VIDEO GAMES AND HUMAN PERFORMANCE

by

JOSEPHINE I. MANINGAT

Bachelor of Science in Chemistry
Adamson University, Manila, Philippines, 1975
Master of Science in Business Administration
De La Salle University, Manila, Philippines, 1981

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Approved by:

Major Professor

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INTRODUCTION

The slowdown in the aerospace technology in the 1960's led to the birth of the video game industry. Led by boredom and a lot of thinking time in his hands, Ralph Baer, an electronics engineer at the New Hamoshire Military Equipment Design Company aptly responded to the need of furthering the utilization of television sets by playing games with them (Range, 1974). This novelty idea was welcomed by Magnavox in 1972 leading to the first home video game for use with home television (TV) sets. At about the same period, Atari introduced Pong, the first 25-cent video game.

The Video Games

As its simplest definition, a video game is a toy. The basic operating mechanism is nothing more than a black and white television set but the new wrinkle is a series of integrated circuits of tiny transistors, diodes and printed circuits comprising the machine or hardware . The game itself refers to a software or computer program written and stored inside the tiny silicon chips. In this context, these games may be classified as computer toys or computerized toys. If toys have a completely computerized activity as their main function and without which they cannot operate, then they are computer toys. On the other hand, computerized toys are those which are enhanced in their activities by the provision of a computerized function but which do not rely solely on the operation of this for the activity of

the toy (Smith, 1982).

The video games were introduced in three forms. The first was a hand-held type containing a small screen and a microprocessor all housed in the small unit. It was battery-operated and relatively short games could be played with it. The "Odyssey" popularized by Magnavox , Atari's video game computer system (VCS) consoles, intellevision's video game consoles and a few other similar products produced by other manufacturers fall into the second type. Each is a rectangular box that needs a television set and a cassette-like cartridge in order to function. Each cartridge contains software or intructions on how to play a particular game, thus it permits flexibility in the choice of games. The rectangular box or the game console itself houses the microprocessor that transforms information in the software to dots or bits of sound on the TV and inititates counter measures as the player waggles his controls. The arcade-type video games commonly referred to as "quarter-eaters" would not function without first feeding the machine with a quarter. These are big units that work independently of TV sets and do not use cartridges. Most games programmed for these arcade games are more intricate, with more physical effects.

There are five basic types of video games: driving games; cannon-base games such as Space Invaders and Centipede; rotating-center-cannon games such as Asteroids; side-projected-rocket games such as Defender, Super Cobra and Scramble; and maze games such as Pac-Man, Berzerk and Crazy Climber (Lowe, 1982).

The Video Game Industry

Video games gained acceptance upon their first introduction in the early 1970's quickly eroding the popularity that the electromechanical pinball machines used to enjoy. Other manufacturers notably Allied Leisure of Florida immediately followed suit and sales increased from $1.5 million in 1972 to $11.4 million in 1973 almost entirely because of video games. This remarkable innovation was however shortlived. Pong, invented by Atari's founder, Nolan Bushnell, like the other games pushed themselves into extinction by their own lack of intelligence. In Pong, electronic paddles slapped a ball - really just a white blip - back and forth across a black-and-white TV screen, then later on in its development, permitted one to play with another person. It took a bit of time to master, but after that it was no challenge, and players became bored.

The mid-'70s constituted the Dark Ages in the arcades. The industry seemed fogbound until 1979. Then, suddenly, commuter railroad stations (Trenkaus, 1983) , dormitories, churches, VIP amusement complexes, airports, delicatessens, gas stations, pizza parlors, doctor's offices, Chinese restaurants, and beauty clinics started crawling with electronic columns of squiggly, glowing monsters that marched toward earthmen with measured thump, thump, thump that changed to frenzied thumpthumpthump. Space Invaders along with Asteroids, Defender, Pac-Man, Centipede and scores of others showed their eerie capabilities for seizing sane people by the imagination. In 1979, video game fanatics spent 75,000 man-years playing the

arcade games contributing $5 billion to the nation's gross national product (GNP) (Skow, 1982). This figure did not even include an estimated $1 billion that consumers paid for video game consoles that hook up to TV sets and for the expensive cassettes that make them work. For comparison, $5 billion represented exactly twice the reported take of all casinos in Nevada, almost twice the $2.8 billion gross of the US movie industry, and three times more than the combined TV revenues and gate receipts of major league baseball, basketball and football.

Not only has the video games craze engulfed USA, it spread across the globe. From Tokyo where most game softwares originated, the games were seen in Amsterdam, Stockholm, West Germany, Australia, in Israel's Arab settlements, in Madrid's lounging places, in the huge black townsnip of Soweto, Johannesburg, in the amusement parlors called "chispas" of Mexico City, among others.

The Development

With the extensive preoccupation on the games, there arose anxiety among people all over the world on the presumed ill effects of video game-playing. Parents and educators pounded on law enforcers to prevent arcades from operating near schools. In the Philippines, various civic organizations commended the banning of the games in the country. Smith (1981) of Fisher-Price toys alleged that computerized games can discourage creativity and social interaction among children. Prolonged playing of the games has been reported to have caused new

illnesses like nerve damage of the hand called "video game palsy" and "Space Invader's wrist". Further, in medicine, Mayo Clinic found out that it could trigger seizures in youngsters who are susceptible to epilepsy.

On the other hand, studies were also conducted that pinpointed the positive influence of video game playing. Lesgold (1982) discussed the development and implementation of computer games for teaching of reading to children. The video game was found to be an effective reward or incentive for exceptional children having emotional problems (Buckalew and Buckalew, 1983) and as a diagnostic test administrator and provider of attention (Mason, 1983). Garfinkel of the University of Minnesota and Klee of Emma Pendleton Bradley Hospital in Rhode Island devised a video game-based test battery that "is brief, engaging, and not language- or culture-bound" such that it can be used to identify learning difficulties due to attention-span problems in children from many different ethnic, educational or income groups. In the medical field, research were conducted to use video games as a possible tool to restore and measure mental functions in seriously injured patients (Mickel, 1982), and as a training and development demonstration of severely retarded adolescents (Sedla et al, 1982). The Epilepsy Center at John Hopkins University Medical School used three specially wired Atari sets to determine the effects of anticonvulsant drugs on learning and ability (Skow, 1982). The military found the effective utilization of video games as a substitute for conventional apparatus testing of performance (Kennedy et al, 1982) and as a psychological test

of skill training and acquisition (Jones et al, 1981). At Fort Eustis, Virginia, it was reported that the Army employs a modified "Battlezone" game as a weapons training device. It was found to act as an "alter" to provide company as if it were another person (Scheibe and Erwin, 1979), and to serve as a medium to recall positive material in memory (Isen et al, 1978). A study by Streufert, et al. (1983) found that increased information load conducted using hand-eye coordination task as a video game resulted in increased proclivity to take risks. In the area of advertising, video games have found usefulness as a pretest to provide quantitative measures of the success of commercials in non-laboratory settings (Grass, 1983).

The Motivational Aspects of Video Games

Some psychologists believed that what makes the games so captivating was their motivational aspect. Malone (1981) suggested that the games offered challenge, created fantasy, and envigorated curiosity. Frederiksen et al (1982) described the power behind the games as due to the presence in the games of clear-cut goals, their fast pace, availability of immediate feedback and variability of levels of challenge. Similarly, Chaffin et al (1982) emphasized feedback, improvement, high response rates, and unlimited ceilings of performance as the motivational features of video games. The military explained that the games had great potential for psychological testing since they involve skills, are self-motivating and highly speeded (Kennedy et al, 1982).

Video games, "Pac-Man" for one, undeniably provided extrinsic supports as players rack up medals for achievement disguised as score points. However, Bowman (1982) reiterated that the games should possess far more than the extrinsic or means-end motivational supports to account for the level of attention they get. He said that the addictiveness of "Pac-Man" suggests that the source of its appeal is grounded in the domain of intrinsic rewards. What makes an activity so so enjoyable as to be intrinsically rewarding was explained in Csikzentmihalyi and Larson's (1980) thesis of a balanced state of interaction, - " a flow state". Flow is described as a condition in which one concentrates on the task at hand to the exclusion of other internal or external stimuli. Action and awareness merge, goals tend to be clear, means are coordinated to the goals, and feedback to one's performance is immediate and umamoiguous. In such a situation, a person has a strong feeling of control - or personal causation - yet, paradoxically, ego involvement is low or nonexistent, so that one experiences a sense of "transcendencence of self", sometimes a feeling of " union with the environment". The passage of time appears to be distorted: some events seem to take a disproportionately long time, but, in general, hours seem to pass by in minutes.

From this perspective, "Pac-Man's" addictiveness would be explained as follows: "It is an action-orientec system where skills and challenges are progressively balanced, goals are clear, feedback is immediate and unambiguous, and relevant stimuli can be differentiated from irrelevant stimuli. Together, this combination contributes to the formation of a flow experience"

(Bowman, 1982). Thus if the video games could command such high degree of concentration following this flow concept, it could be possible that they may be used to develop further a person's concentration ability such that he may concentrate as well in other forms of activity.

Gardner (1979) viewed the computer toys games as sly opponents against which players can exercise their wits, stimulating the latter's learning process, giving an experience of "thinking well". He said "what is important is that they acquire strategies that will enable them to think better in the future, long after they have forgotten the particular moves of a specific game". Thus it may be hypothesized that cognitive performance may improve and the extent of which can be measured using perceptual acuity performance measure.

Another point to consider is that most theories on the motivational aspects of the games emphasized fast pace as a promising contribution to their popularity. Both reaction time and impulsiveness in people may therefore be influenced by playing the games.

Despite numerous applications of video games in various fields, no investigation has been conducted in actual production settings. It is thus noteworthy to consider the possibility that playing video games by production workers may bring about an increase in productivity or workers' performance and an upliftment of employees' morale.

Perceptual Acuity

Perceptual acuity pertains to the accuracy in the perception of form and geometric properties of figures and optical illusions. It has been well demonstrated that there are individual differences in the way in which a person perceives his world. McGurk (1967) questioned whether differences in susceptibility to visual illusions could be possible indicators of other personality traits. It was concluded that resistance to geometric optical illusions is part of a definable nexus of cognitive and interpersonal attributes that contributes positively to the ability of the individual to attain goals, manage dispositions, and cope with the environment.

Perception is one of the many components of intellectual functioning, others being processing, storage, and retrieval of information. To deal effectively with the demands of everyday living, an individual must perceive accurately what is encountered in the visual, auditory, kinesthetic, and other sensory domains. Skills in the interpretation of experience, retention of information, and comprehensiveness of recall will be of little value in coping with the external world if initial perceptions are faulty. For these reasons, attempts have been made by testers of intelligence to assess perceptual functions as a measure of intellectual ability from the days of Cattell in the nineteenth century to the present time. The perceptual acuity test (PAT) by Gough and McGurk (1967) evolved in response to this thrust. A study conducted by Gough and Weiss (1981) reported that the PAT scores correlated significantly with

performance on the Gottschaldt Hidden Figures Test, the Wechsler Adult Intelligence Scale, a personality scale for intellectual efficiency, education, and observers' ratings of variables such as range of interests, level of aspiration, intellectual competence, and the evaluation placed on intellectual and cognitive matters.

Impulsiveness

Impulsiveness is part of a more inclusive class of action-oriented personality dispositions that include extraversion, sensation-seeking, and, in general, lack of "inhibitory behavioral controls" (Barratt and Patton, 1983). It pertains to the tendency to respond quickly rather than inhibiting the response (Buss and Plumin, 1975). It is acting without thinking or adequate reflection, reacting quickly to first impressions or on the spur of the moment, taking risks, getting things done sooner than later, experiencing difficulty in concentrating, restlessless, and distractability (Barratt, 1983). Three subtraits of impulsiveness are recognized motor impulsivess, cognitive impulsiveness, and non-planning impulsiveness and these are measured in the Barratt Impulsiveness Scale test.

Concentration

Concentration is defined as the exclusive attention to one object or close mental application. It is one major element that characterizes "the flow state" as described in

Csikzentminalyi and Larson's theory of a balanced state as discussed earlier.

Reaction Time

Reaction time refers to the length of time a person takes in recognizing a given stimulus or stimuli and only after which he is able to respond. It is normally a function of the amount or extent of stimuli given and the level of difficulty in which they are presented. An activity involving a purely mechanical depression of a button or lever generally elicits the most spontaneous response in contrast to one in which a momentary mental collation or decision-making needs to be done prior to the actual physical response.

