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MOORE´S LAW EVALUATION AND PROPOSAL OF AN ALTERNATIVE FORECASTING MODEL BASED ON TREND EXTRAPOLATION

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ABSTRACT

This study's core objective is to validate whether the model proposed by Moore (1975) adequately describes the technological evolution of microprocessors. It further poses to verify whether this model is a feasible predictive tool and, finally, present an alternative model. To this extent, the forecasting technique method, based on historical data projections, will be applied. Statistical tests employed presented strong indications that the method proposed by Moore (1975) adequately described the evolution of processor component numbers during the 70s, 80s and 90s. As to the 2000s, however, the same cannot be affirmed and consequently the present study encountered grounding for the need to adapt the model to enable its application as a predictive tool.

Key-words: Moore's Law. Forecast. Technological evolution.

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AVALIAÇÃO DA LEI DE MOORE E PROPOSTA DE UM MODELO DE PREVISÃO ALTERNATIVO BASEADO EM TÉCNICAS DE EXTRAPOLAÇÃO DE TENDÊNCIAS

RESUMO

O objetivo deste estudo é averiguar se o modelo proposto por Moore (1975) descreve adequadamente a evolução tecnológica dos processadores; analisar se ainda é plausível utilizá-lo como ferramenta preditiva e, caso não seja, propor um modelo alternativo. Para tanto, utilizou-se o método de previsão tecnológica de extrapolação de tendências. Os testes estatísticos realizados apresentam fortes indícios de que o modelo proposto por Moore (1975) descreve de forma adequada a evolução do número de componentes dos processadores durante as décadas de 70, 80 e 90. Já em relação aos anos 2000, o mesmo não pode ser afirmado, pois detectou-se a necessidade de adaptações para que o modelo possa ser utilizado como ferramenta preditiva.

Palavras-chave: Lei de Moore. Previsão. Evolução tecnológica.

1 INTRODUCTION

The increasing duplication of the number of microprocessor components became known as Moore´s Law during the 70´s. This model was first proposed by Gordon Moore in 1965 and a decade later was modified. The so called Moore Law was consistently a controversial one given that the author defined technological growth in an exponential manner and in this case, one must note that there are physical restrictions that impose a limit to this curve. Based on this maximum limit, several studies (Reitter, 2003; Birnbaum & Williams, 2000; McGrath, 2005) either ponder the possible end of Moore´s Law or the need for its adaptation. An example of relevance is the publication of the International Technology Roadmap for Semiconductors (ITRS), which throughout the 2000´s conducted a series of revisions on the growth rate described by Moore´s Law.

On the other hand, Sutter (2005) and Gilder (1995) suggest that Moore´s Law cannot be deemed either as a law nor as sound forecast, given that the development of the semiconductor industry was not described correctly.

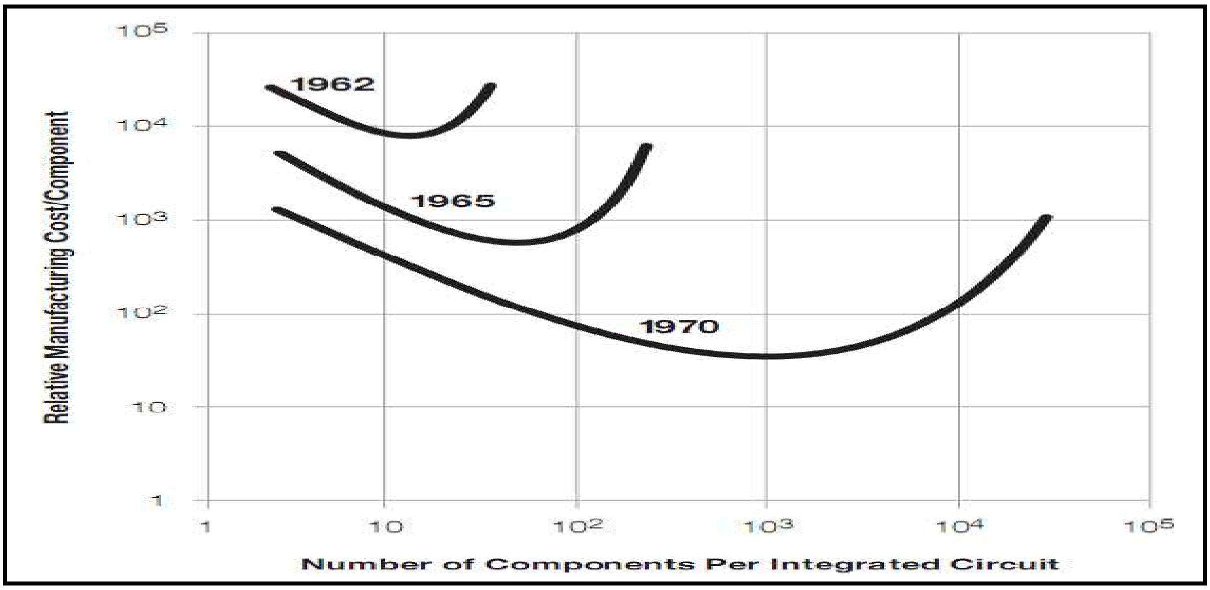
Thus, this article´s research issue is centred in the validation of the model proposed by Moore (1975) and aims to:

- ✓ Confirm whether Moore´s proposed model adequately describes the technical evolution of processors;
- ✓ Analyse if it´s still feasible to utilize this model as a predictive tool and if not, propose an alternative model.

