will concentrate all other R&D centers for the rest of the game, making it the silicon valley of that match.

Also the demand is very big initially and the players cannot supply everything, so the best option is to produce as much as possible without investing in technology, but as the game progresses the supply will reach and overcome demand making a transition to occur and leading to a technological race between companies. The winner of this race would eventually become the monopolist, but normally the game end much before this point is reached.

The investment equations for manufacturing and distribution favor concentration due to the fixed costs, but still many players don't get it right away.

The investment equation for R&D has a diseconomy of scale that forces the payers to invest more and more in it and without certainty of the results since it's resolved with dice. This simulates the uncertainty of R&D and can be explained with lots of examples and cases.

There is no stockpile in the game as the technological level is changed from one turn to the next. This means non-sold products become obsolete and have to be discarded or sold at cost price.

The game does simulate many industries in fact, and not only the computer industry. Many manufacturing industries have seen a movement to low cost countries between 1980 and 1995 and also a technological coevolution forcing them to advance technology or be put out of business.

On the political side there is the simulations that the Eastern Europe is not allowed for operation until turn 4 when the Iron curtain falls, and that will give a new low cost area for production.

The political and technological model is very simple to give the students a better view of the possibilities, and yet the possible combinations are so many, that no two games will be the same. This will reduce their trend to paranoia and allow them to focus on managing the resources.

The cards are merely for forecasting the demand and creating a mechanism of demand growth and are not critical for the game, but give a nice color for the players.

The game model doesn't incorporate many factors like the cost of logistics and maintenance. The price of selling is actually the margin. Also the price is fixed in order to avoid price competition. Incorporating price fluctuations would and create a much more complex model. The game could be

complicated much more, however more complexity does not necessarily means a better learning experience for the participants. The complexity was kept low on purpose to maximize learning for participants.

The facilitator can create more complex variations, or he/she can deal with the other factors using other non-game tools as discussions and readings.

CONCLUSIONS

This article introduces a game for classroom use based on a simplified model of the global computer industry from 1980 to 1995. The game is designed to last four hours and train up to thirty participants.

The game is a translation with minor improvements from the Computers game published in Alves (2001).

The purpose is to create a relatively cheap training tool for Strategy, Business strategy, negotiation, internationalization and game theory.

The game rules section is in an appendix so that it can be printed separately for the participants.

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APPENDIX A GAME RULES

GAME SCENARIO

The year is 1980, and IBM just released an open architecture personal computer that promises to revolutionize the computer market. Everything indicates that new computer generations will be launched every two or three years over the next decades and that this will revolutionize offices throughout the world.

To survive in this industry you must invest in cutting-edge technology, reduce production costs and manage an industry scattered throughout the world. Technical leadership is of the essence in this industry and today's product will become obsolete in a short time. New products are not only more powerful but also cheaper. There is no margin for technological lag.

Your objective is to manage the company over the next 15 years (five turns).

GAME SCALE

- Each turn is the equivalent three fiscal years.
- Each monetary unit (\$ 1) is the equivalent to one million dollars (1 US\$ Million).
- Each production unit (1 PU) is the equivalent 50,000 computers.
- Each group starts with two hundred and fifty Million dollars (\$ 250).
- Each group starts with one fifth (1/5) of the oil reserves worldwide.

- There are eleven regions on the game each representing one or more countries, these are: Australia, Brazil, China, East Coast, West Coast, Western Europe, Eastern Europe, India, Japan, Mexico and SE Asia.
- The demand for computers only exists in four regions: East Coast, West Coast, Western Europe and Japan.
- Eastern Europe is closed for the first three turns. It becomes open for operations in turn four onwards after the USSR ceases to exist.

There are forty market expansion cards representing market growth during the game. They are divided into three types: new market, market expansion and emerging market. Appendix B shows one possible configuration for the cards. The facilitator may create his or her own cards for play.

The names of the companies are fictional and can be changed by the facilitator as desired.