The average reation time with a given number of stimuli can be broken down into three parts: (1) response selection; (2) memory scan; (3) response selection and execution. For a given set of conditions, the first and third parts are assumed to be constant, whereas the second part is interpreted to be a direct reflection of memory-scan speed or memory load (Chiles, 1982).

Productivity

Productivity is commonly defined as the amount of goods and/or services produced per hours of human labor (Wight, 1974). Depending on where an observer looks, there are, however, three kinds of productivity. They are: technical, economic, and social

productivity. Technical productivity is that associated with the workplace and concerns the direct goods or services produced by individuals or work groups coupled with the tools of the workplace. Economic productivity is commonly assumed to result from increased technical productivity but it is not necessarily so. Greater investment in the workplace for increased technical productivity may result in increased and noncompetitive costs for the products or services. Social productivity refers to the desirability and/or usefulness of the products or services produced. In the broadest sense, productivity assessment must take into account all three levels of productivity. But, in most cases, emphasis is given principally to its technical aspect (Judson, 1976).

Technical productivity may be expressed in various ratios. Among a few are:

$$\text{Productivity} = \frac{\text{Output (in goods or services)}}{\text{Input (in dollars, both direct and indirect)}}$$

Source: Vough and Asbeel, 1979

$$\text{Dollarized Productivity} = \frac{\text{Total Sales (\$)}}{\text{Total payroll (\$)}}$$

Source: Sibson, 1976

$$\text{Productivity} = \frac{\sum_{j=1}^{J} (V - E)}{L + C + R + M}$$

where: V = total value to user of each j products or services

E = cost penalty for each factor

causing inefficiencies

C = capital cost

L = labor cost

R = materials cost

M = cost of miscellaneous supplies and services

Source: Hanes and Kriebel, 1978

$$\text{Group Productivity} = \frac{\text{Actual Productive Work Hours}}{\text{Total Work Hours Available}}$$

Source: Gross, 1978

Productivity measurement is an evaluation of worker performance. It is vital that the measurement data be valid and that the meaurement be perceived by the worker as valid and fair. Otherwise, the impact of product assessment may be harmful to productivity.

In developing a productivity measure of any organizational characteristics, it is necessary to take note of the specific decisions for which the data are to be used. Before indices of productivity or motivation are monitored, the organization must have a very clear idea of why it wants the information and how the information is to be used. Specification of task objectives serves as a rigorous definition of what it is the organization wants the individual performer to be able to do (Campbell, 1978).

This requirement for measurement specificity places many demands on a productivity measurement or assessment system.

First, it assumes a detailed analysis of worker performance dimensions. Second, it may impose an indepth and costly measurement system. Third, management must set specific standards for which kinds of and how much outputs are expected.

Some authors believed that productivity data, first and foremost, are used to measure worker output both from the quality and quantity aspect of worker performance with the end objective of improving worker productivity. Yet Judson (1978) reiterated that productivity measurement "must involve measurement at motivating workers and only secondarily to appraise progress." Along this line, it has become the trend in literature and in actual practice that job satisfaction is also measured to determine worker's attitude towards the job. Going further, productivity measures may extend to studying specific work factors or conditions surrounding work, that is, the total quality of working life. This however places a tremendous burden on the measurement system underlying productivity assessment in view of the large number of dimensions that may have to be included.

Job Satisfaction

Job satisfaction has widely been associated with the term "employee morale" (Brayfield and Rothe, 1951). It seems to be derived from a variety of circumstances but in a general working approach, it is commonly asssumed that it can be inferred from an individual's work or his attitude towards his work (Wight, 1974). Hoppock's (1935) concept of job satisfaction is

that it is a combination of psychological, physiological, and environmental circumstances that causes a person to truthfully say "I am satisfied with my job."

A multitude of satisfactions and dissatisfactions may play upon each other to produce the composite attitude reflected in the statement "I am satisfied with my job". Hoppock discussed: "Our definition asumes that it is possible for a person to balance the specific satisfactions against the specific dissatisfactions and thus arrive at a composite satisfaction with the job as a whole". Similarly, Walton (1975) said that job satisfaction is an individual phenomenon; both satisfactions and dissatisfactions are potentially of positive value in the maintenance of an effective society. In the normal worker, there is a persistent force toward experiencing satisfaction and avoiding the experience of dissatisfaction - the latter being generally an unstable and transitional state. The dissatisfied worker will seek ways to change his job or rationalize a change in his evaluation of it. Accomodative processes to assure job satisfaction include changing the job environment, goal reduction, cognitive distortion, resignation, aggression, and withdrawal. Some of these strategies reduce dissatisfaction at heavy personal, organizational, and societal cost.

There are three direct approaches of measuring overall job satisfaction. According to Hoppock (1935), one is to use questions or statements regarding satisfaction with the job as a whole. This is the basis of his test Job Satisfaction Blank No. 5 (JSB). He also identified another method in which different aspects of the job are used. The Tear Ballot for Industry by

W.A. Kerr exemplifies this method (Crites, 1966). Brayfield and Rothe's (1951) approach is the third way of measuring job satisfaction. This dictated the methodology attitude scaling where an attitude scale elicits and quantifies an expression of feeling toward an object. In Crites' (1966) review of these instruments of measure, he highly commended Hoppock's JSB. Among his reasons were: "It is easy to administer and score; it takes only a few minutes to complete. It is applicable to all occupations and it is reasonably valid."

PROBLEM

The primary objective of this study is to determine whether playing video games can improve productivity, judged work performance, and job satisfaction of workers in an actual production setting. The scope of this research also includes a study on the effect of video game playing on an individual's perception, impulsiveness, concentration, and reaction time. Specifically, it is hypothesized that all four aspects of human performance may be improved by playing video games.

METHOD

Before conducting any part of the experiment, each subject was handed an information sheet (see Figure 1). This gave a brief description of the study and also included a form for him to sign indicating his willingness to participate in the study.

The study consisted of three stages. During the first stage, all subjects took the performance measure tests on perception, impulsiveness, concentration, reaction time, and job satisfaction. The subjects' respective foremen filled out the performance evaluation sheets with regard to each subject's job knowledge, ability to be self-motivated, and quality consciousness. Historical data on productivity, attendance, safety, and accuracy of labor reporting were gathered by the experimenter.

The second stage was the video game playing period of one month. About half of the subjects played video games using the Atari 2600 video computer system (VCS) game console. Playing was conducted daily for 30 minutes per work day. Subjects had the option to play during their morning or afternoon fifteen-minute breaks, their lunch or dinner thirty-minute breaks, their ten-minute night breaks, or anytime before or after work provided they completed only a total of thirty minutes playing time per day. Playing could be done either individually or by partners depending on the subject's preference and the limitations of the game played. Any of the provided games could be played and in

INFORMATION SURVEY SHEET

TITLE: Effect of Video Games on Human Performance

OBJECTIVE: To determine if playing video games can improve an individual's reaction time, degree of concentration, impulsiveness, perceptual acuity, and job satisfaction.

BENEFITS OF THE RESEARCH: Video game-playing provides a very amusing way to spend break times and it may possibly result in an improvement on the abovementioned aspects.

TASK: Each subject shall be randomly assigned to either the treatment or control group. In the treatment group, subjects shall play video games by pairs for 30 min per day during break times for one month. The control group shall not be playing video games but both the treatment and control groups will take the different tests of measure before and after the one-month experiment period. If the results of the test after the experiment are better than before the experiment was done, it is possible that the video games caused the improvement.

NOTE: Subjects in the control group will be given a chance to play video games after the experiment period.

DESCRIPTION OF TESTS: For tests on impulsiveness and job satisfaction, a subject shall fill up questionnaires. For concentration and perceptual acuity, he shall answer on an answer sheet as he is presented with slides or an audio tape. He shall press a corresponding button for a light to turn on depending on the stimulus shown in the reaction time test. All tests shall be conducted as a group except the reaction time which is on individual basis.

Figure 1. Research Survey Information Sheet

Are you willing to participate in this experiment by being a subject? yes _____ no _____

If answer is no, please state reason _____

_____

How often have you played video games?

daily _____ few days/week _____ weekly _____

occasionally _____ rarely _____ never _____

How much do you like video games?

not at all _____ little _____ average _____

very much _____ neither like nor dislike _____

Will you be available by the last week of July to August?

yes _____ no _____

NOTE: Results of this experiment shall be made available as an overall analysis not for each subject. A subject may request for his actual test results from the experimenter but the experimenter shall not make available the subject's results without the latter's approval.

Thank you so much for your cooperation. Should you have any questions, please call Josie Maningat at 532-5123 or 776-7970.

NAME _____

AGE _____ SEX _____

DEPARTMENT/SHOP _____ SHIFT _____

Figure 1. Research Survey Information Sheet - Continued

any sequence. Subjects were however required to jot down, everytime they played, the name of the game played and times playing was started and finished. During this same period, production outputs by "workcenter" were monitored and recorded. Collected also were data on each subject's attendance, safety, and accuracy of labor reporting.

In the last stage, which occurred immediately after the playing period of one month, all subjects took the performance tests again and the foremen made subjective evaluations on each subject's performance on job knowledge, self-motivation attitude, and quality consciousness.

Tests

Performance tests on perception, impulsiveness, concentration, and job satisfaction were taken by subjects in groups in a conference room relatively free from outside disturbance or noise. The experimenter announced the names of the tests to be given then requested subjects to answer questions honestly. They were assured that results of the tests would in no way affect their respective jobs and that individual test scores would be treated with strict confidentiality. If desired, each subject would be informed on how he fared on the tests. Then, questionnaires or answer sheets were distributed. Pencils with erasers were also provided. Each test questionnaire or answer sheet included instructions on what had to be done. As much as possible, no further instructions were given by the experimenter. The tests on perception, impulsiveness, job

satisfaction, and concentration were given in that order and took approximately 20 min, 15 min., 10 min., and 15 min., respectively. The only test that was done individually was the reaction time test. This was held in an office room that was closed so that there was no distraction. Only the experimenter and one subject were present everytime the test was conducted. Testing took about 5 min. per subject. Each of these tests are discussed as follows:

Perceptual acuity test (Gough and McGurk, 1967). This test consisted of 30 perceptual problems involving geometric forms, presented by slides. Thirty seconds was used to present each slide to allow respondents to grasp the problem and record answers. Five figures were included in each problem, from which one was to be selected that meets a specified criterion (e.g. being equal in length to a standard, having an area or circumference equivalent to a standard, or constituting the most precise extension of a beginning line). Twenty-five of the problems incorporated geometric illusions of one kind or another; five did not contain illusions. There were three scores: the number of correct choices on the five nonillusion problems, the number of correct choices on the 25 problems involving illusions, and a weighted total score in which additional points were given for certain incorrect but good quality responses to the illusions.

Barratt Impulsiveness Scale (Barratt, 1983). This attitude-scaling-type questionnaire consisted of 48 items. It was accomplished at the subject's pace with no prescribed time limit. The overall test score was the composite score of a

person's motor, cognitive, and non-planning impulsiveness. A high test score represented greater degree of impulsiveness. Figure 2 shows a copy of this test along with its key.

Index of Job Satisfaction (Hopcock, 1935). This test (see Figure 3) was in a questionnaire form with four items. For each question, the subject was to choose from a five-point scale to determine the degree of his response to the overall work situation cited. There was no right or wrong answer but each response had an equivalent number of points. The total number of points for all four questions was converted to a percentile score. The higher this value, the higher was the individual's job satisfaction.

Concentration test. This tape-recorded test consisted of five parts of ten questions each. For each part, one question or instruction was given applicable to the ten sets of five to seven-digit numbers to be mentioned or there was one question for each set of numbers. In whichever case, sets of numbers or separate questions were given once at seven-second intervals. Figure 4 gives the content of this taped test. The correct answers are also shown.

Reaction time test. This test was conducted with the use of a reaction time device. Before the test started, the subject was first asked to read the instructions (see Figure 5). After the experimenter checked if the subject positioned his forefinger (of the preferred hand) about one inch in front of the center of his board's base, a practice session was initiated. This was done to familiarize the subject with the device before

PERSONAL EVALUATION - BIS - 10

NAME: _____ DATE: _____

DIRECTIONS: People differ in the ways they act and think in different situations. This is a test to measure some of the ways in which you act and think. Read each statement and darken the appropriate circle on the right side of the page. Do not spend too much time on any statement. Answer quickly and honestly.