2 MOORE´S LAW

Moore (1965) sets out to forecast the development of the semiconductor industry over the 1970´s. The author noticed that the complexity and cost of semiconductor components had doubled year after year since the production of the first chip. This rapid growth in the number of chip components – in 1965 typically measured by the number of transistors, became popularly known as Moore´s Law and it was subsequently intensely utilized to emphasize rapid change in information technology.

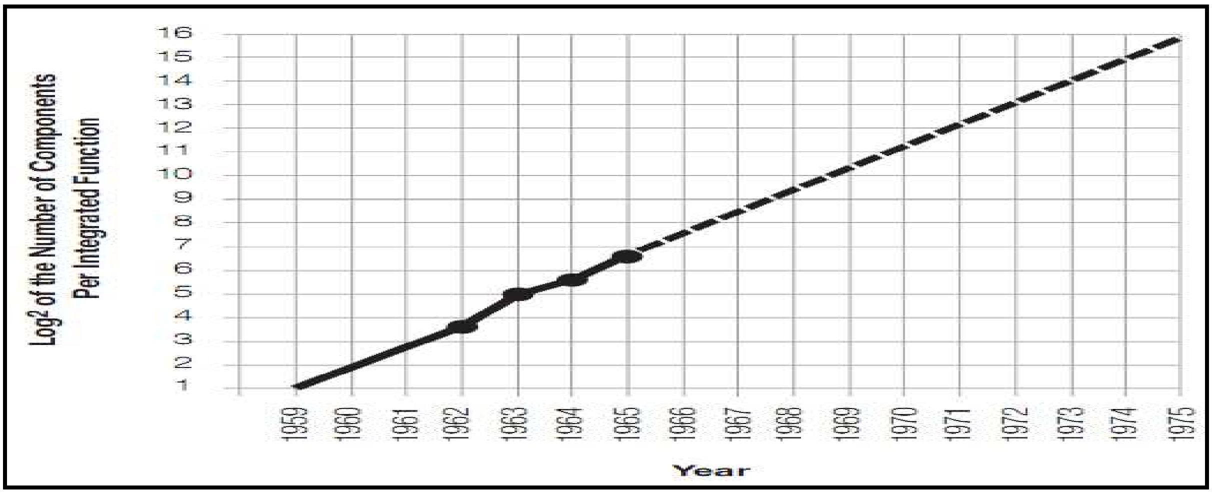
Moore affirms that one of the main advantages in the specific production of chips is the possibility of cost reduction and this advantage is amplified by the development of technologies that allow for a greater number of functions within the same chip. According to Graph 1, the author further affirms that, for simpler circuits, the cost per components is inversely proportional to the number of components. However, as more components are added, benefits are reduced and the cost per component tends to increase. Thus, there is an optimal number of components whereby cost is minimal and this check point varies according to the existing technology at each given time period. Hence, for 1965, the ideal number is approximately 50 components; for 1970, however, the author forecasted the trend to 1000 components. He further declares that in 1970 the manufacturing cost per component ought to have been 1/10 of the value in 1965.



Graph 1: Number of components per integrated circuit

Source: Moore (1965)

Finally, as per Graph 2, the author concludes that the optimal number of components was doubling each year and that this rate, in the short term, would probably continue, if not increase. In the long term however, the author expresses concern as to the reasoning´s validity despite not having observed why it ought to vary over the forthcoming decade, concluding that, given this growth trend, in 1975 there would be a chip comprising 65.000 components at a minimum manufacturing cost. It´s worth noting that the author grounded ponderings on a historical series of no more than four points.



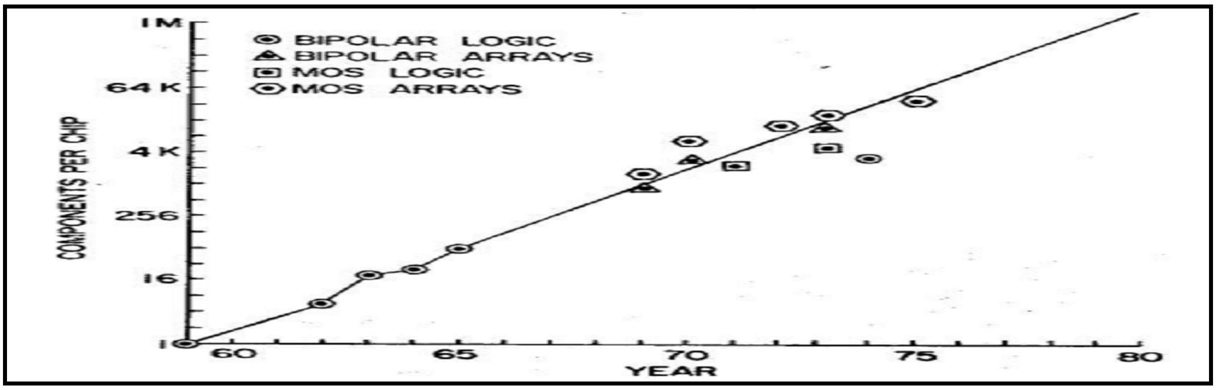
Graph 2: Number of components per integrated circuit

Source: Moore (1965)

Special mention must be made to the fact that the author presents some events that might interfere in this growth rate (such as circuit heat dissipation), but concludes that all might be surpassed. Relevant factors that effectively might have impacted component growth rates and that the author did not mention are the investments in technological advance research and development. Deemed necessary to overcome technical barriers, such investments might be very high and thus reduce growth rates.

