Design Optimization of Equipment Controls Setup and Workstation Tables for the Remote Production Taping of a Media Broadcasting Company

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Abstract

In the Philippines, media broadcasting provides quality television production shows which includes game shows, variety shows, talk shows, television journalism, musicals, soap operas, and many others which utilizes different setting up techniques and methodologies on preparing the entirety of the production set. In this production setup, lights, audio, and broadcast team comprises the three major production teams. All production setups differ from one another because of different requirements for every production shows, resulting to unstandardized setup times. This study aims to optimize the remote production setup of a media broadcasting company in accordance to engineering standards and with consideration of trade-offs that is based on applicable constraints such as Material VA/VE, Product VA/VE, Process VA/VE, Ergonomics, Economic, and Productivity. There are two design options and Based on the over-all rankings of constraints, the second alternative design or the "Workstation with Flip-Up Monitor Rack". yielded a rank of 5 for Material VA/VE, 3.37 for Product VA/VE, 1.5323 for Process VA/VE, 4 for Ergonomics, 3 for Economic, and a governing rank of 5 for the Productivity constraint with an average overall rank of 3.65

Keywords

Value Analysis , ergonomics , economic , remote, broadcasting

1. Introduction

Media Broadcasting companies make a large portion of their profits from advertisements. It is undergoing enormous changes with technology introducing new delivery opportunities and thereby more broadcasters into the equation. Past studies shows the recent wave as well as the implications of mergers and acquisitions both vertical and horizontal in TV broadcasting and Distribution Company, furthermore, it seeks to put a better perspective on the guideline of Mergers and Acquisitions in the TV industry. (Evens, T. and Donders, K. (2016). In the Philippines, media broadcasting was pioneered by the oldest broadcast commercial television network named Company X, The flagship of the network is their quality television production shows. It includes collection of game shows, variety shows, talk shows, television journalism, musicals, soap operas, and others to mention. Considering the aforementioned collection of different television production that they have, the company also utilizes different setting-up techniques and methodologies on preparing the entirety of the production set. The set-up is usually done by the three major production teams namely, lights, audio, and broadcast team. The set-up methodology of one production usually varies from the other because of different studio layout and design for a particular production. That is why the set-up time of the shows not the same with each other are. The set-up time may be affected by the studio area depending on the show they will be taping, or if they will opt to do the taping outside the studio. Because of the varying techniques and demand of the different types of production, no particular standard is established regarding the time it takes to set up the studio or the standard facility layout and design to optimize the set-up process. Upon conducting direct immersion to their remote production site, several observations were gathered and identify the existing problem on the selected area. The set-up tables are unorganized, from its arrangements, to placements on the production site. It mainly prohibits the workers to have an efficient and easy access to the materials that are highly vital to the flow processes of the taping of the show. Also, the existing process is not ergonomically designed and does not provide flexibility and efficiency in handling various types of task for the requirement of the shows. Since no standard time is established, the workers have no clearer direction on how to do the task in accordance to the appropriate and suggested methodology to shorten the usual longer time of set-up. Set-up tables are the supporting equipment to accommodate the portable audio and video materials and other tools needed in setting up a remote workstation. The emphasis in study will be attributed in optimizing the set-up tables in order to facilitate better work flow inside the production area. Nonetheless, the optimization of the set-up table must be done accordingly in order to optimize the set-up process effectively. This is to clear that the optimization of the facility layout and the set-up table are dependent to each other. The optimization of the facility layout will be greatly contributed by the optimized set-up table since it would give way to a more efficient movements and activities around the production area, and the optimization of the set-up table will greatly depend on how it is utilized on the existing facility location and design in which it belongs. This will certainly help in establishing the standards that will be applicable to their operation. Initial observations were gathered, and using the formula from Niebel's Methods, Standards, and Work Design by freivalds and niebel (2009) , this paper determined the ideal number of observations needed for the study.

