The Influence of Introducing IT into Production System: A Case of Japanese Animation (Anime) Industry

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Abstract: How does the introduction of information technology (IT) influence production systems? This paper reveals two important changes by introducing information technology (IT) into a production system in the case of the Japanese anime industry. In particular, it focuses on the production system and the relationship between outsourcing and in-house production. Given this objective, this research explores each process and technology of the production system. The processes that are focused in this research are the art production process, painting process and the process that follows. In addition, it examines three-dimensional computer graphics and digital sakuga (drawing) in the technology. The results of the paper elucidate the following. First, companies in Japan cannot attain successful introduction of IT until IT achieve low cost or/and high quality. Second, the process of choosing in-house production or outsourcing depends upon the following factors. Realizing the integration of multiple processes or enhancing the flexibility of the production process leads to the transition from outsourcing to in-house production. On the other hand, realizing lower cost by the delivery of digitalized data

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through storage media or the Internet results in the transition from in-house production to outsourcing.

Keywords: information technology, outsourcing, in-house production process, anime (cartoon or animation)

1. Introduction

For several years, people worldwide have been enjoying Japanese anime. Today, many anime programs have gained much popularity. However, few studies have explored the relationship among the production process, technical innovations, and organizations within the framework of Japanese anime production.¹ This paper reveals how the introduction of IT influences the production process of Japanese anime.²

This study employed a two-stage research design. The first stage was conducted from July to September 2007. In the first stage, the author interned at the Association of Japanese Animations³ and conducted unstructured interviews with their experts and anime production companies registered with the Association.


² Shintaku (2005) identifies that discontinuous technological change not only disrupts existing technological systems but also changes the competitive environment. Yasumoto (2006) and Ku (2004) discusses the introduction of new technology in product development within the manufacturing industry. In addition, Brynjolfsson and Hitt (1996), Lichtenberg (1995), and Oliner and Sichel (2000) illustrate the relationship between the introduction of IT and productivity.

³ The industry association for Anime production companies http://www.aja.gr.jp/
Results showed that the handling of three-dimensional computer graphics (3DCG) varied with each anime production company. 3DCG are graphics that express three-dimensional space and objects by performing calculations and rendering 2D images with a computer.\(^4\) The second stage of the study was conducted from June to September 2008. The author conducted semi-structured interviews, in which four people were asked to tell the difference between 3DCG and hand drawings. The interviews lasted about an hour and thirty minutes to two hours. The participants were at the management level in their respective anime production companies. Further information was gathered through follow-up surveys via the telephone or email while reviewing publications.

Figure 1 shows crucial production processes of analog anime

![Diagram of production process]

**Figure 1.** Main production process

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\(^4\) Hara (2005) and Kubo and Baba (2009) investigate production systems suitable for full 3DCG.
implemented prior to the introduction of IT. In the following sections, this paper explains three cases for the introduction of IT, the painting process, art production, followed by the art production processes that use 3DCG and digital sakuga (drawing). This research focuses on two important changes by introducing IT into the production system. In particular, the study examines the production system and relationship between outsourcing and in-house production.

2. The Painting Process and Afterwards

In the painting process, first, paper materials of in-between animation are scanned so that they can be entered into a computer. Scanning has replaced the “trace” process in analog animation. In the trace process, paper materials of in-between animation are translated into cell pictures with a trace machine or hand drawings. Scanning has contributed to cost reduction because it eliminates the need for cell pictures.

Second is the process of digital painting. In the process, animations are painted using digital tools, such as a computer, following the instructions of special staff. Digitalization in the painting process contributes to cost reduction and the maintenance of quality. First, digitalization makes it possible to paint specified areas all at once and renders repainting as an easier task. Second, it does not require the use of paints and is not time consuming because one does not have to wait for the paint to dry.

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5 Art production consists of three stages; layout, key frame, and in-between animation.
6 In terms of outsourcing or in-house production, this research does not consider large companies that have always followed in-house production.
7 This section is based on information from the interviews, Yamaguchi (2004), Tokyo University of Technology (2006), and Anime Jinzai Ikusei Kyoiku Puroguramu Seisaku Innkai (2008).
8 In the early stage of digital painting, there was the problem that it made a cold impression in comparison to analog painting; however, there has been
In the mid-1990s, computers were introduced into the painting process and are now being used by almost all companies. In terms of the transition from in-house production to outsourcing, even though companies began outsourcing before the introduction of computers, many companies that previously produced in-house are now outsourcing through storage media or the Internet.\(^9\)

Next, how does IT influence the processes of compositing and editing? With the introduction of IT, the check-before-compositing process has lost its distinct identity by linking special effect (“tokushu kouka”) before compositing and effect process in compositing (Figure 2). In the check-before-compositing process of analog anime, checking inadequacies on cells and combining cells of character and background was carried out. Then, special effects (“tokushu kouka”) is used to work with cells before compositing. On the other hand, effect in compositing process was outsourced to specialized companies generally. After the introduction of IT, however, both processes are now performed on a computer and, generally, in-house. Often, the same person is responsible for both processes. This is because checking and integrating materials using digital data is easy. Therefore, the check-before-compositing process has become less definitive.