		Rarely/never	Occasionally	Often	Almost always/ Always
1.	I plan tasks carefully	0	0	0	0
2.	I do things without thinking	0	0	0	0
3.	I make-up my mind quickly	0	0	0	0
4.	I am happy-go-lucky	0	0	0	0
5.	I don't "pay attention"	0	0	0	0
6.	I have "racing" thoughts	0	0	0	0
7.	I plan trips well ahead of time	0	0	0	0
8.	I am self-controlled	0	0	0	0
9.	I concentrate easily	0	0	0	0
10.	I save regulary	0	0	0	0
11.	I "squirm" at plays or lectures	0	0	0	0
12.	I am a careful thinker	0	0	0	0
13.	I plan for job security	0	0	0	0
14.	I say things without thinking	0	0	0	0
15.	I like to think about complex problems	0	0	0	0
16.	I change jobs	0	0	0	0
17.	I act "on impulse"	0	0	0	0
18.	I get easily bored when solving thought problems	0	0	0	0
19.	I have regular health check ups	0	0	0	0
20.	I act on the spur of the moment	0	0	0	0
21.	I am a steady thinker	0	0	0	0
22.	I change residences	0	0	0	0

Figure 2. Questionnaire on Barratt's Impulsiveness Scale

		Rarely/never	Occasionally	Often	Almost Always/ Always
23.	I buy things on impulse	0	0	0	0
24.	I can only think about one problem at a time	0	0	0	0
25.	I change hobbies	0	0	0	0
26.	I walk and move fast	0	0	0	0
27.	I solve problems by trial-and-error	0	0	0	0
28.	I spend or charge more than I earn	0	0	0	0
29.	I talk fast	0	0	0	0
30.	I often have extraneous thoughts when thinking	0	0	0	0
31.	I am more interested in the present than the future	0	0	0	0
32.	I am restless at the theater or lectures	0	0	0	0
33.	I like puzzles	0	0	0	0
34.	I am future oriented	0	0	0	0

END

Figure 2. Questionnaire on Barratt's Impulsiveness Scale-Continued

Job Satisfaction Blank No. 5
by
Robert Hoppock

Choose the ONE of the following statements which best tells how well you like your job. Place a check mark (√) in front of that statement:

1___I hate it.
2___I dislike it.
3___I don't like it.
4___I am indifferent to it.
5___I like it.
6___I am enthusiastic about it.
7___I love it.

Check one of the following to show HOW MUCH OF THE TIME you feel satisfied with your job:

8___All of the time.
9___Most of the time.
10___A good deal of the time.
11___About half of the time.
12___Occasionally.
13___Seldom.
14___Never.

Check the ONE of the following which best tells how you feel about changing your job:

15___I would quit this job at once if I could get anything else to do.
16___I would take almost any other job in which I could earn as much as I am earning now.
17___I would like to change both my job and my occupation.
18___I would like to exchange my present job for another job in the same line of work.
19___I am not eager to change my job, but I would do so if I could get a better job.
20___I cannot think of any jobs for which I would exchange mine.
21___I would not exchange my job for any other.

Check one of the following to show how you think you compare with other people:

22___No one likes his job better than I like mine.
23___I like my job much better than most people like theirs.
24___I like my job better than most people like theirs.
25___I like my job about as well as most people like theirs.
26___I dislike my job more than most people dislike theirs.
27___I dislike my job much more than most people dislike theirs.
28___No one dislikes his job more than I dislike mine.

Figure 3. Questionnaire on Hoppock's Job Satisfaction Blank

Instructions for Scoring

From Table 1, below, select the scale values of the four items checked by the respondent. Add these four numbers. Their sum is the raw score. Consult Table 2 for percentile rank.

Table 1
Scoring Key for Responses to
Job Satisfaction Blank No. 5

Item Number	Scale Value
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	7
9	6
10	5
11	4
12	3
13	2
14	1
15	1
16	2
17	3
18	4
19	5
20	6
21	7
22	7
23	6
24	5
25	4
26	3
27	2
28	1

Table 2
Percentile Rank of Scores on
Job Satisfaction Blank No. 5

301 Employed Adults
New Hope, Pennsylvania, 1933

Score	Percentile Rank
28	99
27	98
26	93
25	85
24	78
23	72
22	64
21	53
20	40
19	31
18	28
17	25
16	23
15	21
14	20
13	17
12	14
11	11
10	8
9	7
8	6
7	5
6	4
5	2
4	1

Figure 3. Questionnaire on Hoppock's Job Satisfaction Blank - Continued

There are five sets in this test. Each instruction and stimulus presentation will be played only once. You are not allowed to write down each stimulus as you hear it. A stimulus is represented by a five, six or seven digit number. Listen carefully and answer only after the stimulus and/or the question is presented. Do not stay long in any particular question. We shall start.

SET ONE.

YOU WILL HEAR 5-DIGIT NUMBERS ONE BY ONE. INDICATE HOW MANY TIMES YOU HEARD THE NUMBER 7 MENTIONED.

60142	39652
39808	40646
87530	48174
21117	55328
91777	25730

SET TWO

YOU WILL FIRST HEAR A 5-DIGIT NUMBER. THEN ANSWER THE FOLLOWING QUESTION.

91621	WHICH NUMBER WAS IN THE MIDDLE?
91896	ARE THE FIRST AND LAST NUMBERS THE SAME?
55751	WAS THE FIRST NUMBER AN EVEN NUMBER?
47521	WHAT WAS THE SECOND TO THE LAST NUMBER?
85156	ONE ADDED TO THE LAST NUMBER GIVES WHAT NUMBER?
12362	WHICH NUMBER WAS MENTIONED TWICE?
72635	IS THE LAST NUMBER HIGHER THAN THE FIRST NUMBER?
33927	IS THERE A NUMBER 2 MENTIONED?
98176	IS THE MIDDLE NUMBER HIGHER THAN 5?
25189	IS THE NUMBER LOWER THAN THE MIDDLE NUMBER?

SET THREE

WHICH NUMBER OR NUMBERS ARE GIVEN TWICE?

38186	74921
26927	54577
15347	82567
77455	25563
75577	91915

Figure 4. The Concentration Test

SET FOUR

HOW MANY NUMBERS ARE MENTIONED ONCE?

576 347	679 782
510 996	139 758
132 911	950 357
631 591	294 954
964 298	319 177

SET FIVE

A QUESTION WILL FIRST BE GIVEN. THEN A SEVERAL DIGIT NUMBER WILL BE MENTIONED ON WHICH YOU CAN DERIVE THE ANSWER TO THE QUESTION.

HOW MANY NUMBERS ARE PRESENT?	84 173 258
WHAT ARE THE THREE NUMBERS IN THE MIDDLE?	318 313 191
HOW MANY ENEN NUMBERS ARE THERE?	6 296 062
WHICH NUMBERS ARE REPEATED?	9 171 213
WHICH NUMBERS ARE MENTIONED ONCE?	3 927 296 659
IN THE FIRST DIGITS, WHICH ARE ODD NUMBERS?	489 921 946
HOW MANY ZEROS ARE PRESENT?	1 980 105 223
WHAT ARE THE LAST THREE NUMBERS MENTIONED?	1 188 258 318
ADDING 100 TO THE FIRST 3 DIGITS GIVES WHAT NUMBER?	538 212 272
COUNT HOW MANY ODD NUMBERS WERE REPEATED.	511 726 543

Figure 4. The Concentration Test - Continued

REACTION TIME TEST

NAME _____ DATE _____

AGE _____ SEX _____ DEPT. _____

INSTRUCTIONS: Place your forefinger about one inch from the middle of the stimulus board in front of you. The stimulus board has ten tiny bulbs, each has a corresponding button below it. Every time one bulb lights up, immediately press the button to turn off the light.

For practice, you shall have five trials.

For the test proper, you shall have ten trials.

WE SHALL START.

Figure 4. Instruction Sheet for the Reaction Time Test

actual data were collected. There were ten trials, and the order in which the lamps were lighted in this practice run were same as in the final test run. In each trial, one lamp was lighted by the experimenter and the subject had to immediately turn this light off as soon as he saw it. The length of time in seconds and to the nearest millisecond that it took the subject to turn off the light respresented a reaction time value for each trial. The experimenter recorded these values for all ten trials using a form shown in Figure 6 which also indicates the particular order in which the lamps were lighted. The average of the ten trials was computed and this became the reaction time value for each subject. Details on the operation of the reaction time device are discussed later in this section.

Productivity. This was measured in terms of standard efficiency percentage by workcenter based on company records. A workcenter is defined as a group of machines or workstations or people who perform similar operations (Wight, 1974). To illustrate, a number of presses of the same capability that can take the same dies could be considered within one workcenter for capacity planning purposes. Standard efficiency referred to the relationship between the hours spent working on a materials order (actual hours) and the number of completed unit hours (standard hours). It was calculated by dividing standard hours by actual hours. Specifically, standard hours represented the calculated number of hours that a job or order should take as established from previous work studies. On the other hand, actual hours meant the number of hours the workers took to finish the job or

RECORD SHEET FOR THE REACTION TIME TEST

NAME _____ WORKCENTER _____

9

3

1

4

10

7

6

8

2

5

Figure 6. Record Sheet for the Reaction Time Test

order. A job could mean one or more units of a part or intermediate product. Thus a standard efficiency value of 100 could indicate that it took exactly as many hours as the predetermined standard hours to build the units. Less than 100 may mean either of two conditions: that the standards were inaccurate, i.e., that it really should take more time to build the units; or the workers were inefficient, i.e., workers do not quickly work as they should to meet the standards. On the other hand, more than 100 could imply that the workers were performing better than standard, i.e., workers were using shorter time than what the standards suggested; or either more help was used but was not reported or perhaps it really does not take that much time to build the units such that the standards may need a review.

The average of the standard efficiency values for the months of June and July, 1984 constituted the historical or pretest scores on productivity. Recorded values for the video game playing-month of August were used as posttest scores. Whatever was the standard efficiency value of the workcenter became the individual rating for every subject belonging to that workcenter.

Judged Work Performance. This was used as an indirect method of measuring workers' performance. Measurement was made on six attributes: attendance or absenteism, safety, accuracy of labor reporting, self-motivation, quality consciousness, and job knowledge. For the pretest scores on the first three measures, the experimenter obtained data from June and July

company records and calculated the average value on each measure per subject. The actual data during the video game playing month of August constituted the posttest scores. Performance data on self-motivation, quality consciousness, and job knowledge were based on the subjective ratings of the workers' respective foremen before and after the playing period. The foremen accomplished a performance evaluation sheet (see Figure 7) for each worker under his supervision. This evaluation sheet was patterned after the company's performance evaluation form. For each attribute under evaluation, it employed a five-level rating scale instead of the company's four. The five-point rating scale ranged from Excellent to Poor where Excellent was equivalent to five points, Very good - four points, Good - three points, Fair - two points, and Poor - one point. Each attribute had equal weights , so the judged work performance value for each worker was obtained by summing up the scores for all six attributes and calculating an average score. The higher was this score, the better was the worker's performance. A brief explanation on each of the attributes is given as follows:

Attendance - This was governed by the attendance policy of the company. A worker could be in any of six situations: Late (L), Leave early (LE), Absence (A), No word (NW), Non-approved time off (NATO). These are simply defined as follows: L - punching the time card and/or reporting to the employee's workstation seven minutes beyond the start time of a scheduled shift; LE - working less than a scheduled shift; A - if an employee is not physically at work for a designated shift of generally eight or ten hours on a scheduled workday; NW - if

PERFORMANCE EVALUATION

NAME: _____ WORK CENTER: _____

JOB TITLE: _____ DATE: _____

A. ATTENDANCE: Points referred to in this section come directly from the Attendance Policy.

EXCELLENT -- 0 points

VERY GOOD -- 1 - 4 points

GOOD ----- 5 - 8 points

FAIR ----- 9 - 12 points

POOR -----13 or more points

COMMENTS: _____

B. SAFETY: Points referred to in this section come directly from the Accident Policy.

EXCELLENT -- 0 lost time accident; 0 medical treatment

VERY FOOD -- 0 lost time accident; 1 medical treatment

GOOD ------ 0 lost time accident; 2 medical treatment

FAIR ------ 1 lost time accident; 2 medical treatment

POOR ------ 1 or more lost time acc.; 3 or more med.t

COMMENTS: _____

Figure 7. The Performance Evaluation Form - Page 1 of 4 pages

C. LABOR REPORTING:

EXCELLENT -- 100% accuracy COMMENTS: _____

VERY GOOD -- 99.1-99.9% accuracy _____

GOOD ------ 98.1-90.0% accuracy _____

FAIR ------ 97.1-98.0% accuracy _____

POOR ------ 97% or below

COMMENTS: _____
_____

D. SELF MOTIVATION: (for the month of August only)

EXCELLENT -- Always starts work on job on correct time after scheduled break periods.
-- Always go to lunch, break and/or begins clean up at correct time.
-- Does not leave workstation during work period to make non-work related activities (make phone call, etc.)
-- Does not stop working before end of shift.