This paper presented a study of design tradeoffs in Equipment Controls Setup and Workstation Tables for the Remote Production Taping of a Media Broadcasting Company. It aims to optimize the remote production set-up of Company X in accordance with Engineering Standards and with consideration of trade-offs that is based on the applicable constraints such as Material VA/VE, Product VA/VE, Process VA/VE, Ergonomics, Economic, and Productivity. Specifically, this paper will develop process standards using Time and Motion Study , propose three design proposals for the remote production workstation table of video and audio control equipment, select the best design of remote production workstation table among the three proposals using Engineering Trade-off Strategy by Otto and Antonsson, recommend a production set-up strategy with the inclusion of the recommended remote production workstation table and Minimize the over-all set-up time for the remote production set-up.

2. Project Analysis

2.1 Remote Facility Layout

The figure below shows the existing facility layout of the remote production along Quezon City, where the remote taping was held. In the existing facility layout, there are two tents that were used as dressing room and the other tent as technicians control room. The control room is the main focus of the study where the production set up and the workstation are involved. The layout also emphasizes the delivery truck of the equipment which is located in a long distance from the set-up point. With this, the transportation of the equipment consumes the time of the production set-up.

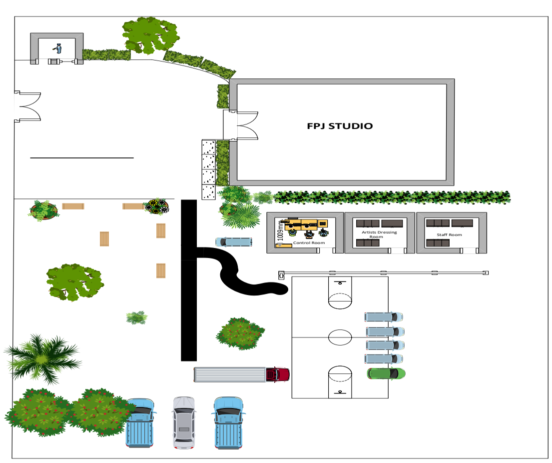


Figure 2.1 Existing Facility Layout

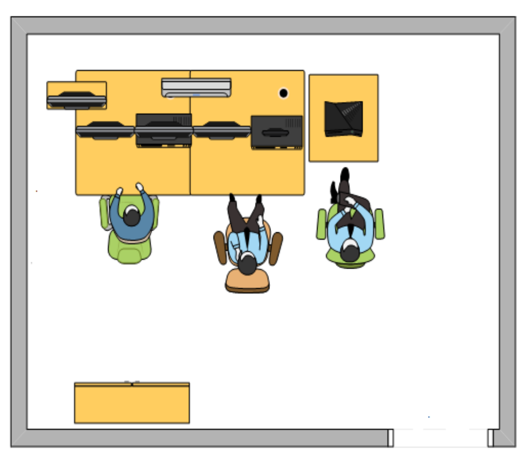


Figure 2.2 Existing Video Control Room Layout

Figure 2.2 shows the existing video control room layout remote production of the taping that was held in the FPJ studio. The figure also shows the location of the equipment whereas the monitors, switcher, communication devices, and the EVS Box were placed according to its set-up production of the video control room. From the figure above, the workstation of the video control consists of two monoblock tables where the monitors and other equipment are placed in compact positioning without the ergonomics standard. According to ergonomics standard, the measurement of the eye-level, elbow height and arms reach.