In the digital compositing process, information of positioning and timing are entered into the software\(^10\) and the materials are combined. In analog anime, the compositing process required the following three factors: expensive equipment, specialized skill, and three people to perform the work. In digital anime using computers, however, the compositing process does not require expensive gradual improvement.

\(^9\) Researchers such as Hanzawa (2001) also indicated the acceleration of outsourcing.

\(^10\) Adobe’s After Effects and Celsys Inc.’s CoreRETAS are software solutions used in Japan’s anime production companies.
equipment and specialized skill, and it allows only one person to perform the work. Furthermore, the number of layers is not limited by using digital data.

In the editing process, in which computers have been introduced, non-linear editors are used. Editing software facilitates the selection of the portion to be edited or revised. In terms of the transition from in-house production to outsourcing, the compositing and editing processes are skewed toward the change from outsourcing to in-house production.

3. 3DCG in the Process of Art Production

Some Japanese anime production companies started to use 3DCG

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11 This section is based on survey interviews.
in TV anime programs from the mid-1990s. Currently, hybrid products combining hand drawings and 3DCG have become mainstream. Figure 3 shows an overview of the production process.

Creators of Japanese anime are skillfully utilizing the advantages of 3DCG and hand drawing to produce superior works. The following describes the five differences between hand drawing and 3DCG.

First is human resource. Animators who perform hand drawings are generally art university graduates. Currently, almost all vocational school graduates are taught anime production. A similar trend is seen among 3DCG operators. However, most animators work in the anime industry, while some 3DCG operators design computer graphics for a game or produce computer-aided designs (CAD) for product development. Animators are usually paid less than 3DCG operators; however, it is said that 3DCG operators in the anime

![Diagram of production process](image)

**Figure 3.** Main production process after introducing 3DCG
industry are paid less than those who create computer graphics for games or operate CAD. Additionally, animators and 3DCG operators may have a different visual sense.

Second is equipment. In hand-drawn animation, animators are not provided with durable equipments. Animators themselves own tools such as taps,\textsuperscript{12} the use of which is standard in many companies. In 3DCG animation, on the other hand, companies must provide operators with standard hardware and software. Companies that produced hand-drawn animation did not consider fixed cost and depreciation. Additionally, in the early stage of introducing 3DCG, the accounting departments were surprised with the high variable costs such as electricity bills.

Third is production style. With hand drawings, once the character setting is complete, production can immediately start without prior preparation. By contrast, in 3DCG, modeling and setup are needed as pre-production preparation, even though character setting is complete. However, once these are finished, the progress of production is quick.

Fourth is technological characteristics. Hand drawings allow almost any expression through imagery. Hence, animators can express unreal images that look cool once they have mastered the necessary skills. However, it is difficult for hand drawing to maintain quality when expressing ships, planes, robots, and other mechanical objects that require several lines. On the other hand, it is easy for 3DCG to maintain quality and it is used for objects with many lines. However, Japanese animators believe that 3DCG is not suited for living things such as people and animals or for objects whose frequency of appearance is less.

\textsuperscript{12} A tap is a piece of equipment used for holding animation paper. It is a metal board with three protrusions. The position of the paper is held fast by using animation paper with 3 holes. Holding the paper fast facilitates the confirmation of animation movement.
Fifth is technological advancement. There are no technological advancements in hand drawing. 3DCG, on the other hand, is a technology used not only in anime but also in games and movies as well as in research fields; moreover, it always experiences some progress. Therefore, in comparison to hand drawing, the use of 3DCG requires keeping up with new expression technologies.

