AN INVESTIGATION INTO THE UBC PHARMACEUTICAL SCIENCES IMPACT MEDIA WALL

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For

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Abstract

The Impact Media Wall (IMW) is a rear-projection based exhibit designed to be a prestigious part of the recently built state-of-the-art Pharmaceutical Sciences building. The six-projector design, accompanied with incapable graphics hardware reduces user experience, consumes high energy and is expensive to maintain. This report proposes two solutions to the currently flawed implementation by considering social, economic and environmental indicators to investigate alternative Media Wall configurations. The first solution reduces the number of required projectors by utilizing short-throw projectors. Having only two projectors instead of six increases the performance while reducing the cost of maintenance. The second solution replaces the projectors with an array of eighteen 55" LED displays. With the implementation of LED displays the visual quality improves greatly. In addition, LED displays are more energy efficient than the current setup. With the presence of two options, the stakeholders are able to decide between paying the premium for high quality LED displays and decreasing the number of projectors for economic benefit.

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LIST OF ILLUSTRATIONS

GLOSSARY

Aesthetics: set of rules concerned about the appreciation and role of beauty.

Back-mail: product returned to the manufacturer.

Bezel: rim that holds a lens or screen.

Configurations: Arrangements of parts.

Edge blending: re-composition of the projected images to adjust light intensity at the intersections.

Frames per second: number of distinct images produced in one second.

Graphics Card: external expansion card which outputs images to a display.

Graphic Rendering: generating images from models using computer programs.

High gain films: rear projection films.

Lumens: amount of light emitted per second in a unit solid angle.

Mirror Assemblies: used to reflect image on mirror surfaces and subassemblies about a plane.

Peer-reviewed: evaluation of work by one or more people of equivalent ability as the producer of the work.

Rear-projection: combines pre-filmed backgrounds with foreground performances.

Short throw projector: a type of projector that is able to produce relatively large projections from short distances.

Sustainable: able to maintain something at a particular level.

Throw ratio: ratio of distance from the screen and the width of the projection

Triple bottom line: a method of investigation considering social, economic and environmental aspects.

Vector Images: images that are defined by geometrical primitives.

LIST OF ABBREVIATIONS

FPS: frames per second

HGF: high gain films

IMW: Impact Media Wall

LCD: Liquid Crystal Display

LED: Light Emitting Diode

TBL: triple bottom line

1.0 INTRODUCTION

The Impact Media Wall is a large 7-by-26 foot projection wall, as shown in Figure 1, located in the University of British Columbia's Pharmaceutical Sciences building, which was inaugurated on 18 September 2012. It is a state-of-the-art learning and research facility designed with the latest sustainable technology. The building showcases a digital exhibition, spanning from the first to the second floor. The Impact Media Wall is a part of this exhibition, and is located on the entrance level.

Designed by a Vancouver based company named NGX Interactive, the IMW is comprised of six large rear projection screens, each with its own projector. Even though the IMW is the key element of the building, over the past year its maintenance has become overwhelming and unanticipated problems have arisen (Shaw, 2012).

The objective of this project is to utilize the *triple bottom line* (TBL) analysis to compare the existing Media Wall with possible alternatives. Considering the social, economical and environmental indicators to investigate alternative configurations, this report aims to assist the faculty of Pharmacy in resolving the current problems with the IMW.

Figure 1: Impact Media Wall

(Source: http://www.flickr.com/photos/ubcpharmsci/8675583287)

2.0 INVESTIGATION

2.1 Primary Investigation

The primary research is based on information collected from the stakeholders of the project, Phil Chatterton (Director of Digital Media Technologies, UBC IT) and Mike Coughtrie (Dean of Faculty of Pharmaceutical Sciences).

The stakeholders provided information regarding the current installation of the IMW, such as a list of hardware and the purpose of the exhibit. This information is used to compare alternative solutions to the current setup. As a part of the primary investigation, a visit to Pharmaceutical Sciences building and observation of the IMW revealed the current technical problems such poor *edge blending*, low *fps* and distracting reflections due to ambient lighting. These problems significantly deteriorated the user experience.