GAME SETUP

The facilitator will distribute the rules among the participants and separate them into four groups or more groups. Each group can have from two to five participants. Distribute three market expansion cards for each group. Remaining cards will be distributed later as the ones already in possession of the groups are used.

The facilitator must draw, or project, the main data table in a blackboard, or wall. Table 1 shows the main data table with all regions. Initially there are no manufacturing plants, distribu-

EXHIBIT 1
FIGURE 1 -GAME MAP WITH ELEVEN REGIONS



EXHIBIT 2
TABLE 1 -MAIN DATA TABLE

Region	Market	f	r	Company													
				HAL Intl			Hewey- Bracket (HB)			Grape computers.			UNIVAC Ent.				
				Plants	Distr.	R&D	Plants	Distr.	R&D	Plants	Distr.	R&D	Plants	Distr.	R&D		
Australia	-	60	60														
Brazil	-	50	70														
China	-	40	80														
East Coast	5	60	50														
West Coast	5	60	50														
W. Europe	5	60	50														
Eastern Europe	-	40*	60														
India	-	50	70														
Japan	5	40	50														
Mexico	-	50	70														
SE Asia	-	40	80														

* - Units can only be installed in Eastern Europe from turn 4 onwards.

Cash	\$ 250	\$ 250	\$ 250
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tion centers or R&D centers. They will begin to be created in turn 1. Initial demand is just five PU's in each of four areas: East Coast, West Coast, Western Europe and Japan. This table will have to be modified along the game as the actions are taken.

GAME SEQUENCE

The game is divided into turns representing three fiscal years. Each turn will be divided into several phases in the following sequence.

- Phase 1 – Market expansion Phase
- Phase 2 – Planning Phase
- Phase 3 – Revelation Phase
- Phase 4 – Technological advance Phase
- Phase 5 – Calculation phase
- Phase 6 – End of turn phase

Repeat these phases until the specified number of turns, or to the end of class time. A two-hour class will probably last two to three turns, while a four-hour class will last for four to five turns.

Each phase is now detailed.

Phase 1 – Market expansion Phase

In this phase each group will select one of their three market expansion cards to become effective. When each group has delivered a card to the facilitator, he will hand out one new card to each group, from the stack of still undistributed cards. Therefore, each group will always have three options at the beginning of each market expansion phase. There are forty market expansion cards altogether.

The cards produce the following effects:

- New market – The market demand of a certain region indicated in the card increases by a certain amount. The amount of the increase is also indicated in the card; usually plus 5 or 10 PU's. This represents the modernization of a certain region that previously did not consume the product. There are 14 cards of this type.
- Market expansion – The market of a certain region indicated in the card is multiplied twofold. This indicates the normal increase of each one of the main world markets, that is, Eastern Europe, West Coast, East Coast and Japan. There are 20 cards of this type.
- Emerging market – This represents the growth of the so-called “emerging” markets that grow quickly and then stop at certain consumer levels, such as Brazil, China, India and Mexico. The number indicated in the card (x2 or x3) will be used to multiply the market with the lowest positive value. Should there be more than one market with the minimum number, the group that launched the card will choose the region in which the card will produce its effect. Two of these cards cannot affect the same area in the same round. Always apply this card after the previous two types have been used. There are six cards of this type.

Phase 2 – Planning Phase

In this phase, players make decisions. They should analyze their own and their competitors' plant, distribution network

dispersal, the market demand in each region, and R&D centers, and decide how to allocate their financial resources.

They can:

- Install new manufacturing plants.
- Install new distribution centers.
- Install new R&D centers.

A manufacturing plant's installation cost (C_{plant}) is given by the equation below, where f is the function of the region, representing the lowest plant installation cost in the each region. F is production capacity expressed in product units (PU's). The player will choose this production capacity. A plant's expansion costs as much as a new plant.

EQUATION 1 COST OF MANUFACTURING PLANT INSTALLATION

$$C_{plant} = f \cdot F + 20 \quad (1)$$

The cost to install a distribution network (C_{dist}) is given by the equation below, where D is the network's distribution capacity expressed in production units (PU's). This cost does not differ from region to region. Distribution capacity (D) is a player's choice. Expanding a distribution network costs as much as a new distribution network.