Another important point that the author did not mention is the assumption whereby growth rates in the semiconductor industry would remain rampant, maintaining high demand levels. This is an important cornerstone given that it leads to scale benefits, core to cost reduction. This might not have been a concern to the segment in 1965, given it was experiencing expansion. Porter (1986) however affirms that as segments grow, an increase in the number of competitors is expected, followed by a resulting reduction in the field´s overall profitability. Thus, one might expect that given the segment´s evolution, the demand per competitor may decrease, negatively impacting the growth rate of the number of components.

Moore (1975) revisits projections prepared 10 years earlier. Graph 3 illustrates different types of chips that were ideated, demonstrating how component growth per circuit effectively behaved as predicted. The author affirms that in 1975, the 16 Kbyte circuit, comprising 65.000 components, was launched on the market. A set of technical reasons is presented by the author as accounting for this evolution, such as the arising of the MOS (metal oxide semiconductor) enabling the insertion of more components per chip, the improvement of manufacturing processes so as to mitigate the production of defective chips, and others.

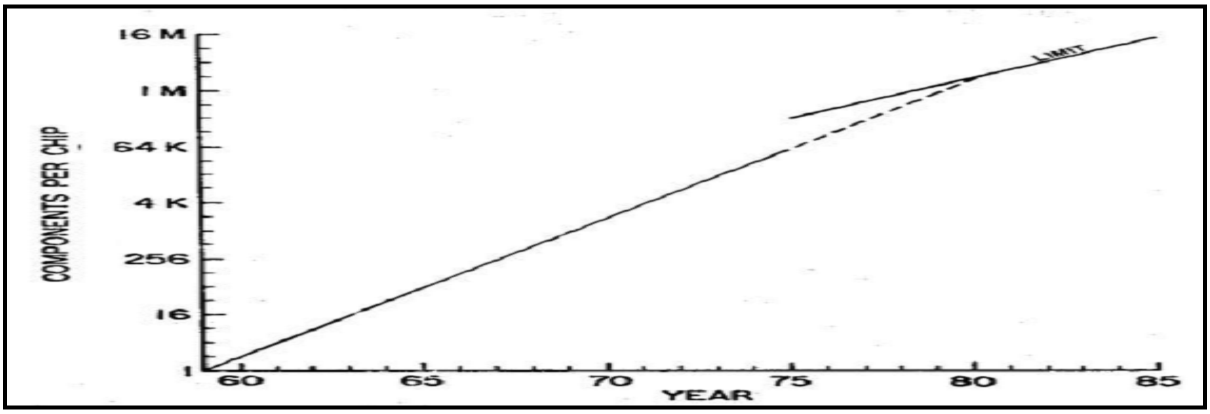


Graph 3: Approximate number of components in complex integrated circuits versus year of launch

Source: Moore (1975)

It´s interesting to notice that Moore (1965) mentions that progress will occur in low cost circuits and the circuit indicated by Moore (1975) with 65.000 components, was launched precisely in 1975, having been treated as a complex circuit and not a low cost circuit.

Moore (1975) forecasts the trend for the last decade and per Graph 4, revises the growth rate for 5 years, i.e., the number of components per chip would double every 2 years. At the end of the article, the author emphasises that the cost per component would continue to decrease and this would further broaden the use of electronic devices throughout society.

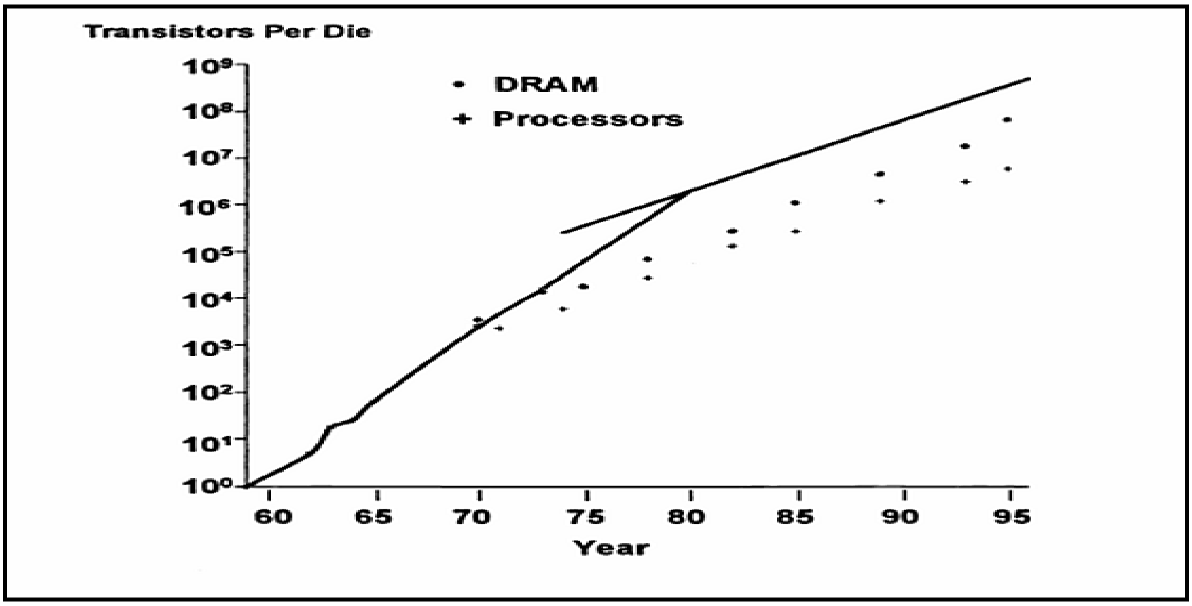


Graph 4: Forecast of the approximate number of components per chip

Source: Moore (1975)

Moore (1995) claims that the chips mentioned are mostly applied to memories and processors and that the evolution of the number of processor components usually occurs at a slower pace. It´s interesting to note that the author himself doesn´t make a distinction between types of chip applications in the 1975 forecast, thus impairing the prediction.