2.2 Secondary Investigation

The secondary research for this investigation include peer reviewed articles, user manuals, scholarly papers on power saving and technology reviews were consulted. These findings are used to compare display technologies such as power consumption, initial costs, maintenance costs and performance, in a manner that satisfies the requirements of TBL analysis.

3.0 INDICATORS

The TBL analysis requires investigations on social, economic and environmental grounds. The impact of these indicators forms the basis of this investigation.

3.1 Social Indicator

The UBC Faculty of Pharmaceutical Sciences intends to implement a technology that would appeal to the public and focus on the contribution of Medicine to human health and the community. This initiative for sustainable healthcare provides evidence for ongoing research and dialogue on economic principles of healthcare, focusing on the role of Pharmacy in bringing changes. The digital exhibits should attract the community and enhance their knowledge of and interest towards pharmacy. The aesthetics of the media wall should comply with the visual standards of a modern building. The interest factor examines whether the media wall will add any value to the Story of Medicine exhibition.

3.2 Economic Indicators

The economic indicators are the financial factors of this investigation. Economic indicators used for comparison include the initial production, maintenance and the power consumption costs. The motive of this investigation is to reduce these costs. Comparison of costs will help evaluate which solution is the cheapest to implement and maintain.

Although the Faculty of Pharmacy is able to cover the costs, it does not want to keep replacing the parts on a frequent basis as it hinders the functioning of the media wall and could result in the media wall being inactive for longer periods of time.

3.3 Environmental Indicators

This type of indicator relates to the impact of the media wall on the environment. The environmental indicators are production materials, recyclability and power consumption. The materials used in the production of the media wall should have little impact on the environment during their production and at the end of their lifespan. The chosen devices should also consume power conservatively to have minimum effect on environment.

4.0 CURRENT SETUP

4.1 Description

The setup designed by NGX Interactive is based on a rear projection system with mirror assemblies. It consists of the hardware shown in Table 1 below.

Line	Hardware	Model Number	Quantity	Estimated Cost (per line)
1	DLP Projectors	PT - DW6300ULS	6	$ 23,394
2	Mirror assemblies	Millennium	6	$ 26,664
3	Rear projection films	EOS-procured film	6	Unable to find
4	Computer	Dell T3500	1	$ 525
5	Video card	Maxtron M9188	1	$ 2,700
6	Edge blending device	TV-One C2-2450A	4	$ 7,980
7	AV rack	Toten TOC22UD	1	$ 837

8	AV rack drawer	Toten TODWR2U	1	$ 58

Table 1: List of Hardware

The total hardware cost of the current setup is estimated to be: $ 62,150. This does not include construction of the outer wall or the glass panel in front of the projection screens. The cost of the projection film was not found; therefore, it had to be omitted from the calculation.

The power consumption of the current system in operation:

- Projectors 6 x 790 W = 4740 W
- Computer = 520 W
- Edge Blending = 4 x 25 W = 100 W

The total power consumption of the system is estimated to be 5360 W, dominated by the projectors.

4.2 Problems

The current Impact Media wall has some problems that inhibit its ability to serve its intended purpose. The problems range from aesthetics to maintenance costs.

4.2.1 Edge Blending Artifacts

The IMW wall was designed to be a seamless display by integrating the 6 projectors with appropriate edge blending units. The system is, however, not displaying as a single entity but rather is segmented into 6 distinct sections that slightly overlap one another. This problem is visually unappealing and hinders the effectiveness of portraying the Story of Medicines to the public. Figure 2 below shows the edge blending errors.

The problem is suspected to be due to incorrect calibration or implementation of the edge blending units and could possibly be fixed through software on the computer or through adjusting the edge blending units themselves.