The preceding is summarized in Table 1. In terms of the change from in-house production to outsourcing due to the introduction of 3DCG, layouts and key frame processes, which were traditionally important and required specialized know-how, are now being maintained for in-house production.\textsuperscript{13} Most in-between animation

\begin{table}[h]
\centering
\caption{The difference between hand-drawing (established technology) and 3DCG (new technology)}
\begin{tabular}{l|l|l}
\hline
\textbf{} & Hand-drawing & 3DCG \\
\hline
\textbf{Workers} & Mostly working only for animation industry & Able to work for game or CAD \\
& Relatively low wage & Relatively high wage \\
\hline
\textbf{Equipments} & Little necessity of extra equipments & Necessity of integrated hardware and software \\
\hline
\textbf{Production style} & No preparation needed & Modeling, set up and so on in advance needed \\
\hline
\textbf{Technological properties} & Capable of drawing freely & Easy to maintain quality \\
\hline
\textbf{Visual expressions} & Good at expressing people, nature and so on & Good at expressing “mecha”, fluid phenomena and so on \\
\hline
\textbf{Technological advance} & Matured & Remarkably developing \\
\hline
\end{tabular}
\end{table}

\textsuperscript{13} This is fundamentally a comparative issue. Not all original layouts and key frame processes are in-house productions. The rate of in-house production for these processes is higher than that for in-between animation processes.
processes, on the other hand, have been outsourced prior to the introduction of 3DCG. By introducing 3DCG, three different scenarios emerge: (1) a transition from outsourcing to in-house production (2) maintenance of in-house production, and (3) continuation of outsourcing. In 3DCG, the in-between animation is automatically created on the basis of the key frame. Hence, shifting 3DCG to in-house production means shifting in-between animation to in-house production.

Companies shifting the in-between animation process from outsourcing to in-house production are those who mainly express mechanical objects in anime. These companies succeed in in-house production in their field of expertise by utilizing 3DCG to reduce costs.

Large-scale companies within the industry continue to retain in-house production14 and usually tend to perform 3DCG in-house as well. Next, companies that mainly express people in anime tend to retain outsourcing. Because anime that express people requires proficient hand drawing, 3DCG is not important to these companies.

4. Digital Sakuga (Drawing) in the Process of Art Production15

Digital sakuga (drawing) became viable technology after the dawn of the 21st century.16 In digital sakuga (drawing), art production does not require pencil and paper, but a pen tablet. Digital sakuga (drawing) tends to be used for in-between animation and works17

14 There is almost no company that does all its in-between anime process in-house. This is also a comparative issue.
15 The material in this section is based on the interview surveys, Yamaguchi (2004), Tokyo University of Technology (2006), and Anime Jinzai Ikusei Kyouiku Proguramu Seisaku Iinkai (2008).
16 Yamaguchi (2004) explains that digital sakuga (drawings) became a reality after the introduction of “Stylos” by Celsys Inc. in 2002.
17 For example, works that target children and where the characters are distorted. It is used at Toei Animation for the production of “Nono-chan.”
with low technological requirement. Therefore, digital sakuga (drawing) contributes to cost reduction because it eliminates the use of paper, scanning, and dirt removal\textsuperscript{18} and makes the correction of lines easier, even though achieving quality is difficult.

The most popular software used in digital sakuga (drawing) in Japan is Stylos HD by Celsys Inc. Stylos HD\textsuperscript{19} has the ability to handle both vector\textsuperscript{20} and raster\textsuperscript{21} graphics and creates an animator's work environment with features, such as multi-layer functionality, strengthening of the light table, and shake correction.

On the other hand, digital sakuga (drawing) has yet to be widely applied into anime production companies. One reason is that it is difficult for digital sakuga (drawing) to express delicate shades and thicknesses of lines drawn by pencils. Second is the inability to reproduce the feel created by using pencils. For example, the pen tablet does not provide the slight sandy effect that pencils provide. Third reason is the high cost of introducing pen tablets. Pen tablets, which are cheaper than liquid crystal tablets, present problems due to their small size in comparison to computer displays used as output media. These reasons may disappear in the future through innovations.

\textsuperscript{18} Dirt removal is the procedure for removing impurities from the picture’s surface that occurs from scanning.
\textsuperscript{19} Information related to Stylos HD is based on Anime Jinzai Kyouiku Puroguramu Seisaku linkai (2008).
\textsuperscript{20} Anime Jinzai Kyouiku Puroguramu Seisaku linkai (2008) explains that vector graphics are based on the combination of the straight and curve lines that connect control points. In addition, they are not suited for images, including an infinite number of colors such as those in pictures or watercolors, but geometric and simple shapes.
\textsuperscript{21} Anime Jinzai Kyouiku Puroguramu Seisaku linkai (2008) explains that raster graphics widely applied because it is easy to use. But it cannot maintain quality with expansion as its structure arranges the pixels on the grid pattern.
5. Discussion

This section summarizes the effects of the introduction of IT into the three steps of post-painting process, 3DCG, and digital sakuga (drawing) in Japanese anime production. This section is based on the analysis discussed in previous sections.