Moore (1995) presents a comparison between forecast and effective data, as depicted in Graph 5.



Graph 5: DRAM memory and processor component counts as of 1975 in comparison to 1975 forecasts.

Source: Moore (1995)

The author declares that the forecast was overestimated mostly due to the fact that the 16 Kbytes CCD type memory became a reality in 1975 and assumptions expected 64 Kbytes and up to 256 Kbytes to become feasible over the following years. This evolution largely corresponded to the curve foreseen in 1975, however an issue concerning the technology utilized in CCD type memories impaired this increase in the number of components and the products were not launched on the market.

According to Moore (1995), this fact directly impacted his forecast, however, as can be seen from the discounted graph, the straight line projections and those that correspond to reality are parallel, and thus the author affirms that the rate of component number evolution, despite the mistake, was similar to that projected. Further on this study shall validate the author´s declarations.

3 METHODOLOGY

Porter (1991) defines technology as a systemized knowledge that is used to alter, control or organize elements of our physical or social environment. Technological forecasts on the other hand correspond to the prediction of activities that focus on technological change. The current study analyses the model proposed by Moore (1975) and Moore (1965) and suggests a predictive model for next decade´s microprocessor evolution. To this extent, technological forecast models and methods shall be employed.

Porter and Rossini (1987) affirm that there are several classifications for technological prediction models: monitoring, specialist opinions, trend forecasts, modelling and scenarios. According to this classification, the current study fits the trend extrapolation method given that it´s a situation whereby there are documented trends and historical series. The very authors emphasize that even this classification presents limitations. One of the most relevant impairments lies in the fact that monitoring is not a predictive method in itself but rather a technique for the systematic gathering and analysis of data that give rise to forecasts.

Porter (1991) presents another alternative to classify methods whereby these may be direct, correlative and structural.

- ✓ Direct methods are those that directly foresee the measuring parameters of relevant technology characteristics. They do not explicit correlations with technological, economic, social and political contexts and imply in greater assumptions in relation to the nature and continuity of contexts. Some examples of applicable direct methods are specialist opinions (via Delphi or Survey research), temporal series analysis and trend forecasting (via growth curves, substitution or life cycle).
- ✓ Correlative methods relate technology development at stake to growth or change in one or more elements of the pertaining context. Examples include scenario analysis, crossed impact and analogies, amongst others.
- ✓ Structural methods ensure predictions taking into account the cause and effect relation between technology and its context. Causal models, simulation models, amongst others, are typical examples.

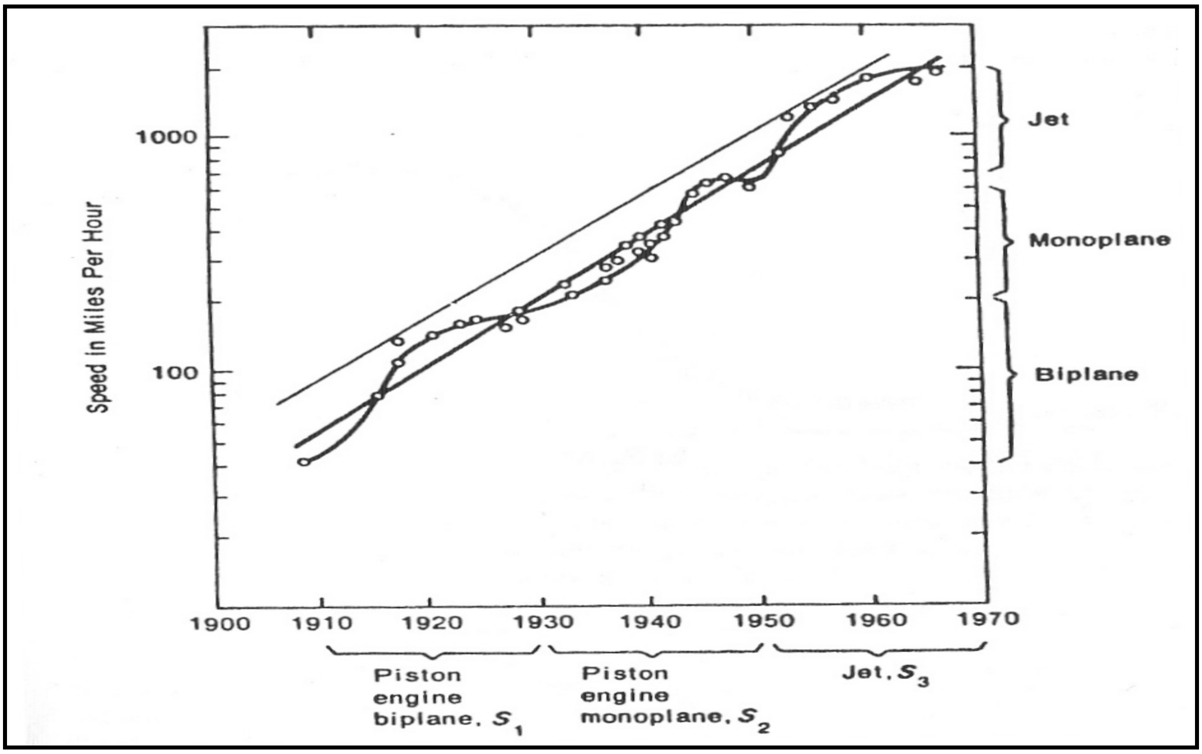
According to Porter´s typology (1991), the current study adopted direct methods using trend forecasts given that it is ground on assumptions such as the nature and continuity of technological contexts set forth by historical data trends. The author indicates the major steps for the preparation of studies based on trend extrapolations. Initially one must clearly define which are the study variables as well as their historical series.