2.3 Actual Video Control Workstation Layout

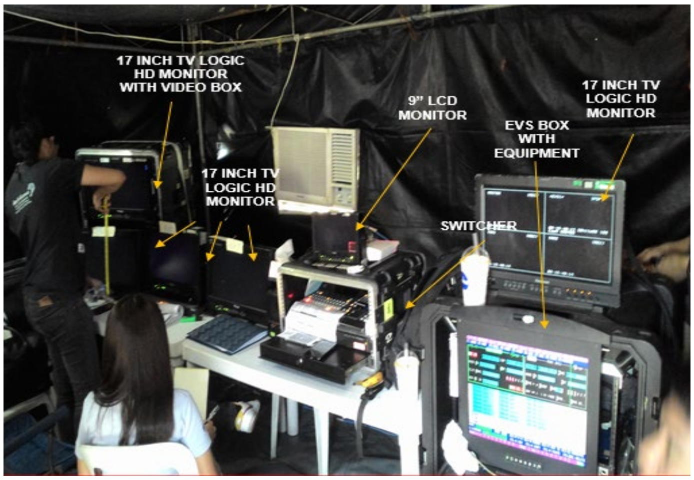


Figure 2.3 Existing Remote Video Control Set-up

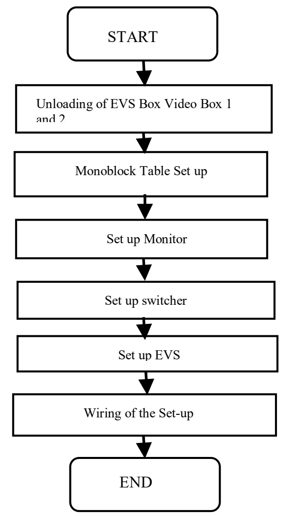


Figure 2.4 Flow Process Chart Video Control Set-up

The figure 2.3 shows the existing video control set-up of media broadcasting company for their remote production. The set-up houses the basic video equipment required for every remote shooting produced by the TV station. The set-up is assembled on two (2) monoblock tables placed side-by-side which act as their temporary workstation.This basic set-up is composed of the following equipment; a switcher, a video distribution amplifier, two video boxes, four (4) 17-inch TV Logic HD Monitor, and 9-inch LCD Monitor. The set-up also includes an EVS box which houses the equipment used for video editing. The whole system is housed within a 381cm by 381cm makeshift tent.

2.4 Video Control Setup Process

1. Unloading of EVS Box, Video Box 1 & 2 .In this process, the EVS Box, Video Box 1 & 2 and other equipment are unloaded from the truck. After unloading, the equipment is placed in the vicinity of production. Like the audio equipment, the EVS, and Video boxes are unloaded farther from the center point of the production which causes long transportation.

2. Monobloc Table Set-up. During this process, the monobloc tables are assembled. 2 monobloc tables are used as the workstation of the technical members of the production which is not ergonomically design within the vicinity.

3.Setting up of Monitor. After processing the monobloc table, the monitors are being set. There are four 17" monitors that are being used in the production which is aligned to each video camera. Every scene that is happening outside the vicinity are being monitored and each technical member are assessing the director and other member within the scene to control and fix any discrepancies.

4. Setting up Switcher and setting up EVS. In this process, the switcher is being set up and connecting it at the monitor. Switcher is being used as a device to switch a second camera set on from the monitor to another. During this process, the EVS is also being set up. EVS usually used as editing device for controlling the videos recorded such as taping

5. Wiring of the whole set up. After all the process of setting up, Wiring is the last process to assess.

3. Project Design

This paper shows the three (3) workstations designed and the optimized using time and motion study. For the workstation design 1 it was named as Workstation with Detachable Monitor Racks as to the consideration of the monitor racks are detachable, the design 2 was named as Workstation with Flip-Up Monitor Rack where the monitor rack is designed to be flipped-up and designed in a way that the workstation would appear just a plain storage box, and for the design 3 which was named as Workstation with Pull-Up Monitor Rack that 3 can be tilted downwards.