Nearly all companies have introduced IT in their painting process and the process that followed. Digital painting, compositing, and editing also contribute to cost reduction as well as maintaining and improving quality. The painting process has been traditionally outsourced. In addition, the introduction of IT has accelerated outsourcing. This is because the costs of outsourcing have decreased through storage media and the Internet. Conversely, the compositing and editing processes tend to change from outsourcing to in-house production. This is due to the improvement in production flexibility and integration of side processes in addition to cost reduction.

In terms of 3DCG, many companies use 3DCG in combination with hand drawing. This is because hand drawing and 3DCG have their respective field of expertise with regard to cost and quality. In terms of the change from in-house production to outsourcing by the introduction of 3DCG, there are three characteristics: (1) large scale companies retain in-house production (2) companies that mainly express mechanical objects in anime transition from outsourcing to in-house production, and (3) companies that mainly express people in anime retain outsourcing.

Digital sakuga (drawing) is not widespread in Japan because it insufficiently contributes to quality and cost reduction. Digital sakuga (drawing), however, will become widespread if liquid crystal tablets with lower price are introduced or animators feel pen tablets can reproduce the feel that using a pencil brings through innovation.
Introducing IT is not considered effective until the advantages from lower cost or/and increased quality become apparent. The following summarizes the outsourcing and in-house production of existing processes, and the outsourcing and in-house production processes after the introduction of new IT from their respective axes, excluding digital sakuga (drawing) which is not widely used (Table 2).

What about digital sakuga (drawing)? As previously stated, digital sakuga (drawing) is not widespread. But Toei Animation, which is established and large in this industry, introduced digital sakuga (drawing) for in-house production of works requiring low-performance levels. It should be noted that Toei Animation is an

Table 2. Changes in production system after introducing IT

<table>
<thead>
<tr>
<th>After introducing IT</th>
<th>Outsourcing</th>
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<tbody>
<tr>
<td>In-house</td>
<td>Outsourcing</td>
</tr>
<tr>
<td>Before</td>
<td>In-house</td>
</tr>
<tr>
<td>• 3DCG (to in-betweens) (these companies are large scale)</td>
<td>• Digital painting (through the internet or storage media)</td>
</tr>
<tr>
<td>Outsourcing</td>
<td>• 3DCG (to in-betweens) (these companies are good at expressing mecha)</td>
</tr>
<tr>
<td></td>
<td>• Non-linear editing</td>
</tr>
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<td></td>
<td>• Digital compositing</td>
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22 Davis (1989) and Davis, Bagozzi, and Warshaw (1989) analyzed user acceptance of IT in terms of quality (perceived usefulness) and cost (perceived ease of use).

23 Conversely, Yasumoto and Shiu (2007) analyzed how new technology is adopted through collaboration between companies.
exceptional case given the following points: (1) Toei Animation traditionally keeps in-house production for in-between animation and (2) digital sakuga (drawing) was introduced in their overseas subsidiary. Companies that outsource in-between animation will not necessarily shift to in-house production in the future by introducing digital sakuga (drawing).

The influence of digital sakuga (drawing) in the future in art production might be dependent upon processes in which its importance is low (in-between animation) or high (layout or key frame), such as in the case of 3DCG. The companies might retain outsourcing processes of low importance, such as in the case of the in-between animation process, and in-house production processes of high importance, such as layouts or key frame processes after the introduction of IT.

6. Conclusion

This research analyzed the influence of IT on the production process in the anime industry from the perspective of quality, cost, and transition to and from in-house production and outsourcing. Following are the results: (1) introducing IT will not be successful until the advantages from lower costs or/and increased quality become apparent (2) transitions from outsourcing to in-house production by the introduction of IT depends on the growth of importance in related processes, such as integration of production processes or an increase in flexibility (3) transitions from in-house production to outsourcing depend on cost reduction in related processes.

Following are the limitations and suggestions for future research. The subject of this research is not companies that undertake one or two processes; for example, start-ups in anime that undertake painting processes gradually extend into the in-between animation
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process. For these companies, the implications of distinguishing in-house production and outsourcing will be different from this research.

Finally, there is also a need for future research into IT, such as digital sakuga (drawing), that has not yet been widely adopted.

References


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