Following the core objective of this study, the adopted variable is the number of most modern processor components, given that Moore´s assumption (1965) of adopting low cost processors as a reference, prove to be inadequate to describe this market´s exponential growth, inclusively as to the data presented by the very same author in Moore (1975). The historical series of this variable was extracted from Intel (2007) and Moore (1975). So as to validate the data, ITRS (2001), ITRS (2005) and Yang (1998) were also examined to confirm the use of the referred historical series.

The first step proposed by Porter (1991) is to identify the model that best describes innovation patterns of the technology under study. The author emphasizes that models that describe S curves (such as Fisher-Pry and Gompertz) must be considered, given that these picture most technological evolution patterns. Other possible models are learning curves, exponential and even linear growth.

Exponential growth occurs during some periods or phases (Hamblin, Jacobsen & Miller, 1973 apud Porter, 1991); so, this expansion rate changes and another stage emerges. Therefore, during technological evolution at different times, continuous exponential progress is usually feasible, however at varied growth rates. Consequently, functions that describe technological progress most often display the format depicted in Graph 6 that pictures technological evolution within the aviation industry. As can be observed, progress in the development of a technology starts slowly, given that numerous impairments towards technological evolution demand surpassing.

Once this stage is over, technology presents fast growth rates and subsequently subsides to a slower pace given that it evolves with intensity and extra benefits only arise upon great effort and investment. At this point, the rise of a new technology and of R&D labs focus attention in it´s development – and thus the cycle begins. This is why the authors conclude that each cycle may be illustrated by an "S" shaped curve covering approximately 10 year periods, herein describing the technological evolution of microprocessors.



Graph 6: Technological development

Source: Porter (1991)

Moore (1965) and Moore (1975) clearly state that the growth rate of the technology at stake is exponential and continuous to the extent that the number of components in processors ought to double every 2 years. The author mentions that the model has remained valid for several decades but does not impose a maximum limit or decelerations in growth levels. The current study will validate the model proposed by Moore (1975) and, as will be described in step two, will test several alternative models.

The second phase emphasized by Porter (1991) is to test the adherence of the various models with data. This study undertook numerous adherence and statistical significance tests, with views as to both validating the model proposed by Moore (1975) and so as to suggest an alternative model that might prove to better fit the technological trend described by the historical series.

The third step is to use the model defined in the previous step to forecast upcoming data. In this step, the current study defined, by means of statistical regression models, the equations that govern the technological evolution at hand. Furthermore, a comparison was prepared concerning the data projected following Moore´s (1975) model.

4 MOORE´S LAW VALIDATION

One might crosscheck Moore´s (1975) proposed model as to the presence of discrepancies before actual data covering the period between 1975 and 2006, as of historical data comprising all processors launched by a company, launch dates and the evolution of the number of transistors or components.

Table 1 and Graph 7 present an evolution in the number of transistors based on the actual amount of transistors within the most advanced processor in 1975, the Intel 8080. A preliminary analysis of the historical series demonstrates that the mistake accumulated over years presented a major oscillation and in some cases great amplitude.