Figure 3.1 Workstation with Detachable Monitor Racks (Design 1)

Figure 3.2 Workstation with Flip-Up Monitor Rack (Design 2)

Figure 3.3 Workstation with Pull-Up Monitor Racks (Design 3)

The figure 3.1 above shows the closed, half-open, and full set of the workstation which considers the overall design. In the closed version of design 1, the equipment is already hidden in their perspective slots located on the sides of workstation. This also displays the handle that holds the columns together and at the same time as storage for easy pulling and pushing function. In the figure that displays the whole set-up, the monitor columns are already drawn out of their racks and are already placed in their respective slots. The figure displays the opened and ready-to-use visualization of the design. The closed version of the proposed design 1, monitor columns are already hidden in their respective slots located on the sides of the table. This also displays the brace which holds the columns together and at the same time serves as a handle when the proposed design is closed or in box form for easy pulling and pushing function. The proposed process of setting-up the workstation with detachable monitor rack. From 14 elements with a total of 68.22 minutes, the proposed process optimized the design 1 in Video Control Set-up to 8 elements and a total of 23.65 minutes. To validate the result, the Pro Model Simulator was used for the complete validation.

The figure 3.2 above shows closed, half-open, and full set of the workstation which considers the overall design. In the closed version of design 2, it shows the visualization of the covered proposed design 2 with all the devices concealed inside. To ready the table for storage, it will only take the user two steps. First, the user will pull down the row of monitors to conceal them. The next step is to replace the front panel to cover the rest of the equipment. For the fully-equipped workstation, the monitors and the other equipment are already placed in their respective places. The design features a single row of four (4) 17" LCD monitors. The row of monitors is designed in such a way that they are already in a fix position and so thus their wiring connections. All the user has to do is pull the panel upward to reveal the monitors. From fourteen (14) elements with a total of 68.22 minutes, the proposed process takes five (5) operation processes and two (2) transportation processes to fully prepare the workstation. It would only take 17.6 minutes to ready the set-up. To validate the result, the Pro Model Simulation was used for the complete validation.

Figure 3.3 shows closed, half-open, and full set of the workstation which considers the overall design. In the closed version of design 3, it shows the typical type of the workstation when stored. The visualization of the proposed design 3 where all the equipment is placed strategically in such a way that everything would be within the user's reach. The set of monitors are equipped with sliders so that it could be pulled upward when about to be used and pushed downward when about to be stored. The sub-storage for the monitors which will be drawn upwards from its designated slot on the table when the monitors are to be used. The table above shows the proposed process of preparing the workstation will Pull-up which takes 18.1 minutes compared from the existing with 68.22 minutes. The whole process takes five (5) operating process and two (2) transportation process to fully prepare the product.

4. Applicable constraints, standards and trade-offs

Multiple constraints were used in this paper to choose the most capable design. The constraints included in this study were Material VA/VE, Product VA/VE, Process VA/VE, Ergonomics, Economic, and Productivity. The values for each constraint will be an input to evaluate the tradeoffs. Different constraints consists of different level of significances, applicable standards were also applied. The design with the highest total weighted score based from the calculation of the ranking scale will be chosen. Applicable Standards are Workstation Standards , : Eye line – to screen distance.

4.1 Material VA/VE

This paper considered the material specifications of the materials used mainly for paneling and for framing.. The mechanical properties of the materials determine the strength capability of each material. This paper used the bending strength, tensile strength, and the modulus elasticity of the material as the main considerations for the materials' mechanical properties. The tensile strength (measured in Mega Pascal or MPa) is a measure of the force required to pull the material until it breaks. Consequently, the tensile of a material is the maximum pulling force it can take before it breaks. The modulus of elasticity (measured in Elastic Modulus) refers to the measure of a material's resistance to being deformed elastically when a force is applied. While a material's flexural strength (MPa) on the other hand, refers to the measure of force required to bend the material until it breaks. On the other hand, the flexural strength of a material is the measure of maximum flexural force it can take before it breaks. The chemical components of the materials used for the table top and side panels were disregarded since the materials used were of different type from each other. For the framing materials used for each design, their mechanical properties and chemical properties were not given considerations as the materials available locally are of general purpose and are of no grade. Thus, it will unable to provide the specifications of each material. Fiberglass reinforced polyester was used for the design 1, narra plywood was used for design 2, and for design 3, marine plywood was used for the table top and side panels.