VERY GOOD -- Almost always starts work on job on correct time after scheduled break periods.
-- Almost always go to lunch, break and/or begins clean up at correct time.
-- Does not leave workstation during work period to make non-work related activity.
-- Does not stop working before end of shift.
-- Does not stop working before end of shift.

GOOD -------- Sometimes starts work late.
-- Sometimes goes to lunch, break and/or begins clean up before correct time.
-- Sometimes leaves workstation during work period to do non-work related activities.

FAIR ------- Seldom starts work on time after breaks.
-- Frequently goes to break, lunch and/or begins clean up before correct time.
-- Frequently leaves workstation during work period to do non-work related activities.
-- Often stops working before end of shift.

Figure 7. The Performance Evaluation Sheet - Continued

POOR -------- Continually starts to work on job late
------ after break periods.
-- Goes to break, lunch and/or begins clean up before correct time.
-- Often leaves workstation during work period to go non-work related activities.
-- Often stops working before end of shift.

COMMENTS:
_____
_____
_____
_____

E. QUALITY CONSCIOUSNESS:

EXCELLENT -- 100% no rework caused by employee

VERY GOOD -- 98.4 - 99.9% rework caused by employee

GOOD ------ 96.8 - 98.3% rework caused by employee

FAIR ------ 95.1 - 96.7% rework caused by employee

POOR ------ 95% or below rework caused by employee

COMMENTS:
_____
_____
_____
_____

F. JOB KNOWLEDGE:

EXCELLENT -- Reads and compares blueprint
------ specifications to unit or part before, during and after completion of work on unit or part to ensure a correct and good fit.
-- Has good fit on all units or parts.
-- Meets all weld specifications and reads weld gages.
-- Able to work in all weld/set-up work centers.
-- Informs foremen of any problems with print or material before beginning work on part or unit.
-- Works with minimum of supervision.
VERY GOOD -- Reads and compares blueprint specs to unit
------ or part before, during and after completion of work on unit or part to ensure a correct and good fit.

Figure 7. The Performance Evaluation Form - Continued

-- Meets almost all weld specs and reads weld gages.
-- Able to work in almost all weld/set-up work centers.
-- Informs foremen of almost all problems with print or material before beginning work on part or unit.
-- Works with minimum of supervision.

GOOD ------ Reads and compares almost all blueprint specs to unit or part before, during and after completion of work on unit or part to ensure a correct or good fit.
-- Has good fit on most units or parts.
-- Meets most weld specs and reads weld gages.
-- Able to work in most weld/set-up work centers.
-- Informs foremen of most problems with print or material before beginning work on unit or part.
-- Works with minimum supervision.

FAIR ------- Reads and compares most blueprint specs.
-- Has good fit on most parts or units.
-- Meets most weld specs and reads weld gages.
-- Able to work only in few work centers.
-- Informs foremen of most problems with print or material before beginning work but sometimes proceeds with work on unit or part when in doubt of specs, which creates rework.
-- Works with some need of supervision.

POOR -------- Not able to read all blueprints; may occasionally neglect to compare blueprint specs with unit or part.
-- Seldom has good fit on units or parts.
-- Occasionally meets weld specs and reads weld gages.
-- Creates rework for self and others.
-- Most of time neglects to inform foremen of problems with prints or material until it is too late.
-- Works with supervision often.

COMMENTS: _____

_____

_____

OVERALL RATING: _____ SUPERVISOR: _____

DATE: _____

Figure 7. The Performance Evaluation Sheet - Continued

an employee fails to contact the supervisor of the department until one hour after the start of a normally scheduled shift to the end of the middle of the normally scheduled shift of an absence or lateness; NATO - if an employee leaves the work place without prior approval of his immediate supervisor or if the employee does not contact his immediate supervisor until after the start of the middle of the normally scheduled shift of an absence or lateness. Each sickness however was also marked as one absence and counted alone unless it was not related to a previous day's illness. Each situation experienced was equivalent to a certain number of points: L - one point; LE (working less than 1/2 of a scheduled shift) - two points; LE (working 1/2 or more of a scheduled shift) - one point; A - three points; NW - five points. Cummulative total number of points indicated in the evaluation sheet was based on a six months evaluation period. Thus for the pretest score, the total score for the two months was divided by two to get the average then this average was multiplied by six. For the posttest score, the score was just multiplied by six.

Safety - Scoring was likewise based on the company policy on safety. A medical tretment was defined as treatment administered by a physician or by a registered professional person under the standing orders of a physician. It does not include first aid treatment. First aid is a one time treatment and subsequent observation of minor scratches, cuts, burns, splinters and so forth, which do not normally require medical care even though provided by a physician or registered

professional personnel. A lost time accident is one in which an employee is injured on the job causing the injured employee to miss a full day employment on any day following the date of injury. The scale provided on the evaluation sheet applied to a twelve-month period. The end of July was considered the cut-off point for the cummulative points where data for June and July and data for the month of August were used.

Accuracy of labor reporting - Everyday each worker reported information on what units were worked on, how many hours he worked on them, etc. A production clerk then fed this information to the computer in accordance with the company's materials requirements planning (MRP) methodology. The difference between the total number of entries and the number of errors he committed divided by the total number of entries he made constituted the percentage of his accuracy of reporting labor output.

Criteria for evaluation on self-motivation, quality consciousness, and job knowledge are all explained in the evaluation sheets.

For all the above attributes evaluated, the posttest scores used were data on observed performance for the month of August. August was the period in which subjects in the experimental group played video games whereas those in the control group did not.

Experimental Design

The pretest and posttest experimental design (Campbell and Stanley, 1973) was used in this study. Two conditions of the

hypothesized independent variable of video game playing were playing or not playing, and the subjects were randomly assigned to one of the two conditions. The seven dependent variables were: perception, impulsiveness, concentration, reaction time, job satisfaction, productivity, and overall work performance. A comparison of pretest and posttest scores on each of the dependent variables was used to establish the effect of video game playing on perception, impulsiveness, concentration, reaction time, job satisfaction, productivity, and overall work performance.

Assignment and sequence of conditions. Subjects were randomly assigned to either the control or the experimental group. Members of the experimental group played the games whereas those in the control group did not. The procedure followed in the assignment of subjects was to first number chronologically the various workcenters from one to eleven. Any number between one to eleven was taken from a statistical random table (Snedecor and Cochran, 1980) and the workcenter equivalent to that number was assigned to the control group until the total number of subjects in the control group was about half the total number of all subjects. The subjects belonging to the remaining workcenters were assigned to the experimental group.

Scores on productivity represented by standard efficiency percentages were measured by workcenters. It was therefore necessary that every workcenter with all its subjects should be assigned to just one of the two groups. It was not desirable for subjects in one workcenter to be split up, such

that a few would be assigned to the control group and the rest to the experimental group. In view of this and despite the initial randomized allocation, a few workcenters had to be reassigned.

Subjects and Recruitment Procedure

Subjects. Thirty-three subjects participated in this study. All were production workers at Balderson Inc. Table 1 shows the subjects' profile by workcenter and work shift, age, level of exposure to video game playing, and job description.

Balderson, Inc. is a company located at Wamego, Kansas. It started as a small blacksmith shop in 1949. Very rapid growth in the 1960's to 1970's led the company to the undertaking and implementation of Materials Requirements Planning (MRP) program. The benefits of MRP to the Balderson were demonstrated in many ways: productivity increases, reduced purchasing, greater customer service, and profitability. MRP has also helped the company survive the economic hard times of the early 1980's. Balderson has a total employment of about 300 people and it produces a whole line of attachments for Caterpillar-made track-type tractors, wheel tractors, track loaders, wheel loaders, excavators, pipelayers, and motor graders worldwide. Among these products are eight types of blades, seventeen kinds of buckets, six types of quick couplers, five designs of snow removals, and any other special kinds as needed by the customer. Figure 8 illustrates a few of Balderson's products.

Table 1. The Subjects' Profile

A. BY WORKCENTER AND WORK SHIFT

CONTROL GROUP				EXPERIMENTAL GROUP			
WORKCENTER NAME	NUMBER OF WORKERS			WORKCENTER NAME	NUMBER OF WORKERS		
	PER WC	PER SHIFT 1	PER SHIFT 2		PER WC	PER SHIFT 1	PER SHIFT 2
FX1	2	1	1	WS3	10	5	3
WW2	3	2	2	WW1	2	2	
WA5	3	2	1	MP1	3		3
ML1	2		2	MA2	1	1	
MA1	1		1				
WS1	5	2	3				
MS1	1		1				
TOTAL	17	7	10		16	10	6

Table 1. The Subjects' Profile - Continued

B. BY AGE

NUMBER OF WORKERS IN THE CONTROL GROUP				NUMBER OF WORKERS IN THE EXPERIMENTAL GROUP			
⟨20	21-30	31-40	⟩41	⟨20	21-30	31-40	⟩41
-	11	4	2	2	13	-	1

C. BY LEVEL OF EXPOSURE TO VIDEO GAMES

NUMBER OF WORKERS IN THE CONTROL GROUP				NUMBER OF WORKERS IN THE EXPERIMENTAL GROUP			
NEVER	RARELY	OCCASIONALLY	FEW DAYS PER WEEK	NEVER	RARELY	OCCASIONALLY	FEW DAYS PER WEEK
5	8	3	1	3	9	4	-

Table 1. The Subjects' Profile - Continued

D. BY JOB DESCRIPTION

JOB DESCRIPTION	NUMBER OF WORKERS	
	CONTROL GROUP	EXPERIMENTAL GROUP
WELDERS	13	10
BRAKE OPERATORS	2	3
CUTTERS	1	1
JAW OPERATORS	1	-
TOTAL	17	16

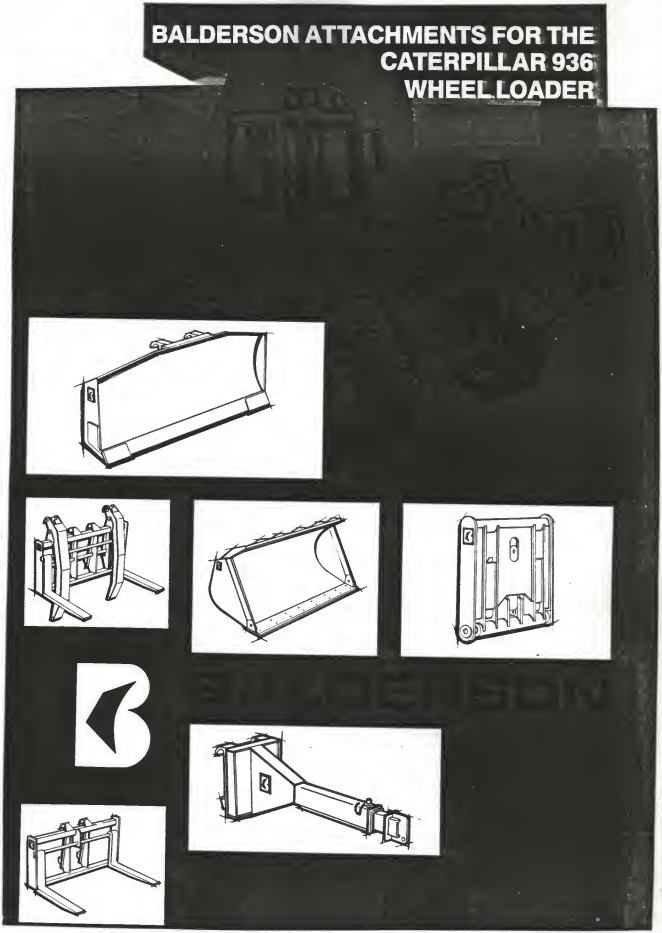

Figure 8, A Few Products of Balderson, Inc.

Recruitment Procedure. Upon approval of the study by company management, a meeting was arranged with the production supervisor and foremen. The highlights of the research, as summarized in the research summary sheets (see Figure 1) furnished to them, were explained describing the research objectives, the role they will play and those of the prospective subjects, among others. They were also requested to distribute research survey information sheets (see Figure 9) to the workers under their supervision. On a scheduled day, the research details were explained to all the production workers in several group meetings in the plant. The subjects indicated their willingness to participate in the study by affixing their signatures on the second page of the survey sheet.

