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Identifying and forecasting the reverse salient in video game consoles: A performance gap ratio comparative analysis

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ABSTRACT

This study uses the reverse salient methodology to contrast subsystems in video game consoles in order to discover, characterize, and forecast the most significant technology gap. We build on the current methodologies (Performance Gap and Time Gap) for measuring the magnitude of Reverse Salience, by showing the effectiveness of Performance Gap Ratio (PGR). The three subject subsystems in this analysis are the CPU Score, GPU core frequency, and video memory bandwidth. CPU Score is a metric developed for this project, which is the product of the core frequency, number of parallel cores, and instruction size. We measure the Performance Gap of each subsystem against concurrently available PC hardware on the market. Using PGR, we normalize the evolution of these technologies for comparative analysis. The results indicate that while CPU performance has historically been the Reverse Salient, video memory bandwidth has taken over as the quickest growing technology gap in the current generation. Finally, we create a technology forecasting model that shows how much the video RAM bandwidth gap will grow through 2019 should the current trend continue. This analysis can assist console developers in assigning resources to the next generation of platforms, which will ultimately result in longer hardware life cycles.

1. Introduction

Video game console manufacturers encounter a difficult strategic decision regarding timing when launching a new platform. In order to achieve wide adoption at a rapid pace, they must often market a new console at no profit or as a loss leader, with the expectation that revenues on software licensing through secondary sales throughout the life of the product will balance out and eventually produce increasingly profitable margins. Ideally, a console manufacturer would like to maximize the length of time between product generations in order to minimize the number of loss leaders and low-margin hardware introductions they have to absorb. On the other hand, if a competing console platform can launch a technically superior generation ahead of the opposition, it will likely cut into the market share of the incumbent system's software sales. Likewise, when no new consoles from any manufacturer appear on the market for a long period, consumers generally shift interactive software purchases to the always-evolving personal computer platform. The console manufacturer's dilemma ends up being that launching new platforms too often will lead to diminished margins, but letting a generation's technology lag too far behind the competition will lead to diminished market share. The objective of this research is to provide a forecasting methodology for interactive entertainment ecosystems to optimize the timing of incremental technological generations.

Over the life of a technological generation, users can perceive a growing gap between the game play experiences on a console compared to the same software titles running on an up-to-date PC. Measuring the growing lag between these experiences over time will provide a quantifiable metric for further analysis.

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Classical diffusion models [1] usually take into account independent, first-time products and do not consider substitutes, complements and relationships between product categories and their specification requirements [2]. Studying technological systems evolution, we will use the reverse salience methodology to analyze the performance gap between PCs and consoles that could potentially lead to a better understanding of when the manufacturer should launch the next generation and what specifications they should include. The causal relationship between reverse salience and the technological generation change of interactive entertainment consoles is that increasing performance gaps will lead to diminished market share, which one can only solve by launching the next generation.

Reverse salience is the measure of the technological disparity between subsystems and the entire system's limited level of performance [3]. In other words, the sub-system that is hindering the full performance potential, the reverse salient, should be identified and corrected for the betterment and the progress of the whole system [4,5]. In this study, we measure the performance gap and time gap as analytical measures of reverse salience magnitude. Performance gap measure reflects the dynamics of change in the evolution of the technological system through magnitude changes in reverse salience [6,7]. While performance gap is the performance differential between the reverse salient subsystem and the most advanced subsystem, the time gap is the duration of time the reverse salient needs to improve to the performance of the most advanced subsystem [3].

2. Technology forecasting in the video game industry

The interactive entertainment industry's global market has been flourishing in the last few years. By 2007, United States video game revenues exceeded the sales of both the box office and music recording industries, becoming the third largest entertainment industry behind book publishing and DVDs.[1] According to PricewaterhouseCoopers' "Global Entertainment and Media Outlook: 2010–2014",[2] they expect the video game industry to expand at an annual rate of 10.6%, growing from $52.5 billion in 2009 to $86.8 billion by 2014. Notwithstanding the considerable popularity of video games, the scope of academic research in this field has not been as comprehensive. In his paper "The Ideology of Interactivity", Garite [8] says for example, that "Most of the work on video games published within the past two-and-a-half decades has been limited to either popular, journalistic accounts of the history of the game industry, or so-called 'empirical' studies of the effects of video game." In the literature, the authors of this paper have also found very few papers that have studied the forecasting of video games technical evolution. For instance, Wolfe [9] has used the Delphi technique to conduct a survey among US experts in order to predict how the future business of games may look. In the paper "Achieving Disruptive Innovation", Sun et al. [10] show how the adoption of TRIZ theory (Theory of Inventive Problem Solving) is feasible to forecast the evolution of video game console systems as a distributive technology. On the other hand, Dedehayir [3] emphasizes that historical trends or temporal changes in reverse salience magnitude of any sub-system, in the video game system, could be used to forecast the future changes in the gaming performance on the holistic PC system.

When choosing between forecasting methodologies that can effectively characterize video game hardware evolution, matching the technology growth to a modeling scheme with a similar profile will result in the most accurate estimations [11]. Bowonder, Miyake, and Muralidharan [12] explain that technology progresses in a similar fashion as evolution in nature. We need to "anticipate surprises, convergence and divergence of technologies, as well as interactive events." One can see these concepts in video game evolution as hardware superiority is not the only factor in the survival of the fittest. Rather artificial selection [13] and chance events [14,15] can favor and lock-in [16] an inferior but more accessible console. The progress of personal computers can be viewed similar to the constant recombination and mutation of genetics, whereas video game consoles evolve generationally with punctuated equilibrium.

Technology Cycle Time [17] has been shown to accurately assess technological progress through examination of patent reference ages. Bibliometrics and Patent Analysis [18] have been shown as reliable early indicators that the subject technology is evolving at a rapid pace. However, Rossel [19] warns that early detection and warning schemes using weak signals are often oversimplified and have costs that can outweigh the benefits, and can easily lead to poor resource management. Since console manufacturers have often chosen to protect their IP with trade secrets over patents, the profile for the early indicators cluster does not match well for this investigation.

The Technology Futures Analysis Methods Working Group [20] suggests exploring and integrating new methodologies to take advantage of data resources when analyzing complex systems. When dealing with a complex system containing multiple parameters, one can construct a composite model to develop a single measure of performance. While some systems can be analyzed by looking at a single parameter, other may require two or more parameters to be utilized in a composite score [21]. We are using Martino's perspective as we develop CPU score as a performance measure for our analysis. Martino [21] used this methodology along with regression modeling to characterize the progress of fighter jet subsystems. Inman, Lane, and Anderson [22] later re-analyzed Martino's data using TFDEA (Technology Forecasting Data Envelopment Analysis). They argue their approach exhibits improved predictive accuracy. Anderson, et al. [23] performed a similar study using TFDEA on a multiple parameter CPU model. This paper integrates Martino's regression methodology with Dedehayir's reverse salient approach in order to compare the technology gap between PC's and consoles. In the recommendations for future research, we discuss revisiting our data with TFDEA for a comparative analysis.

3. Reverse salience

The etymology of the term "Reverse Salient" goes back to World War I military jargon to describe a weak segment in a battlefront that is not advancing as quickly as the rest of the line [24]. A reverse salient, in any technological system, refers

[1] http://vgsales.wikia.com/wiki/Video_game_industry#Comparison_with_other_forms_of_entertainment

[2] http://www.pwc.com/gx/en/press-room/2010/E-and-M-players-seek-new-roles-digital-value-chain.jhtml