Table 4.1 Panel Mechanical Property Comparison

Mechanical Property	Design 1	Design 2	Design 3
	Plexiglas Acrylic Sheet	GI Sheet	Marine Plywood
Flexural Strength (MPa)	110.31	350	59
Tensile Strength (MPa)	72.39	482	85
Modulus of Elasticity (E)	3102.64	29000	12000

The table 4.1 above shows the mechanical property comparison between the materials used for the table panels of the designs. The comparison is a measure of three properties, flexural strength, tensile strength, and modulus of elasticity. Under the mechanical property consideration, it shows that the material used for the design 2 is stronger than the materials used for the designs 1 and 2.

4.1 Product VA/VE

In this criterion the overall weight of the materials was considered for each respective design. The total weight was obtained by determining the individual weight of each significant material used in constructing the design.

The table 4.2 below shows the total weight of each table obtained through the product value analysis / value engineering. The table shows that design 1 is the lightest design as compared to other designs having an overall weight of 74.18 kilograms. Design 2 on the other hand, being the heaviest design has an estimated weight of 101.32 kilograms. This criterion Product VA/VE will be given a significance level of 5. The total weight of each design was converted to their corresponding percentage so as to fit the data with the formula to be used. Design 1 being the lightest was assigned as the benchmark with gaining a 100%, the percentage difference of design 2 and 3 from design 1 were 73.02% and 75.73% respectively.

Table 4.2 Table Weight Comparison

Product VA/VE	Design 1	Design 2	Design 3
Table Weight (kilograms)	74.18	101.32	91.15

4.3 Process VA/VE

In this criterion the processes in the assembly and fabrication of each respective designs was considered. The criterion's level of importance given was 1 since the designs are not due for mass production. The table 4.3 shows the fabrication time comparison between each design. It goes to show that design 3 requires the least fabrication time as compared to designs 1 and 2 which requires a fabrication time of 18.75 hours and 20.5hours respectively. The obtained total weights were converted to their percent differences to fit the data to the formula to be used. Design 3 requiring the shortest time to fabricate got 100% and would act as the benchmark. Designs 1 and 2 got 86.67% and 79.27% respectively.

Table 4.3 Fabrication Time Comparison

Process VA/VE	Design 1	Design 2	Design 3
Fabrication Time (Hours)	18.75	20.5	16.25

4.4 Ergonomics

This paper gave consideration to the science of fitting the workstation to a man in terms of Ergonomics compliance. Accordingly, Ergonomics is an applied science concerned with designing and arranging things people use so that the people and things interact most efficiently and safely. This criterion is one of the important factors to be considered in designing the workstation table and improving the equipment set-up process of Company X remote production taping. Four Ergonomic constraints attributes were given consideration under this criteria, such constraints include the eye-line to screen distance, work surface height, table top width according to reach, and lastly, table top length according to reach. The client has given Ergonomics constraint a point of five (5) for the level of importance.

The computations for the results in table 4.4 were computed through getting the percentage of compliance by dividing the actual dimension per sub constraint per design to the median of the range of the ergonomics standard measurement. The percentage of compliance was averaged to identify which workstation design has the most dimensions that have complied with the ergonomics standard. It shows that design 1 has complied 54.4975% to the ergonomics standards of workstation measurement. Design 2 complied 51.205% and lastly, design 3 has a 58.4975% compliance to Ergonomics workstation standards.