A total of 42 production workers volunteered to be subjects. However, only 33 qualified to be subjects on the basis of which workcenter he belonged and the volunteer rate per workcenter. In view of the productivity measurement by workcenter, only workcenters with a volunteer rate of 50% or more were chosen. Thus, only those workers classified under these workcenters became the participants in the study.

Volunteers who were turned down were allowed to play the video games after the study was over as a token of appreciation for their interest in the study.

Apparatus or Materials

Atari 2600 Video Computer System (VCS) Console. Figure 10 illustrates the Atari VCS console used in this study. It

RESEARCH PROJECT

PROJECT TITLE: Effect of Video Games on Human Performance

OBJECTIVE: To determine if playing video games can improve an individual's reaction time, degree of concentration, impulsiveness, perceptual acuity or mental alertness, work efficiency or productivity, job satisfaction, absenteism or tardiness, and overall work performance.

BENEFITS OF RESEARCH:

1. To the subjects: Video game- playing will provide a very amusing way to spend break times and subjects may possibly improve on the aspects abovementioned.
2. To the discipline: Providing video games in an industrial setting is a fairly inexpensive way of motivating employees. Further improvement in the aspects earlier mentioned have many potential applications.

EXPERIMENTAL DESIGN:

There shall be about 30 subjects, 15 of which shall be randomly assigned to the treatment group and the other 15 to the control group. The treatment group will be playing video games daily by pairs for 30 min. for one month while the control group will not. Both groups however will be tested on the 8 different aspects before and after the one month video-game playing

Figure 9. Research Summary Handout

period.

All the tests except that on overall work performance, productivity, and absenteism/tardiness shall be taken directly by the subjects. These latter measures shall come from evaluation of records and shall need the cooperation of the supervisors.

NOTE: To prevent possible bias in the experiment, please do not mention to your employees that they shall also be tested on work performance, productivity, and absenteism/tardiness.
employees that they shall be

DESCRIPTION OF TESTS: For tests on impulsiveness and job satisfaction, a subject shall fill up questionnaires. For concentration and perceptual acuity, he shall answer on an answer sheet as he is presented with slides or an audio tape. He shall press a corresponding button for a light to turn on depending on the stimulus shown in the reaction time test. These tests shall all be conducted as a group except for the reaction time which shall be on individual basis.

APPROXIMATE TIME SCHEDULE:

1. The experiment including tests shall be conducted by last week of July to August of this year.

2. Most tests shall be conducted during a few days before and after the actual video-game playing period of one month.

For any questions/ comments/ suggestions, please call Josie Maningat at 532-5123 or 776-7970.

Thank you so much for your kind attention.

Figure 9. Research Summary Handout - Continued

Figure 10. The Atari 2600 Video Computer System Console

operated together with a TV set, a game cartridge, and either a joystick or paddle controllers. The console was connected to the TV using a game switch box. During operation, the cartridge was inserted into the console and the joystick or paddle gave the player control over the elements in the game. The mechanism of the joystick was described by Stanton et al (1983) as: "Tilting the stick pushes the nylon base against a piece of dimpled metal switch on the circuit board. When it is released and centered by the spring action, the metal pops up, and the switch opens again." Most of the games used in this study necessitated the use of joysticks; only the game Kaboom used the paddles. The paddles were potentiometer-type units that controlled a value over a linear range. They were effective for precise screen positioning.

Video games. The games used in this study are listed in Table 2. These were chosen based on the overall favorable ratings of B, B+, A- or A given to them by game reviewers (Book of Atari Software, 1983 and 1984). In the A through F grading system, A meant Superior, B - Good, C - Average, D - Poor, and F - Unacceptable. The reviewers grading criteria were: game concept, creativity, game depth, challenge, graphics, error handling, documentation, holds interest, and value for money. A brief description of each criterion is indicated in Table 3. Copies of instruction booklets on playing these games were compiled in manual form and were made available to all subjects at all times.

Reaction time device. The reaction time device

Table 2. List of Video Games Used and their Ratings

NAME OF GAME	RATING	NAME OF GAME	RATING
Asteroids	B+	Keystone Kapers	A-
Bridge	A-	Pitfall	A
Chopper Command	A-	Riddle of the Sphinx	A-
Checkers	B	River Raid	B
Cosmic Ark	B+	Robot Tank	B
Dragster	A-	Spider Fighter	B
Ice Hockey	B+	Super Cobra	B
Kaboom	B+	Tennis	A-

Table 3. Description of Criteria for Rating of Games

CRITERION	DESCRIPTION
Game Concept	Is the idea behind the game sound?
	Does it require strategy and offer a goal?
Game Depth	Does the game have much of a scenario?
	Does it offer a number of challenging levels?
Challenge	Does the game challenge the participant, or is a game one will tire of quickly?
Graphics	Was excellent use made of the computer's graphics capabilities, or not?
	Are the visual effects pleasing or dull?
Error Handling	Does the program "crash" during execution?
Documentation	Does the documentation answer all questions clearly, and is it extensive?
Holds Interest	Is this game one you would like to play over and over, or is it one that you will soon lose interest in?
Controllability	How responsive is the game to either keyboard, paddle, or joystick control?

consisted of two boards and a timer (see Figure 11). One board had ten small lamps with corresponding activator buttons for use of the subjects while the other board only had the buttons to be used by the experimenter. The boards were connected to a timer such that as soon as the experimenter depressed a button, the lamp corresponding to that button in the subject's board lighted and simultaneously the timer started count in milliseconds. The timer was instantaneously stopped as soon as the subject depressed the button corresponding to the lighted lamp. The timer registered the total time in seconds and to the nearest millisecond from the moment the lamp lighted until it was turned off by the subject. This time constituted a reaction time value.

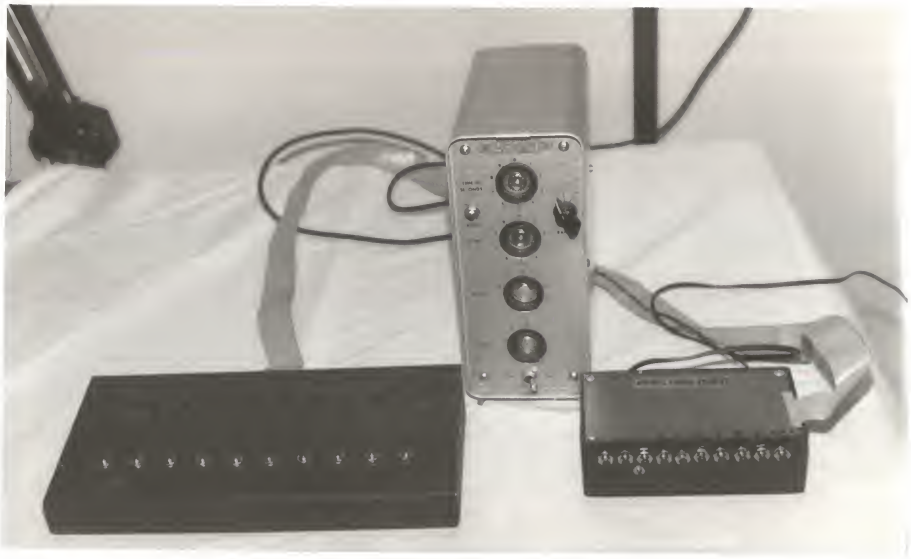

Figure 11. The Rection Time Device

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RESULTS

The pretest and posttest scores on perception, impulsiveness, concentration, reaction time, job satisfaction, productivity, and judged work performance for the control and experimental groups are given in Tables 4 and 5, respectively. With the exception of productivity and judged work performance, all data in these tables represented actual test scores for each subject. Productivity values were derived from the standard efficiency figures obtained by workcenter and all members of the same workcenter shared the same productivity value. Data on judged work performance as shown in Tables 4 annd 5 were taken from the average of each individual's rating on attendance, safety, acccuracy of labor reporting, self-motivation, job knowledge and quality consciousness. Tables 6 and 7 show the pretest and posttest values of each subject on the abovementioned performance attributes.

Tables 8 to 14 are analysis of covariance (ANCOVA) tables on perception, concentration, impulsiveness, reaction time, job satisfaction, productivity, and overall work performance. Table 15 shows a summary of the corrected means for the control and the experimental groups, the F values, and the p values for all the tests.

Table 4. Pretest Scores of Control and Experimental Groups on Seven Performance Measures

THE CONTROL GROUP

Perceptual Acuity (pts.)	Impulsiveness (pts.)	Concentration (pts.)	Job Satisfaction (pts.)	Reaction Time (sec.)	Productivity (%)	Judged Work Performance (pts.)
21	46	30	53	0.494	91	3.7
19	35	32	40	0.553	89	4.3
14	44	32	28	0.632	73	3.7
10	61	31	40	0.589	73	4.5
17	48	33	53	0.520	73	3.5
19	53	33	53	0.519	74	3.7
21	58	30	72	0.506	72	4.3
25	47	34	28	0.524	73	3.3
14	53	13	31	0.739	74	4.0
15	49	34	64	0.584	116	4.2
12	53	32	28	0.514	74	3.2
16	38	28	78	0.653	73	3.3
11	45	25	72	0.587	89	4.0
22	64	28	85	0.623	89	3.3
17	60	32	64	0.644	73	4.0
21	34	25	14	0.635	72	4.3
7	41	20	40	0.977	91	3.8
MEAN	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN
16.53	48.77	28.94	49.59	0.6055	80.53	3.83

THE EXPERIMENTAL GROUP

Perceptual Acuity (pts.)	Impulsiveness (pts.)	Concentration (pts.)	Job Satisfaction (pts.)	Reaction Time (sec.)	Productivity (%)	Judged Work Performance (pts.)
25	67	33	53	0.493	112	3.7
7	44	30	31	0.626	69	3.7
8	50	23	11	0.490	78	3.8
17	52	29	28	0.528	69	4.4
22	36	33	64	0.467	112	4.2
27	69	35	25	0.543	112	2.8
25	67	34	31	0.613	69	4.2
20	48	22	40	0.512	106	4.8
10	45	32	28	0.547	69	4.5
19	65	29	23	0.544	69	4.2
15	57	26	40	0.554	78	3.5
11	45	26	14	0.603	69	2.5
15	44	24	31	0.581	69	4.0
12	55	30	53	0.552	69	3.8
17	50	31	40	0.550	69	3.8
17	50	37	64	0.519	69	3.7
MEAN	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN
16.69	52.75	29.62	36.00	0.5451	80.50	3.85

Table 5. Posttest Scores of Control and Experimental Groups on Seven Performance Measures

THE CONTROL GROUP

Perceptual Acuity (pts.)	Impulsiveness (pts.)	Concentration (pts.)	Job Satisfaction (pts.)	Reaction Time (sec.)	Productivity (%)	Judged Work Performance (pts.)
18	35	35	64	0.405	85	3.3
16	38	34	53	0.464	85	4.7
18	43	34	31	0.612	76	4.3
13	59	32	40	0.586	76	4.5
24	36	40	28	0.455	76	3.8
15	50	42	53	0.590	52	4.0
25	56	38	93	0.533	102	4.5
19	45	35	28	0.514	76	4.5
18	45	22	25	0.634	52	3.8
18	56	39	78	0.564	133	4.3
13	52	40	28	0.492	52	3.7
20	63	33	31	0.632	76	4.5
20	46	30	78	0.561	85	3.3
21	63	29	64	0.549	85	4.0
19	62	29	64	0.538	76	4.0
16	43	26	23	0.592	102	3.8
13	47	19	53	0.911	85	4.8
MEAN	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN
12.75	49.35	32.77	49.06	0.5666	80.82	4.11

THE EXPERIMENTAL GROUP

Perceptual Acuity (pts.)	Impulsiveness (pts.)	Concentration (pts.)	Job Satisfaction (pts.)	Reaction Time (sec.)	Productivity (%)	Judged Work Performance (pts.)
20	52	31	53	0.482	145	4.0
14	50	37	31	0.598	80	4.3
16	47	31	14	0.425	78	4.5
18	56	29	28	0.532	80	4.0
18	38	42	64	0.478	145	4.5
17	78	43	64	0.447	145	2.7
22	66	35	28	0.552	80	4.2
27	41	45	31	0.433	143	4.7
17	35	36	28	0.540	80	4.5
19	83	31	25	0.460	80	4.5
17	54	32	40	0.543	78	4.2
18	48	29	6	0.554	80	4.2
16	59	34	64	0.437	80	4.5
18	62	29	64	0.568	80	4.0
13	57	36	40	0.534	80	4.2
15	45	32	64	0.467	80	3.7
MEAN	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN
17.19	54.44	34.5	40.25	0.5156	95.88	4.17