EQUATION 2 COST OF INSTALLING A DISTRIBUTION NETWORK

$$C_{Dist} = 10 \cdot D + 20 \quad (2)$$

The cost to install a research center ($C_{R\&D}$) is given by the equation below, where r is fixed and a function of the region, and n varies. The value for n is zero if there are no other research centers in the region, and n will equal ten if there are other research centers already installed in the region (your own or other players'). This means that it is cheaper to install and maintain a research center in first world regions, and that they tend to cluster. The variation of n induces the ‘Silicon valley effect’ of clustering.

EQUATION 3 COST OF INSTALLING A RESEARCH AND DEVELOPMENT CENTER

$$C_{R\&D} = r - n \quad (3)$$

Example:

One player decides to install a plant with a capacity of 5 PU's per round in Japan; its cost is $40 \times 5 + 20$ or 220\$.

Having decided to distribute these products, he also decides to install a distribution network in Western Europe, capable of distributing his entire production. This costs $5 \times 10 + 20$, or 70\$.

Finally, he decides to install a new research center in the West Coast of the US, where they already have a center, together with another player. Thus, the installation cost is 50-10, or 40\$.

The player's total expenditures are $220 + 70 + 40$, or 330\$.

Note that the distribution network does not need to be in the same location of the manufacturing plant. The freight cost is simplified to be zero. Also there are no maintenance costs after installation, only the cost to install the assets.

Phase 3 – Revelation phase

In this phase all the decisions taken during the previous phase are revealed, so that the decisions taken privately are now public. The facilitator will mark the decisions on the board, or spreadsheet.

Phase 4 – Technological advance phase

In this phase each group calculates its new technological level. The original technological level in the first round is 1 (one), and it advances in each round by a variable number as a function of the number of research centers operating for the group in that round.

The technological increase value is the sum of a certain number of six-faced dice (1D6) given by the equation below, where n is the number of research centers operating, and the function [...] means "the integer part of". Therefore, the integer of the root of n is the number of six-faced dice to be cast.

**EQUATION 4
TECHNOLOGICAL ADVANCE**

$$T = \lfloor \sqrt{n} \rfloor \cdot D6 \tag{4}$$

The table below helps figuring out the results of the formula in terms of dice number.

**TABLE 2
TECHNOLOGICAL ADVANCE**

Research Centers	T
1-3	1D6
4-8	2D6
9-15	3D6
16-24	4D6
25-35	5D6
36-48	6D6
49-63	7D6
64-80	8D6
81-99	9D6
100-120	10D6

The round's technological level affects Market Share as computed in the calculation phase. The technological level is leveled at the end of the round, during the end of turn phase. This represents industrial espionage, standardization and reverse engineering among companies; thus, technological leadership in one round does not necessarily ensure leadership in subsequent rounds.

Phase 5 – Calculation phase

In this phase the professor will compute financial calculations in the following sequence:

- a) Debit of investments.
- b) Calculation of each region's market share.
- c) Credit of sales earning

Plant, distribution network and research center investment costs are given by the previously indicated equations.

Market Share calculation should be made as follows. Look at each region individually one by one beginning with Australia and going all the way down to SE Asia following the order of Table 1. In each region, the market will consume the products with the higher technology first, then the products with the second highest technology, and so forth until demand is met.

Sales earnings are 100\$ per PU's sold. This is not a price, but rather the margin for each PU sold.

Example:

Suppose also that in a region three players distributed 1, 2 and 3 PU's, and that the technological levels of these competitors are 11, 12 and 10 respectively. Suppose also that market demand is 5 PU's.

The 12-technology products are sold first, that is, 2 PU's, then the player at technology 11 sells another 1 PU. Finally comes the turn of player rated at technology 10, but the market will only absorb 2 more PU's, therefore, the 1 PU remaining with this player will not be sold and lost. There is no stockpile.