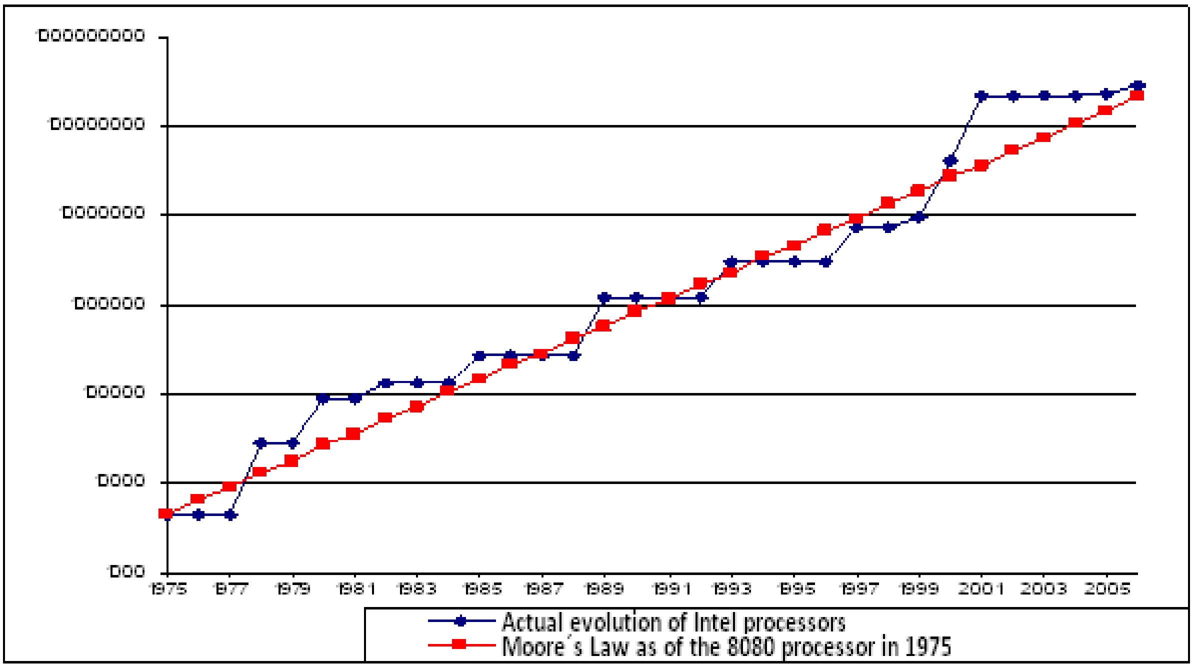
One of the points worth mentioning once analysing the historical series is that the values forecast along the 70´s and 80´s were all in all inferior to those observed. During the 90´s however, this trend was reversed, given the number of transistors foreseen in relation to that observed, and thus, the actual curve came closer to that forecast by Moore.

This fact may be confirmed by the hypothesis tests that are detailed in suit. According to Hammond (2004) the event of relevance that took place during the 80´s (with the launch of the 486 processor) was the inclusion of the cache memory in the calculation of Intel´s processor transistors. This spun off an abrupt increase in the number of transistors, which leaped from 275.000 to 1.200.000, approximately 350% worth of an increase, as pictured in Table 1.

Table 1: Evolution of Intel processors

PROCESSOR	LAUNCH YEAR	NBR. OF TRANSISTORS		DEVIATION	ERROR
		ACTUAL	FORECAST BY MOORE		
8086	1978	29.000	18.000	(11.000)	-37,93%
8088	1979	29.000	27.000	(2.000)	-6,90%
80186	1980	92.000	36.000	(56.000)	-60,87%
Intel 286	1982	134.000	72.000	(62.000)	-46,27%
Intel 386	1985	275.000	216.000	(59.000)	-21,45%
Intel 486	1989	1.200.000	864.000	(336.000)	-28,00%
Intel Pentium	1993	3.100.000	3.456.000	356.000	11,48%
Intel Pentium 2	1997	7.500.000	13.824.000	6.324.000	84,32%
Intel Pentium 3	1999	9.500.000	27.648.000	18.148.000	191,03%
Intel Pentium 4	2000	42.000.000	36.864.000	(5.136.000)	-12,23%
Intel Itanium	2001	220.000.000	55.296.000	(164.704.000)	-74,87%
Pentium D	2005	230.000.000	221.184.000	(8.816.000)	-3,83%
Pentium Core 2 Duo	2006	291.000.000	294.912.000	3.912.000	1,34%

Source: Intel (2007)



Graph 7: Evolution in the number of processor components

Analysing errors concerning the last couple of years (2005 and 2006) one notices that these are the most minor historical mistakes. One might be mislead to conclude that the model proposed by Moore (1975) better fits current times as opposed to earlier years. This closing thought is not correct given that forecast amounts are not cumulative. Should one analyse the values it´s quite evident that the number of transistors doubled in the 70´s every 20 months, whilst in the 80´s every 24 months, during the 90´s every 34 months and along the years 200 every 26 months. Thus, the growth rate during the 2000´s is the highest within the historical series, which suggests the need to adapt the model proposed by Moore (1975).

With views to supporting the validation of the model proposed by Moore (1975), several hypothesis tests were prepared that measure the existence or not of a relation between real values and those forecasted by Moore (1975). The tests were divided into 4 periods: from 1975 to 1979, from 1980 to 1989, from 1990 to 1999 and from 2000 to 2006. Thus, the nullifying hypothesis (H0) is the existence of a correlation between data foreseen by Moore (1975) and the real data observed during the period, and, as an alternative hypothesis (H1), the non existence of a correlation between data foreseen by Moore (1975) and that effectively observed during the period.

Table 2: Pearson´s correlation coefficients

PERIOD	PEARSON'S CORRELATION COEFFICIENT
70´s	0,910
80´s	0,839
90´s	0,952
2000´s	0,674*
1975 to 2006	0,865

*Presented no statistical relevance

As can be seen from Table 2, within a significance level of 5% the nullifying hypothesis is rejected, whereupon one accepts the existence of a correlation between the model proposed by Moore (1975) and the actual data of events that took place during the 70´s. Likewise, there is a correlation with real 80, 90 and 1975 to 2006 data. In as much as the decade of the 2000´s is concerned, the nullifying hypothesis cannot be rejected and thus affirm there is a correlation between the proposed model and reality.

All in all, there are indications that the model proposed by Moore (1975) was valid for the past decades, particularly for foreseeing growth in the number of processor components during the 90´s, however, currently, it calls for adaptations.