Table 6. Pretest Scores of Control and Experimental Groups on Six Attributes of Judged Work Performance

THE CONTROL GROUP

Attendance (pts.)	Safety (pts.)	Labor Reporting (pts.)	Self-Motivation (pts.)	Quality Consciousness (pts.)	Job Knowledge (pts.)	MEAN OF SIX ATTRIBUTES (pts.)
3	5	4	3	3	3	3.7
4	5	4	5	4	4	4.3
5	5	3	3	3	3	3.7
5	5	3	5	5	5	4.5
2	5	4	3	4	3	3.5
5	5	4	4	2	2	3.7
5	5	1	5	5	5	4.3
2	5	4	3	3	3	3.3
2	5	5	4	4	4	4.0
5	5	2	5	4	4	4.2
1	5	3	3	4	3	3.2
1	5	3	3	4	4	3.3
5	5	4	3	4	3	4.0
1	5	4	3	3	4	3.3
5	3	5	4	4	3	4.0
5	5	5	4	3	4	4.3
5	5	1	4	4	4	3.8
MEAN	MEAN	MEAN	MEAN	MEAN	MEAN	
3.59	4.9	3.47	3.77	3.71	3.56	

THE EXPERIMENTAL GROUP

Attendance (pts.)	Safety sive (pts.)	Labor Reporting (pts.)	Self-Motivation (pts.)	Quality Consciousness (pts.)	Job Knowledge (pts.)	MEAN OF SIX ATTRIBUTES (pts.)
2	5	4	4	4	3	3.7
1	5	4	4	4	4	3.7
4	5	4	3	4	3	3.8
5	5	4	4	5	4	4.4
5	5	3	4	4	4	4.2
1	5	2	3	3	3	2.8
5	5	3	4	5	3	4.2
5	5	5	5	4	5	4.8
5	5	5	4	4	4	4.5
3	5	5	4	4	4	4.2
3	5	4	2	3	4	3.5
2	5	1	2	3	2	2.5
5	5	2	4	4	4	4.0
3	5	4	3	5	3	3.8
1	5	4	5	4	4	3.8
2	5	5	3	4	3	3.7
MEAN	MEAN	MEAN	MEAN	MEAN	MEAN	
3.25	5.0	3.69	3.62	4.0	3.56	

Table 7. Posttest Scores of Control and Experimental Groups on Six Attributes of Judged Work Performance

THE CONTROL GROUP

Attendance (pts.)	Safety (pts.)	Laboring (pts.)	Self-Motivation (pts.)	Quality Consciousness (pts.)	Job Knowledge (pts.)	MEAN OF SIX ATTRIBUTES (pts.)
5	5	2	2	3	3	3.3
5	5	5	5	4	4	4.7
5	5	5	4	4	3	4.3
5	5	3	4	5	4	4.5
1	5	4	3	5	5	3.8
2	5	5	5	4	3	4.0
5	5	2	5	5	5	4.5
5	5	5	4	4	4	4.5
1	5	5	4	4	4	3.8
5	5	3	5	4	4	4.3
2	5	5	3	4	3	3.7
5	5	5	4	4	4	4.5
1	5	5	3	3	3	3.3
5	5	5	3	3	3	4.0
5	3	5	4	5	3	4.0
5	5	3	4	4	3	3.8
5	5	5	4	5	5	4.8
MEAN	MEAN	MEAN	MEAN	MEAN	MEAN	
3.94	4.9	4.14	3.88	4.12	3.71	

THE EXPERIMENTAL GROUP

Attendance (pts.)	Safety sive (pts.)	Laboring (pts.)	Self-Motivation (pts.)	Quality Consciousness (pts.)	Job Knowledge (pts.)	MEAN OF SIX ATTRIBUTES (pts.)
5	5	3	4	4	3	4.0
5	5	5	4	4	3	4.3
5	5	5	4	4	4	4.5
1	5	5	4	5	4	4.0
5	5	5	4	4	4	4.5
1	5	2	3	3	2	2.7
5	5	5	3	4	3	4.2
5	5	3	5	5	5	4.7
5	5	5	4	4	4	4.5
5	5	5	4	4	4	4.5
5	5	5	3	3	4	4.2
5	5	5	3	3	4	4.2
5	5	5	4	4	4	4.5
3	5	5	3	5	3	4.0
1	5	5	5	5	4	4.2
1	5	5	4	4	3	3.7
MEAN	MEAN	MEAN	MEAN	MEAN	MEAN	
3.88	5.0	4.56	3.81	4.06	3.62	

Table 8. Analysis of Covariance on Video Game Playing and Perception

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: Posttest Score

SOURCE	DF	SUM OF SQUARES	MEAN SQUARES	F VALUE	PR > F
MODEL	2	75.7844	37.8922	4.02	0.0284
ERROR	30	282.9429	9.4314		
CORRECTED TOTAL	32	358.7273			

SOURCE	DF	TYPE III SS	F VALUE	PR > F
VIDEO	1	0.4449	0.05	0.8295
PRETEST SCORE	1	75.4946		

PARAMETER		ESTIMATE	T FOR HO: PARAMETER=0	PR > T	STD ERROR OF ESTIMATE
INTERCEPT		13.0775 B	7.10	0.0001	1.8416
VIDEO	CONTROL	0.2324 B	0.22	0.8295	1.0698
	EXPT'L	0.0000 B	.	.	.
PRETEST SCORE		0.2837	2.83	0.0082	0.1003

LEAST SQUARES MEANS

VIDEO	POSTTEST SCORE LSMEAN	STD ERR LS MEAN	PROB > T HO:LSMEAN=0	HO:L	PROB > T MEAN1= MEAN2
CONTROL	18.0215	0.7449	0.0001		0.8295
EXPT'L	17.7894	0.7678	0.0001		

Table 9. Analysis of Covariance on Video Game Playing and Concentration

GENERAL LINEAR MODELS PROCEDURE

DEPENEDENT VARIABLE: Posttest Score

SOURCE	DF	SUM OF SQUARES	MEAN SQUARES	F VALUE	PR > F
MODEL	2	338.9730	169.4865	6.94	0.0033
ERROR	30	732.9058	24.4302		
CORRECTED TOTAL	32	1071.8788			

SOURCE	DF	TYPE III SS	F VALUE	PR > F
VIDEO	1	13.9413	0.57	0.4559
PRETEST SCORE	1	314.1530	12.86	0.0012

PARAMETER		ESTIMATE	T FOR H0: PARAMETER=0	PR > T	STD ERROR OF ESTIMATE
INTERCEPT		15.8028 B	2.95	0.0061	5.3584
VIDEO	CONTROL	-1.3037 B	-0.76	0.4559	1.7258
	EXPT'L	0.0000 B	.	.	.
PRETEST SCORE		0.6311	3.59	0.0012	0.1760

LEAST SQUARES MEANS

VIDEO	POSTEST SCORE LS MEAN	STD ERROR LS MEAN	PROB > T H0:LSMEAN=0	PROB > T H0:LSMEAN=0
CONTROL	32.9740	1.2002	0.0001	0.4559
EXPT'L	34.2777	1.2372	0.0001	

Table 10. Analysis of Covariance on Video Game Playing and Impulsiveness

GENERAL LINEAR MODELS PROCEDURE

DEPENEDENT VARIABLE: Posttest Score

SOURCE	DF	SUM OF SQUARES	MEAN SQUARES	F VALUE	PR > F
MODEL	2	1996.2696	998.1348	13.50	0.0001
ERROR	30	2218.6395	73.9547		
CORRECTED TOTAL	32	4214.9091			

SOURCE	DF	TYPE III SS	F VALUE	PR > F
VIDEO	1	27.1769	0.37	0.5489
PRETEST SCORE	1	1783.1803	24.11	0.0001

PARAMETER		ESTIMATE	T FOR H0: PARAMETER=0	PR > T	STD ERROR OF ESTIMATE
INTERCEPT		11.7431 B	1.31	0.1998	8.9566
VIDEO	CONTROL	-1.8590 B	-0.61	0.5489	3.0666
	EXPT'L	0.0000 B	.	.	.
PRETEST SCORE		0.8094	4.91	0.0001	0.1648

LEAST SQUARES MEANS

VIDEO	POSTEST SCORE LS MEAN	STD ERROR LS MEAN	PROB > T H0:LSMEAN=0	PROB > T H0:LSMEAN=0
CONTROL	50.9169	2.1099	0.0001	0.5489
EXPT'L	52.7758	2.1764	0.0001	

Table 11. Analysis of Covariance on Video Game Playing and Reaction Time

GENERAL LINEAR MODELS PROCEDURE

DEPENEDENT VARIABLE: Posttest Score

SOURCE	DF	SUM OF SQUARES	MEAN SQUARES	F VALUE	PR > F
MODEL	2	0.209328	0.104664	52.02	0.0001
ERROR	30	0.060363	0.002012		
CORRECTED TOTAL	32	0.269691			

SOURCE	DF	TYPE III SS	F VALUE	PR > F
VIDEO	1	0.001155	0.57	0.4546
PRETEST SCORE	1	0.176130	87.53	0.0001

PARAMETER		ESTIMATE	T FOR H0: PARAMETER=0	PR > T	STD ERROR OF ESTIMATE
INTERCEPT		43.0794 B	0.85	0.3998	50.4339
VIDEO	CONTROL	12.5360 B	0.76	0.4546	16.5453
	EXPT'L	0.0000 B	.	.	.
PRETEST SCORE		0.8439	9.36	0.0001	0.0902

LEAST SQUARES MEANS

VIDEO	POSTEST SCORE LS MEAN	STD ERROR LS MEAN	PROB > T H0:LSMEAN=0	PROB > T H0:LSMEAN=0
CONTROL	0.5419	0.0112	0.0001	0.4546
EXPT'L	0.52947	0.0116	0.0001	

Table 12. Analysis of Covariance on Video Game Playing and Job Satisfaction

GENERAL LINEAR MODELS PROCEDURE

DEPENEDENT VARIABLE: Posttest Score

SOURCE	DF	SUM OF SQUARES	MEAN SQUARES	F VALUE	PR > F
MODEL	2	7301.1837	3650.5918	16.39	0.0001
ERROR	30	6682.3315	222.7444		
CORRECTED TOTAL	32	13983.5151			

SOURCE	DF	TYPE III SS	F VALUE	PR > F
VIDEO	1	27.8074	0.12	0.7263
PRETEST SCORE	1	6661.6097	29.91	0.0001

PARAMETER		ESTIMATE	T FOR H0: PARAMETER=0	PR > T	STD ERROR OF ESTIMATE
INTERCEPT		11.7084 B	1.82	0.0780	6.4156
VIDEO	CONTROL	-1.9642 B	-0.35	0.7263	5.5592
	EXPT'L	0.0000 B	.	.	.
PRETEST SCORE		0.7928	5.47	0.0001	0.1392

LEAST SQUARES MEANS

VIDEO	POSTEST SCORE LS MEAN	STD ERROR LS MEAN	PROB > T H0:LSMEAN=0	PROB > T H0:LSMEAN=0
CONTROL	43.8355	3.7436	0.0001	0.7263
EXPT'L	45.7998	3.8667	0.0001	0.1450

Table 13. Analysis of Covariance on Video Game Playing and Productivity

GENERAL LINEAR MODELS PROCEDURE

DEPENEDENT VARIABLE: Posttest Score

SOURCE	DF	SUM OF SQUARES	MEAN SQUARES	F VALUE	PR > F
MODEL	2	16250.7316	8215.3658	53.28	0.0001
ERROR	30	4574.7836	152.4928		
CORRECTED TOTAL	32	20825.5152			

SOURCE	DF	TYPE III SS	F VALUE	PR > F
VIDEO	1	1877.5728	12.31	0.0014
PRETEST SCORE	1	14383.4370	94.32	0.0001

PARAMETER		ESTIMATE	T FOR H0: PARAMETER=0	PR > T	STD ERROR OF ESTIMATE
INTERCEPT		-17.3684 B	-1.44	0.1602	12.0620
VIDEO	CONTROL	-15.0929 B	-3.51	0.0014	4.3013
	EXPT'L	0.0000 B	.	.	.
PRETEST SCORE		1.4068	9.71	0.0001	0.1449

LEAST SQUARES MEANS

VIDEO	POSTEST SCORE LS MEAN	STD ERROR LS MEAN	PROB > T H0:LSMEAN=0	PROB > T H0:LSMEAN=0
CONTROL	32.9740	1.2002	0.0001	0.4559
EXPT'L	34.2777	1.2372	0.0001	