Table 4.4 Ergonomics Compliance

Ergonomics Constraint	ACTUAL DIMENSION (in)			PERCENTAGE OF COMPLIANCE TO STANDARD			ERGONOMICS STANDARD MEASUREMENT (in)
	DESIGN 1	DESIGN 2	DESIGN 3	DESIGN 1	DESIGN 2	DESIGN 3	
Eye - line to screen distance	20.87	27.56	21.65	71.97%	95.03%	74.66%	24 – 34
Work Surface Height	26.37	26.37	26.37	95.89%	95.89%	95.89%	25 – 30
Table Top width according to reach	20.87	27.56	21.65	34.78%	13.87%	32.34%	32-below
Table top length according to reach	50.79	58	41.34	15.35%	0.0333%	31.1%	60
				54.4975%	51.205%	58.4975%	

4.5 Economic

This criterion defines the cost-effectiveness of each proposed design. The total costs were considered in the design. It includes the material cost and manufacturing cost. Material costs include all the costs incurred from buying the raw materials required for the production. In Design 1, cost of the raw materials to be used for production which includes the sliders used for monitor racks was considered, this material are not present in the other two designs. For the second design, it includes the basic manufacturing cost of the table, and also the cost of the raw materials to be used. Unlike the first design, the sliders for the monitor racks are not present, but instead, the design features a pull-up lever which will serve as a support for the monitors' horizontal panel. For the workstation with detachable monitor rack (Design 1), the total cost of material amounted to PHP 22,837.43. For the workstation with flip-up monitor rack, the total cost of material amounted to PHP 14,162.84. And for the third design, workstation with pull-up monitor rack, the material cost amounted to PHP 16,805.

Table 4.5 Material Cost Comparison

Economic Constraint	Level of Importance	Design 1	Design 2	Design 3
Total Cost	3	Php 22,837.43	Php 14,162.84	Php 16,805

4.6 Productivity

This criterion considered the set-up time. For the workstation with detachable monitor racks (Design 1) it would only take the production team an estimated time of 23.65 minutes. This resulted from removing the unnecessary processes and excessive set-up time from the existing process. 41.55 minutes was removed from the existing set up time of 68.22 minutes. While for the workstation with flip-up monitor racks (Design 2) would only take an estimated time of 17.6 minutes to set-up. An excess time of 50.62 minutes was removed from the existing way of setting up the workstation. And lastly, as for the workstation with pull-up monitor racks (design 3), it would only take 18.1 minutes for set-up.

Table 4.6 Set-up time Comparison

Productivity Constraint	Level of Importance	Design 1	Design 2	Design 3
Total Set-Up Time	5	23.65 minutes	17.6 minutes	18.1 minutes

4.7 Trade-Offs

The constraint evaluations are summarized and ranked according to the level of importance using a formula from the Model on Trade-Off Strategies in Engineering Design by Kevin N. Otto and Erik K. Antonsson (1991) for the quantitative scaling of constraints. The importance of each criterion (on a scale of 0 to 5, as 5 being the highest importance) was assigned, and each design methodology's ability to satisfy the criterion (on a scale of 0 to 5, as 5 being the highest ability to satisfy the criterion) was also tabulated. On the other hand, this study set the governing rank for each criterion involved and was based on the initial research and analysis made for the design.

The computation of ranking ability to satisfy the criteria of the design proposal is as follows:

$$\%\text{Difference} = \frac{\text{Highest - Lowest Value}}{\text{Lowest Value}} \quad (1)$$

$$\text{Subordinate Ranking} = \text{Governing Rank} - (\%\mathit{Difference} * 10) \quad (2)$$

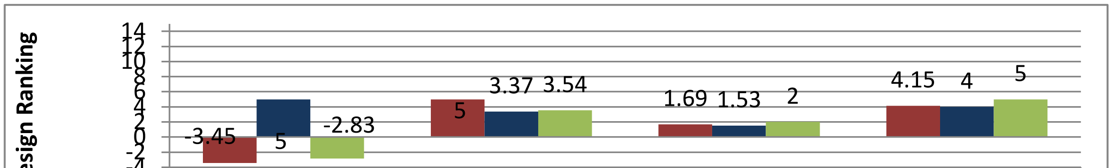
The governing rank is the subjective choice of this study. Assigning the value for each criterion's importance was also based on the subjective judgment. The subordinate rank (Equation 2) is a variable that corresponds to its percentage (%) distance from the governing rank along the ranking scale.