5 HISTORICAL SERIES ANALYSIS

Hair (1998) claims that there are numerous functions whereby one might adjust a set of data. The core issue is which function represents the best adaptation, that is, portrays greatest adherence to data observed. One of the methods whereby one may evaluate the quality of the adjustment is Pearson´s correlation coefficient, that is, R2. Therefore, according to Porter (1991), at first, the adherence of the most probable models before the actual historical series was tested. In alignment with the evidence in the studies of Moore (1965), Moore (1975) and Porter´s (1991) previously described recommendations, the first curves subject to testing were those that presented exponential growth. Thus, the logarithmic, quadratic, cubic, logistic, Gompertz and Fisher-Pry curves were utilised.

Table 3: Function adherence to the actual historical series

FUNCTION	R2				
	ENTIRE PERIOD	70´s	80´s	90´s	2000´s
Logarithmic	0,251*	0,602	0,314*	0,603	0,668
Gompertz	0,686	0,797	0,555	0,887	0,572
Fisher-Pry	0,809	0,000*	0,566	0,913	0,482
Quadratic	0,821	0,810	0,695	0,921	0,688
Cubic	0,892	0,893	0,824	0,923	0,753
Logistic	0,961	0,750	0,794	0,906	0,957

*Presented no statistical relevance

The table above presents R2 results encountered covering the entire historical series period (from 1975 to 2006) and for each decade. Statistical significance tests for the 4 curves were prepared and thus, within a reliability interval of 95%, only the Logarithmic curve does not display relevant statistical adherence in relation to the period defined by the 80´s and from 1975 to 2006.

Despite the Logistic curve´s strong adherence, as previously mentioned and emphasised by Porter (1991), the functions that describe technological progress usually present Graph 6 formats and thus, normally, different periods of technological evolution are represented by S curves that best picture the given timeframe. The author further emphasises that so as to infer which periods ought to be studied, one should analyse at which points of the historical series major technological changes took place.

Therefore, despite the strong adherence and statistical relevance of the Logistic curve to the historical series (especially in relation to the series' latter period), choice was made to conduct a complementary study so as to identify intervals within the historical series to enable logistic curve adjustment to even higher adherence levels.

Hammond (2004) states that the greatest technological advances involving processors occurred at approximately every 10 years, as of 1975. This justifies the testing of logistic curve adherence during the 1975-1985, 1986-1995 and 1996-2006 intervals.

Table 4: Logistic curve adherence tests in relation to the historical series

PERIOD	R2
1975-1984	0,917
1985-1994	0,873
1995-2006	0,906

As can be seen from the previous table, the model defined by the time periods 1975-1985, 1986-1995 and 1996-2006 presented improved adherence before the historical series. Following suit, the equations that describe the model:

$$y_{75-84} = \frac{1}{\frac{1}{135000} + (0,0022 * 0,3323^{t})}$$

Equation 1: Logistic curve for the 1975 to 1984 period

$$y_{85-94} = \frac{1}{\frac{1}{10000000} + (0,0000072 * 0,66^{t})}$$

Equation 2: Logistic curve for the 1985 to 1994 period

$$y_{95-06} = \frac{1}{\frac{1}{300000000} + (0,0000012 * 0,4758^{t})}$$

Equation 3: Logistic curve for the 1995 to 2006 period

It´s worth noting that studies were prepared for periods other than those presented and that the chosen timeframe presented best adherence amongst all of those subject to testing.

So as to enable the extrapolation of the trend described by the historical series, a single curve that represents component growth trend for the next decade must be defined. To this effect, one must note that the Logistic curve is determined by the equation:

$$y = \frac{1}{\frac{1}{U} + (Bo * B1^{t})}$$

and that it´s shape is defined by 3 parameters: U, B_0 and B_1, as per table 5 below:

Table 5: U, B_0 and B_1 Parameters for the periods under study logistics curve

PERIOD	75-84	85-94	95-06
U	135000	10000000	300000000
B_0	0,0022	0,0000072	0,0000012
B_1	0,3323	0,6600	0,4758

Thus the U, B_0 and B_1 parameters of the curve that will represent the 2007 to 2015 period must be defined. To this effect, the adherence of Linear, Logarithmic, S, Exponencial and Potent curves relative to the 3 periods of each parameter was tested. The table below displays the curves, the R^2 and the equations (in terms of the analysis period) that presented the best adjustments for the U, B_0 and B_1 parameters.

Table 6: Curves with best adjustments for U, B_0 and B_1 parameters

PARAMETER	CURVE WITH BEST ADJUSTMENT	R^2	EQUATION
U	Exponential	0,9954	$Y_p = 3329{,}4e^{3{,}8531p}$
B_0	Potent	0,9796	$Y_p = 0{,}0017p^{-6{,}9919}$
B1	S	0,7560	$Y_p = e^{(-0{,}4885+(-0{,}5814/p))}$
PARAMETER	CURVE WITH BEST ADJUSTMENT	R^2	EQUATION
U	Exponential	0,9954	$Y_p = 3329{,}4e^{3{,}8531p}$
B_0	Potent	0,9796	$Y_p = 0{,}0017p^{-6{,}9919}$
B1	S	0,7560	$Y_p = e^{(-0{,}4885+(-0{,}5814/p))}$

6 PROPOSED MODEL

As of equations that describe the trends of each given parameter, one might define the shape of the Logistic curve that will describe the fourth period from 2007 to 2015. The equation that follows presents the model proposed.

$$y_{07-15} = \frac{1}{\frac{1}{11005033577} + (0{,}0000000243 * 0{,}5305^{t})}$$