Table 14. Analysis of Covariance on Video Game Playing and Judged Work Performance

GENERAL LINEAR MODELS PROCEDURE

DEPENEDENT VARIABLE: Posttest Score

SOURCE	DF	SUM OF SQUARES	MEAN SQUARES	F VALUE	PR) F
MODEL	2	1.1693	0.5847	3.20	0.0551
ERROR	30	5.4870	0.1829		
CORRECTED TOTAL	32	6.6564			

SOURCE	DF	TYPE III SS	F VALUE	PR) F
VIDEO	1	0.0250	0.14	0.7144
PRETEST SCORE	1	1.1368	6.22	0.0184

PARAMETER		ESTIMATE	T FOR H0: PARAMETER=0	PR) T	STD ERROR OF ESTIMATE
INTERCEPT		2.7060 B	4.54	0.0001	0.5964
VIDEO	CONTROL	-0.0550 B	-0.37	0.7144	0.1490
	EXPT'L	0.0000 B	.	.	.
PRETEST SCORE		0.3800	2.49	0.0184	0.1524

LEAST SQUARES MEANS

VIDEO	POSTEST SCORE LS MEAN	STD ERROR LS MEAN	PROB) T H0:LSMEAN=0	PROB) T H0:LSMEAN=0
CONTROL	4.1097	0.1037	0.0001	0.7144
EXPT'L	4.1647	0.1069	0.0001	

Table 15. Summary of LS Means, F Values, and p Values on Seven Performance Measures

TEST		LS MEANS	F VALUE	p > F
PERCEPTUAL ACUITY	Control	18.0218	0.05	0.8295
	Expt'l	17.7894		
IMPULSIVENESS	Control	50.9169	0.37	0.5489
	Expt'l	52.7758		
CONCENTRATION	Control	32.9740	0.57	0.4553
	Expt'l	34.2777		
REACTION TIME	Control	0.5419	0.57	0.4546
	Expt'l	0.5294		
JOB SATISFACTION	Control	43.8355	0.12	0.7263
	Expt'l	45.7998		
PRODUCTIVITY	Control	80.8035	12.31	0.0014
	Expt'l	95.8963		
JUDGED WORK PERFORMANCE	Control	4.1097	0.14	0.7144
	Expt'l	4.1647		

DISCUSSION

The assignment of subjects to the control or experimental groups resulted in two groups which were not entirely equivalent (see Table 1). The workcenters where the control subjects belonged were different from those of the experimental subjects. Although the subjects were mostly welders, the age distribution, number of people in each work shift, and the extent of exposure to video game playing were not exactly the same. In such a situation, there arises a possibility that the subjects in one group may be better in any or all the performance attributes to start with. To account for the differences in the initial characteristics, lower experimental error, and give more precise comparisons between treatment conditions, an analysis of covariance (ANCOVA) was thus used (Snedecor and Cochran, 1980). The analysis was performed on each of the seven performance measures where the pretest scores were used as the covariates.

Perception

The F value obtained on the ANCOVA on perception was 0.05 equivalent to a very high p value of 0.8295. This implies that at the 95% confidence level, there was no significant difference between the control and the experimental test score means. Playing video games did not cause any significant improvement on an individual's keenness of perception and

cognitive performance as measured by the Perceptual Acuity test. This suggests that Gardner's (1979) notion that the computer games" may stimulate the learning process" and enable players "to think better in the future long after they have forgotten the particular strategies on the game" is not be true as indicated under the particular conditions of this study (at least for this type of persons). On the other hand, perhaps cognitive ability of the subjects may still have been improved but only temporarily, say, only during and a few hours after they played. This supposition however remains to be seen.

Concentration

In playing the games, a generally high level of concentration is required of a player so he can rack up points and beat the computer or his opponent. In the game River Raid, for instance: the player has to simultaneously shoot or avoid enemy tankers, jets, or helicopters, avoid collision against islands or river banks, shoot the next bridge he sees, be aware of changes in the river patterns, and watch his fuel supply and refuel if necessary. Especially when he flies at a faster speed, a momentary distraction can cause his plane's crash. Thus there is indeed no doubt as to what game analysts believe: that the games do require concentration. If a player plays often, then he almost always have to concentrate often too and in so doing, he gets more training or practice at the ability to concentrate. When this happens, it is possible that he may carry this ability with him as he peforms other forms of activity, not only playing video games; he may even get better at doing it. This hypothesis

was however not supported by the findings in this study. Table 15 revealed that the concentration test scores mean of the subjects who played the games were not significantly different from those who did not play. The p value was 0.5489, much higher that the 0.05 value required for statistical significance at the 5% alpha level.

Impulsiveness and Reaction Time

Neither the impulsiveness and the reaction time of the subjects who played the games did not show any considerable improvement as compared with those who did not play at all. As shown in Table 15, the means on impulsiveness for the control and the experimental groups were 50.92 and 52.78 points, respectively, and on reaction time, 0.5419 and 0.5294 second, respectively. The analyses of covariance on impulsiveness and reaction time (see Tables 10 and 11) both gave values much higher than the 0.05 value that is expected if statistical significance were achieved. Thus, despite the inherent fast pace of most games, an individual's reaction time did not appear to be shorter even if he played daily for about 30 minutes. Likewise, even if the games pushed him to waggle his controls quickly in order to win, his tendency to simply indulge without consideration of other factors and consequences of actions (as in the case of being purely impulsive), did not occur.

It seemed that of the perfomance measures being tested, the reaction time aspect of an individual would be the most likely that would be improved in view of the fast pace of playing

and the extensive hand-eye coordination practice accorded to him. Besides, the reaction time device was of the same basic activity: it also needed coordination between the hand and the eyes. The test results however did not support this hypothesis.

Productivity, Judged Work Performance, and Job Satisfaction

As the literature suggested, there has been a trend to measure job satisfaction along with productivity as productivity measurement "involves measurement at motivating workers..." As such, these two measurements were made in this stucy. Further, whereas productivity measurement in terms of the standard efficiency percentages by workcenter was an attempt at evaluating productivity in a direct and objective manner, the judged work performance was an indirect method of work performance measurement. As mentioned, judged work performance data were based on six different attributes of performance. Three of these, namely, attendance, safety, and accuracy of labor reporting were based on company records on how subjects actually performed on these aspects. Ratings of workers' job knowledge, quality consciousness, and self-motivation were the subjective judgments of the workers' foremen. The evaluation sheet completed by every foreman identified each subject by the subject's name and workcenter. The rationale was to prevent possible bias in the foreman's judgment if he were reminded of which group the subject belonged to. All the foremen however could have prior knowledge on which worker played games since they could have seen them playing in the game areas.

These three measures were used in order to understand

better the overall effect of video game playing on actual production workers. Moreover, it is hoped that the result in one may give a possible insight or explanation to the results of others.

Table 13 shows the analysis of covariance on productivity scores between the control and experimental groups. This convincingly showed that productivity of the experimental group statistically improved whereas that of the control did not. The difference between the performance of the control and the experimental groups was pronounced; the control's least squares mean was 80.8% whereas that of the experimental group was 95.9%. The ANCOVA p value was very low at 0.0014 implying statistical significance at beyond the 99% confidence level.

Along with this important finding, it is vital to mention the underlying assumptions used in this productivity assessment along with some implications of the assumptions and results. Team productivity, as in the case of the standard efficiency values, is said to be a product of its members capabilities and effort (Bass, 1982). This implies the importance of the contribution of each member of the team to completely account for the overall team productivity value. This was the concept of team productivity as used in this study. What was assumed though was that the performance of at least 50% of the team membership fully accounted for the total productivity of the team or workcenter. This was one constraint that had to be contended with. The recruitment of subjects was on a purely volutary basis. As such, it was virtually impossible to obtain

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subjects who would constitute completely intact workcenters, that is, that all workcenters involved had absolutely all their members participating. This was particularly true with workcenters with a large membership like 10 or 20 workers.

Secondly, it was assumed that all variables that could possibly influence team productivity, except those that could be afffected by video game playing, remained unchanged during the course of the study. The interrelationships of the variables affecting team productivity as envisioned by McGrath and Altman (1966) are illustrated in Figure 12. Inasmuch as the subjects in every workcenter and in both the control and the treatment groups were the same workers at least two months before and at the end of the study, it may be reasonably assumed that the basic characteristics of the members (biographical characteristics, abilities, positions) remained unchanged and did not exert any influence on productivity. What appeared likely to have contributed to the dramatic improvement on productivity could be some changes on conditions imposed on the teams. The workers performed the same tasks with the same task specifications, using the same machines, and were subjected to the same management policies and goal specifications. Considering the above conditions imposed on the team, what remains that could influence productivity is the introduction of video games. This may have modified team interactions which in turn could have affected team performance as what the productivity diagram shows.

If the video games led to the provision in the plant of "game areas" where workers played video games in the spirit of recreation, relaxation, and competition, then it follows that the

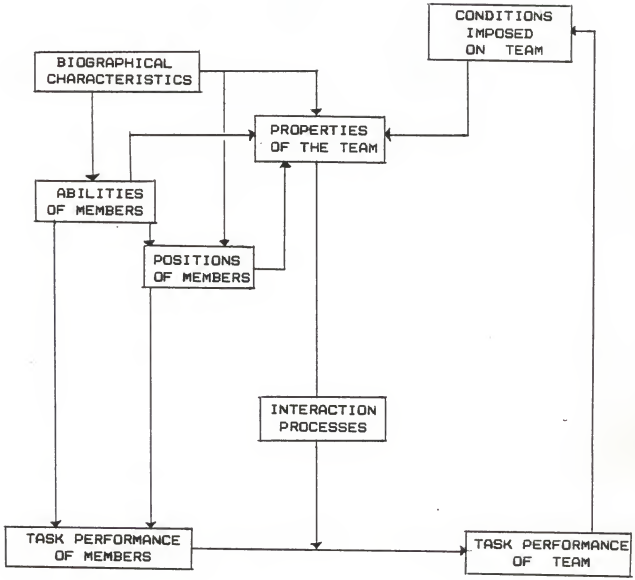

Figure 12. Some Important Linkages among McGrath-Altman Classes of Factors Affecting Team Productivity

physical work environment could indeed have been enhanced and in the process and social interactions may have been fostered. With these in mind, the quality of working life has come into play. The elements of relevance to the workers' quality of working life involve task, the physical work environment, and the social environment within the plant, the administrative system of the enterprise and the relationship between life on and off the job (Walker, 1975).

In view of the above considerations, the improvement on productivity could be attributed to video game playing in view of its ability to modify the environment of the workers that likely improved interactions among workers and perhaps even the quality of their working life.

ANCOVA tables on judged work performance and job satisfaction (see Tables 12 and 14), showed that playing video games did not exert any improving effect on these two measures. To verify this finding on the judged work performance, separate analysis of covariance was performed on scores from each of the six attributes comprising the average judged work performance values. Tables 16 to 21 showed that in neither one of these attributes was there any statistical significance obtained. For each attribute evaluated, the mean of the experimental group was not significantly different from that of the control. This accounts for the negative finding on judged work performance.

Table 16. Analysis of Covariance on Video Game Playing and Attendance

GENERAL LINEAR MODELS PROCEDURE

DEPENEDENT VARIABLE: Posttest Score

SOURCE	DF	SUM OF SQUARES	MEAN SQUARES	F VALUE	PR) F
MODEL	2	106.0189	53.0094	0.92	0.0579
ERROR	30	1726.7084	57.5570		
CORRECTED TOTAL	32	1832.7273			

SOURCE	DF	TYPE III SS	F VALUE	PR) F
VIDEO	1	0.8632	0.01	0.9033
PRETEST SCORE	1	102.4092	1.78	0.1923

PARAMETER		ESTIMATE	T FOR H0: PARAMETER=0	PR) T	STD ERROR OF ESTIMATE
INTERCEPT		3.5080 B	1.52	0.1381	2.3038
VIDEO	CONTROL	-0.3251 B	-0.12	0.9033	2.6546
	EXPT'L	0.0000 B	.	.	.
PRETEST SCORE		0.2654	1.33	0.1923	0.1990

LEAST SQUARES MEANS

VIDEO	POSTEST SCORE LS MEAN	STD ERROR LS MEAN	PROB) T H0:LSMEAN=0	PROB) T H0:LSMEAN=0
CONTROL	4.7515	1.8441	0.0151	0.9033
EXPT'L	5.0766	1.9011	0.0121	

Table 17. Analysis of Covariance on Video Game Playing and Safety

GENERAL LINEAR MODELS PROCEDURE

DEPENEDENT VARIABLE: Posttest Score

SOURCE	DF	SUM OF SQUARES	MEAN SQUARES	F VALUE	PR > F
MODEL	2	3.8788	1.9394	99999.99	0.0000
ERROR	30	0.0000	0.0000		
CORRECTED TOTAL	32	3.8788			

SOURCE	DF	TYPE III SS	F VALUE	PR > F
VIDEO	1	0.0000	.	.
PRETEST SCORE	1	3.7647	.	.