5. Conclusions and Recommendations

Table 5.1 shows the comparison of decision criteria (also known as trade-offs) that have been to compare each design versus one another. This is a main advantage in choosing the best design that would cater the needs and the requirements of Company X remote set-up. Material VA/VE covers the consideration of the proponents to the strength of the material used for the table top and side panels. Design 2 obtained the governing rank of 5 as it has the strongest type of material used. For the Product VA/VE which considers the total weight of the constructed table, design 1 obtained the governing rank of 5 being the lightest among the three designs. Under the Process VA/VE which considers the number of hours required to fabricate the product, design 3 got the governing rank of 2 having the least number of hours for fabrication. Ergonomics consideration on the other hand determines the ergonomic compliance of each designs. Under this consideration, design 3 won the tradeoffs being the most ergonomically designed. Design 2 gained the governing rank of 3 under the economic constraint. And lastly, the table that requires the least set-up time emerged to be design 2 which obtained the governing rank of 5.

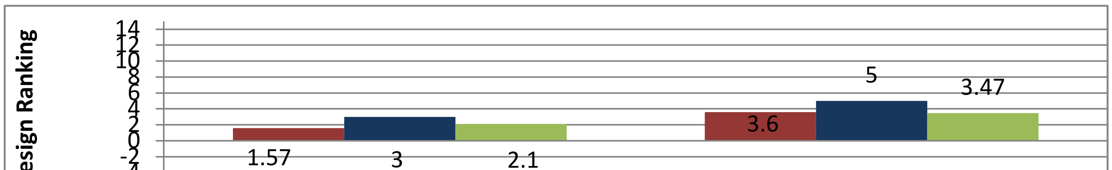
Table 5.1 Ranking Summary

Constraints	Level of Importance	Design 1	Design 2	Design 3
Designer's Perspective				
Material VA/VE	5	-3.45	5	-2.83
Product VA/VE	5	5	3.37	3.54
Process VA/VE	2	1.6992	1.5323	2
Ergonomics	5	4.15	4	5
Client's Perspective				
Economic	3	1.574903	3	2.16962
Productivity	5	3.60	5	3.47
Over-all Rank		2.10	**3.65**	2.22



	Material VA/VE	Product VA/VE	Process VA/VE	Ergonomics
Design 1	-3.45	5	1.69	4.15
Design 2	5	3.37	1.53	4
Design 3	-2.83	3.54	2	5

Fig.5.1. Decision Criteria Summary (Designer's Perspective)



	Economic	Productivity
Design 1	1.57	3.6
Design 2	3	5
Design 3	2.1	3.47

Fig. 5.2. Decision Criteria Summary (Client's Perspective)

Figure 5.1 and 5.2 shows the computed and compared over-all rankings of the three designs based on the trade-offs between Material VA/VE, Product VA/VE Process VA/VE, Ergonomic, Economic, and Productivity. Based on the over-all rankings of constraints, the designers chose the second alternative design or the "Workstation with Flip-Up Monitor Rack". The chosen design yielded a rank of 5 for Material VA/VE, 3.37 for Product VA/VE, 1.5323 for Process VA/VE, 4 for Ergonomics, 3 for Economic, and a governing rank of 5 for the Productivity constraint with an average overall rank of 3.65

Based on the observations and the results of the study. This paper recommend the following: Use of "Workstation with Flip-Up Monitor Racks" (Design 2) as the best alternative for their existing layout. Plan ahead of time and Recommended Planning such as ; Upon the ocular visit with the focal person, study the area of the production to optimize the process of transporting the equipment.; To obtain the recommended planning, the focal person should establish all the constraints such as economic, ergonomic and productivity that may encounter during the ocular visit and make a strategy for unloading the equipment and for utilization of manpower ; Meet the people involve with the production and discuss the strategy to avoid delays and other factors that can affect the set up production.

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Biographies

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