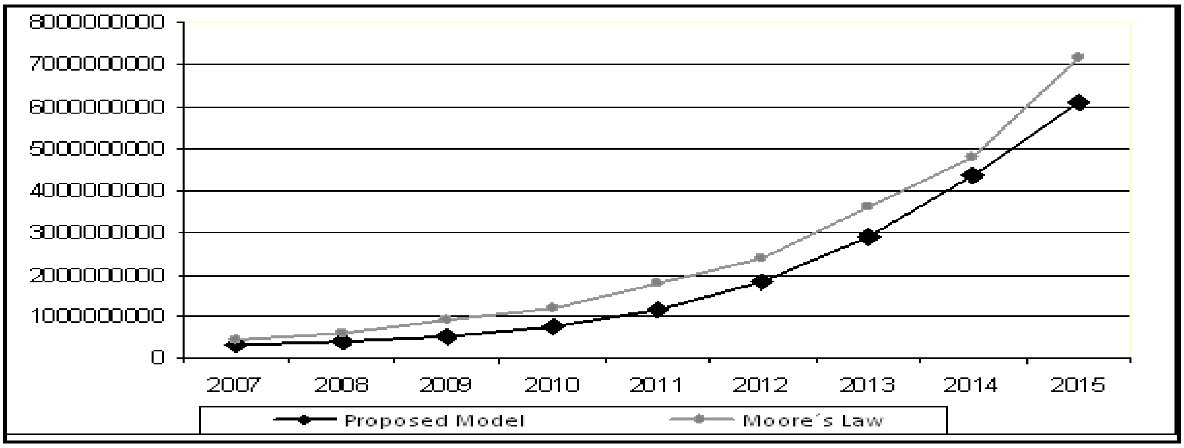
Equation 4: Proposed model for the period between 2007 to 2015

From equation 4, one may extrapolate the trend for the years from 2007 to 2015. The Table 7 and Graph 8 compare the values proposed by Moore (1975) and the values resulting from the model proposed by this study.

Table 7: Comparison between the proposed model and Moore´s (1975)

YEAR	MOORE'S LAW	PROPOSED MODEL
2007	448.614.292	335.167.739
2008	598.152.389	402.552.970
2009	897.228.583	527.330.795
2010	1.196.304.777	754.888.724
2011	1.794.457.166	1.158.582.253
2012	2.392.609.555	1.840.850.021
2013	3.588.914.332	2.904.610.879
2014	4.785.219.110	4.371.189.768
2015	7.177.828.665	6.083.994.470

From the previous Graph 8 verify that the model proposed by this study presents a reduced growth rate as compared to Moore´s Law. Whilst Moore (1975) proposes that the number of processor components doubles every 2 years, the proposed model foresees a deceleration of this rate to approximately 2.8 years.



Graph 8: Comparison between the proposed model and Moore´s (1975)

The main global study that refers to Moore´s Law is the International Technology Roadmap for Semiconductors (ITRS). Since 1999, this study is coordinated by the Semiconductor Industry Association (SIA) and seeks to analyse and predict technological advances within the semiconductor segment over the forthcoming 15 years. The process of preparing the ITRS is the responsibility of four members of each of the sponsoring countries – Japan, Korea, Taiwan, USA and the European Commonwealth. Studies are prepared resorting to segment specialists. In 2003, 940 specialists were called upon and in 2005, 1288.

The ITRS (2003) foresaw the deceleration in the growth rate proposed by Moore (1975), to the extent that the number of components in a processor should double every 3 years within the next 15 years. In 2006, the specialists revised the growth rate to 2,5 years based on the technological evolution experienced between 2004 and 2005. ITRS (2005) also presents the most relevant technological factors that are contributing with the deceleration in the growth rate at stake.

Thus, it is of interest to emphasise that the results encountered by the acknowledged ITRS study – prepared by hundreds of European, American and Asiatic specialists – is in line with the results obtained by the present study.

7 CONCLUSIONS

Statistical tests employed presented strong evidence that the model proposed by Moore (1975) adequately describes the evolution of the number of processor components during the 70´s, 80´s and 90´s. However, during the 2000 decade, the same cannot be affirmed and thus, the current study found evidence of the need to adapt the model for use as a predictive tool.

Based on the historical series tracing the evolution of the number of processor components from 1975 to 2006, three periods of technological advances were identified (from 1975 to 1984, from 1985 to 1994 and from 1995 to 2006) and these are best described by logistic functions. The strong adherence presented by logistics curves enabled the extrapolation of the historical series with a high degree of reliability and therefore the proposed model foresaw a deceleration in the growth rate defined by Moore (1975) to approximately 2.8 years.

Special mention is to be made to the fact that the model proposed by Moore (1975) presents some inconsistencies. The forecast growth rate should describe the evolution of optimal cost processors and according to the analysis undertaken by this study, the model describes the evolution of recently launched processors, therefore those of higher cost.

Another relevant point is that the author did not clearly define a period for his prediction and that is why when one analyses a 31 year period, the model presents a major oscillation in relation to actual data, despite sound adherence to the initial and closing figures of the historical series. Clearly the author did not take into consideration the various technological advance cycles that took place during the study period. Notwithstanding these facts, it becomes evident that the model proposed by Moore (1975) is worthy of great credit once the author foresaw, based on a historical series of 10 points, the behaviour and evolution of processors for the coming 25 years.

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