Phase 6 – End of Turn phase

Once the calculations are made, the companies should show a positive cash; should they show negative cash, they should choose one of their manufacturing plants, distribution networks or research centers to the bank at half the investment price.

Should they still not show positive results, they should repeat the process until they run positive or declare bankruptcy

The facilitator may at his discretion grant additional money for the group to keep itself in the game without going bankrupt.

The technological level is now equaled; this represents industrial espionage, standardization and reverse engineering among companies; thus, technological leadership in one round does not necessarily ensure leadership in subsequent rounds.

APPENDIX B
Market expansion Cards

New Market

Australia



+5

New market

Australia



+10

New Market

Brazil



+5

New Market

Brazil



+10

New Market

China



+5

New Market

China



+10

New Market

Mexico



+5

New Market

Mexico



+10

New Market

India



+5

New Market

India



+10

New Market

SE Asia



+5

New Market

SE Asia



+10

New Market

Eastern Europe*



+5

New Market

Eastern Europe*



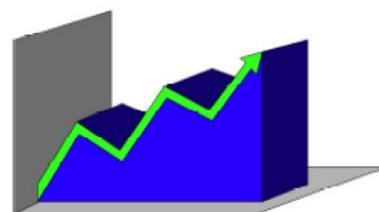
+10

Emerging Market



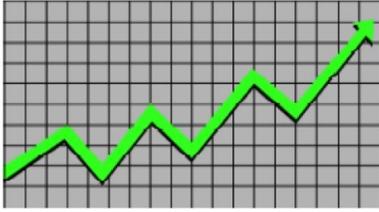
x2

Emerging Market



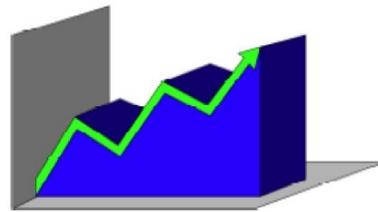
x3

Emerging Market



x2

Emerging Market



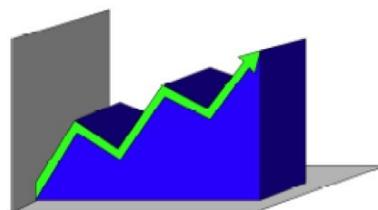
x3

Emerging Market



x2

Emerging Market



x3

Market expansion

Japan



x2

Market expansion

Western Europe



x2

Market expansion

Japan



x2

Market expansion

Western Europe



x2

Market expansion

Japan



x2

Market expansion

Western Europe



x2

Market expansion

Japan



x2

Market expansion

Western Europe



x2

Market expansion

Japan



x2

Market expansion

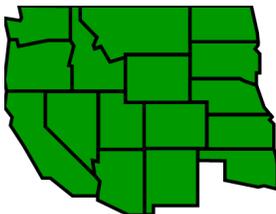
Western Europe



x2

Market expansion

Costa W



x2

Market Expansion

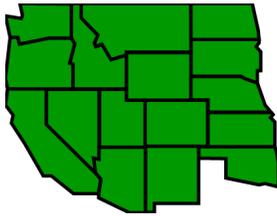
Costa L



x2

Market expansion

Costa W



x2

Market Expansion

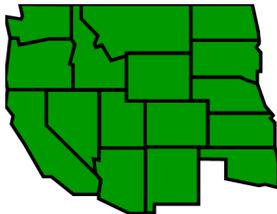
Costa L



x2

Market expansion

Costa W



x2

Market Expansion

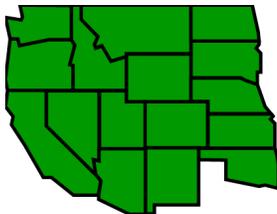
Costa L



x2

Market expansion

Costa W



x2

Market Expansion

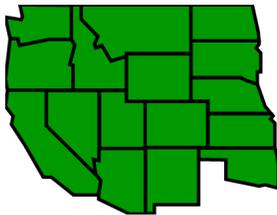
Costa L



x2

Market expansion

Costa W



x2

Market Expansion

Costa L



x2