PARAMETER		ESTIMATE	T FOR H0: PARAMETER=0	PR > T	STD ERROR OF ESTIMATE
INTERCEPT		0.0000 B	99999.99	0.0000	0
VIDEO	CONTROL	0.0000 B	99999.99	0.0000	0
	EXPT'L	0.0000 B	.	.	.
PRETEST SCORE		1.0000	99999.00	0.0000	0

LEAST SQUARES MEANS

VIDEO	POSTEST SCORE LS MEAN
CONTROL	4.9394
EXPT'L	4.9394

Table 18. Analysis of Covariance on Video Game Playing and Accuracy on Labor Reporting

GENERAL LINEAR MODELS PROCEDURE

DEPENEDENT VARIABLE: Posttest Score

SOURCE	DF	SUM OF SQUARES	MEAN SQUARES	F VALUE	PR > F
MODEL	2	0.4971	0.2486	0.53	0.5931
ERROR	30	13.0777	0.4671		
CORRECTED TOTAL	32	13.5748			

SOURCE	DF	TYPE III SS	F VALUE	PR > F
VIDEO	1	0.4504	0.96	0.3345
PRETEST SCORE	1	0.0756	0.16	0.6905

PARAMETER		ESTIMATE	T FOR H0: PARAMETER=0	PR > T	STD ERROR OF ESTIMATE
INTERCEPT		97.5255 B	17.76	0.0001	5.4900
VIDEO	CONTROL	-0.2422 B	-0.98	0.3345	0.2466
	EXPT'L	0.0000 B	.	.	.
PRETEST SCORE		0.0224	0.40	0.6905	0.0557

LEAST SQUARES MEANS

VIDEO	POSTEST SCORE LS MEAN	STD ERROR LS MEAN	PROB > T H0:LSMEAN=0	PROB > T H0:LSMEAN=0
CONTROL	99.4957	0.1712	0.0001	0.3345
EXPT'L	99.7379	0.1768	0.0001	

Table 19. Analysis of Covariance on Video Game Playing and Self-Motivation

GENERAL LINEAR MODELS PROCEDURE

DEPENEDENT VARIABLE: Posttest Score

SOURCE	DF	SUM OF SQUARES	MEAN SQUARES	F VALUE	PR > F
MODEL	2	10.4439	5.2220	20.09	0.0001
ERROR	30	7.7985	0.2600		
CORRECTED TOTAL	32	18.2424			

SOURCE	DF	TYPE III SS	F VALUE	PR > F
VIDEO	1	0.0049	0.02	0.8916
PRETEST SCORE	1	10.4037	40.02	0.0001

PARAMETER		ESTIMATE	T FOR H0: PARAMETER=0	PR > T	STD ERROR OF ESTIMATE
INTERCEPT		1.3643 B	3.35	0.0022	0.4074
VIDEO	CONTROL	-0.2450 B	-0.14	0.8916	0.1782
	EXPT'L	0.0000 B	.	.	.
PRETEST SCORE		0.6754	6.33	0.0001	0.1068

LEAST SQUARES MEANS

VIDEO	POSTEST SCORE LS MEAN	STD ERROR LS MEAN	PROB > T H0:LSMEAN=0	PROB > T H0:LSMEAN=0
CONTROL	3.8366	0.1239	0.0001	0.8916
EXPT'L	3.8611	0.1277	0.0001	

Table 20. Analysis of Covariance on Video Game Playing and Quality Consciousness

GENERAL LINEAR MODELS PROCEDURE

DEPENEDENT VARIABLE: Posttest Score

SOURCE	DF	SUM OF SQUARES	MEAN SQUARES	F VALUE	PR) F
MODEL	2	6.4716	3.2358	11.42	0.0002
ERROR	30	8.4981	0.2833		
CORRECTED TOTAL	32	14.9697			

SOURCE	DF	TYPE III SS	F VALUE	PR) F
VIDEO	1	0.1269	0.45	0.5084
PRETEST SCORE	1	6.4394	22.73	0.0001

PARAMETER		ESTIMATE	T FOR H0: PARAMETER=0	PR) T	STD ERROR OF ESTIMATE
INTERCEPT		1.4867 B	2.67	0.0121	0.5564
VIDEO	CONTROL	0.1269 B	0.67	0.5084	0.1896
	EXPT'L	0.0000 B	.	.	.
PRETEST SCORE		0.6439	4.77	0.0001	0.1351

LEAST SQUARES MEANS

VIDEO	POSTEST SCORE LS MEAN	STD ERROR LS MEAN	PROB) T H0:LSMEAN=0	PROB) T H0:LSMEAN=0
CONTROL	4.0918	0.1305	0.0001	0.5084
EXPT'L	3.9649	0.1346	0.0001	

Table 21. Analysis of Covariance on Video Game Playing and Job Knowledge

GENERAL LINEAR MODELS PROCEDURE

DEPENEDENT VARIABLE: Posttest Score

SOURCE	DF	SUM OF SQUARES	MEAN SQUARES	F VALUE	PR > F
MODEL	2	4.8609	2.4305	5.85	0.0072
ERROR	30	12.4724	0.4158		
CORRECTED TOTAL	32	17.3333			

SOURCE	DF	TYPE III SS	F VALUE	PR > F
VIDEO	1	0.0377	0.09	0.7655
PRETEST SCORE	1	4.8070	11.81	0.0019

PARAMETER		ESTIMATE	T FOR H0: PARAMETER=0	PR > T	STD ERROR OF ESTIMATE
INTERCEPT		1.7868 B	3.17	0.0035	0.5641
VIDEO	CONTROL	0.0676 B	0.30	0.7655	0.2246
	EXPT'L	0.0000 B	.	.	.
PRETEST SCORE		0.5160	3.40	0.0019	0.1517

LEAST SQUARES MEANS

VIDEO	POSTEST SCORE LS MEAN	STD ERROR LS MEAN	PROB > T H0:LSMEAN=0	PROB > T H0:LSMEAN=0
CONTROL	3.6994	0.1564	0.0001	0.7655
EXPT'L	3.6318	0.1612	0.0001	

After the one month video game playing period, the subjects in the experimental group were requested to fill out a poststudy questionnaire (see Figure 13). The rationale was to obtain the workers' view on some elements of the study. The subjects' responses supported most of the findings. About 67% of the workers believed that they did not notice any improvement on their ability to react faster to a stimulus, or their ability to concentrate. Although approximately 67% of them thought that they were not working better during the month they were playing the games, a good 79% said that they felt "happy", "awake", "all pumped-up", all keyed-up", or "had fun" playing the games and after playing the games. Everybody, except one, thought it became "easier to go back to work" or that the "break went faster"; the worker who had difficulty going back to work felt he wanted to play more. The dramatic improvement on productivity may therefore have been brought by this upliftment of spirits or a result of some kind of motivation.

The above comments may also be an indication that somehow, job satisfaction and the quality of working life were improved. Yet, this was perhaps not enough to allow them to say, "I am satisfied with my job." Following Hoppock's view, the scale of satisfactions on the job versus the amount of dissatisfactions on the job may still have tilted towards dissatisfactions such that despite the satisfaction they felt playing the games, they still could not utter, "I am satisfied with my job".

SURVEY SHEET

NAME _____

PLEASE ANSWER QUESTIONS HONESTLY.

1. HOW DID YOU FEEL AFTER PLAYING VIDEO GAMES?

_____

2. DID YOU FEEL RELAXED OR TENSE AFTER PLAYING?

_____

COMMENTS:

_____

3. DID YOU EVER FEEL ALL WORN OUT OR TIRED AFTER PLAYING?

_____

COMMENTS:

_____

4. WHAT GAME DID YOU PLAY MOST? WHY?

_____

5. DO YOU THINK THE KIND OF GAME YOU PLAYED INFLUENCE THE WAY YOU FEEL AFTERWARDS? YOUR COMMENTS PLEASE. _____

_____

6. IMMEDIATELY AFTER PLAYING, DID YOU EXPERIENCE DIFFICULTY IN GETTING STARTED AT WORK OR DOING YOUR WORK? PLEASE EXPLAIN BRIEFLY.

_____

Figure 13. The Poststucy Questionnaire

7. ON THE CONTRARY, DO YOU THINK YOU WERE ABLE TO WORK BETTER OR MORE EFFICIENTLY AFTER PLAYING? PLEASE GIVE YOUR COMMENTS.

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8. DID YOU NOTICE ANY CHANGE OR IMPROVEMENT AT ALL AS FAR AS YOUR ABILITY TO RESPOND TO ANY GIVEN STIMULUS? PLEASE CITE EXAMPLES IF ANY OR COMMENT. ----------

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9. DID YOU OBSERVE ANY CHANGE IN YOUR ABILITY TO CONCENTRATE ON DOING ANYTHING? YOUR COMMENTS PLEASE. ----------

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10. HAVE YOU NOTICED ANYTHING ABOUT YOURSELF AT ALL THAT CHANGED AFTER THIS ONE MONTH OF PLAYING VIDEO GAMES? PLEASE COMMENT. ----------

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NOTE: PLEASE USE THE BACK OF PAPERS IF NEEDED.

Figure 13. The Poststudy Questionnaire - Continued

Gauging from the subjects' responses, it appears that the level of excitement or feeling of being "awake" occurred during and immediately after playing the games. It may thus be possible that the perceptual acuity, concentration, and reaction time may have been improved but only momentarily. Whatever the extent of improvement there may have been, this did not last long enough to have been measured in this study. For one thing, in this investigation the tests were conducted a day or two before and after the one month playing period. It remains to be seen what could be the results had the tests been conducted immediately before and after each playing session. Likewise, all the findings might be different if the video game playing period were extended to a relatively longer period of time like six months or one year.

The most noteworthy finding of this study is the positive improvement on workers' productivity during the video game playing period. The video game consoles along with the game cartridges and TV sets are relatively inexpensive. This was one advantage of the games that has led the military into investigating their use as substitutes for conventional apparatus in performance and psychological testing (Kennedy et al., 1982). To set these units in the production setting is not at all a problem since only a small amount of space is needed and they are portable so they have flexibility of being moved around. It therefore becomes such a tremendous bargain for company management if these could cause such significant improvement on workers' productivity as shown. Some caution should however be

exercised with respect to these findings on productivity. These results may only be limited to the particular conditions in the study and may not apply to all production situations. For instance, the subjects in this study were all relatively young, with the mean age being 24 years old. If the production workers were older, they might not care very much about playing these games. Therefore, the availability of these games even in the most accessible places in the plant might turn out to be useless if the workers would not play with them.

CONCLUSIONS

1. The productivity of workers for one month was improved by allowing them to play video games during their break times for about 30 minutes daily in game areas located within the plant. This finding may however not apply to all production settings.

2. Playing video games did not appear to significantly enhance job satisfaction and judged work performance based on test results. Yet, subjective opinions of workers reveal the possibility of a partial improvement in job satisfaction particularly in the area of quality of working life or working environment.

3. Perception, concentration, impulsiveness, and reaction time were not significantly improved by video game playing. Nevertheless, it remains to be seen if the effects could be different if the playing period were of longer duration or if the tests were conducted immediately before and after each playing session.

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VIDEO GAMES AND HUMAN PERFORMANCE

by

JOSEPHINE I. MANINGAT

Bachelor of Science in Chemistry
Adamson University, Manila, Philippines, 1976
Master of Science in Business Administration
De La Salle University, Manila, Philippines, 1981

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the
requirements for the degree

MASTER OF SCIENCE

Department of Industrial Engineering
KANSAS STATE UNIVERSITY
Manhattan, Kansas

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ABSTRACT

The effect of playing video games on seven aspects of human performance was investigated. Results showed that the productivity of workers can be improved by allowing them to play video games daily for about 30 minutes in games areas provided for inside the plant. Quantitative measures of job satisfaction and judged work performance revealed that neither job satisfaction nor judged work performance can be enhanced by playing video games. The subjective opinions of workers however indicated the development of an overall feeling of enhanced spirits during and after video game playing. Further, the study discovered that playing video games did not significantly improve an individual's perception, impulsivenss, concentration, and reaction time.