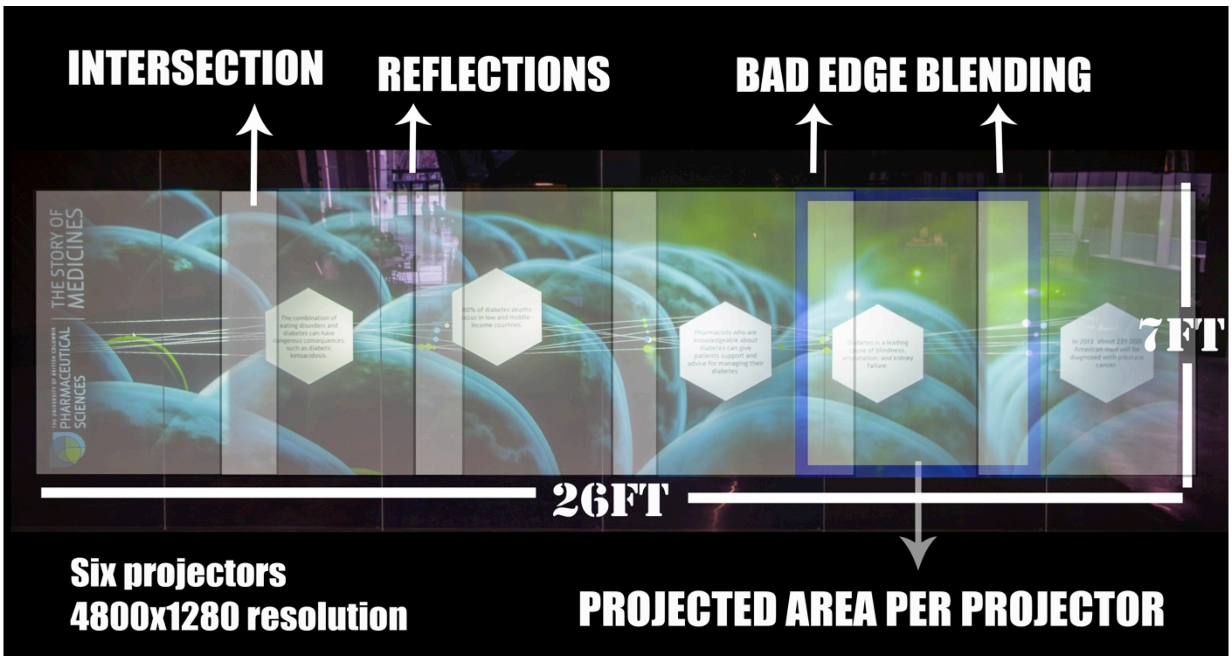

Figure 2: Edge Blending Errors

4.2.2 High Maintenance Costs

The Panasonic projectors used within the current IMW require frequent replacement of the projector bulbs. Each projector uses two bulbs to achieve the high brightness required in the rear-projection setup (Panasonic PT-DW6300ULS

User Manual, p28). It is recommended that the lamps be replaced after 1800 hours of use.

NGX Interactive designed the wall to be operational for 8 – 15 hours a day. This results in 2,900 to 5,475 hours per year. Each projector will require 1 – 3 lamp replacements each year. The cost of one lamp is $240 ("Replacement Lamp Module for Panasonic ET-LAD60 Projectors", 2013). The average bulb replacement cost per year is calculated below:

$$Cost = \frac{2\ times}{1\ year} * \frac{2\ lamps}{1\ projector} * \frac{\$240}{1\ lamp} * 6\ projectors = \$\ 5760$$

The average bulb replacement cost, when the system is running the designed amount of hours, is almost 10% of the initial cost of the entire IMW's hardware costs. This is a large maintenance cost. If the lamps are not replaced then the image quality will deteriorate rapidly, and the lamps could explode and release gas (Panasonic PT-DW6300ULS User Manual, p10).

The projectors themselves will need to be replaced after some time. They are warrantied for 3 years ("Panasonic Projectors: Panasonic PT-DW6300ULS DLP projector", n.d) and therefore 3 years will be the minimum replacement time. The cost of replacing the 6 projectors would be about $ 23,000 as calculated before. The projectors account for almost 40% of the hardware costs of the IMW and therefore the replacement costs are very large.

4.2.3 High Power Consumption

The power consumption of the IMW was estimated to be 5360 W in the description above. If the media wall operates for 11.5h each day, which is the average of the designed system, then the resulting power consumption per day is:

$$11.5\ h * 5236\ W = 62kWh$$

The energy consumption per month results in 1800kWh. The average commercial energy charge is about $0.0942 per kWh ("BC Hydro - Business Rates Prices", n.d.). The cost of operating the IMW per year is therefore:

$$\$0.0942 * 1850kWh * 12months = \$2091$$

The cost of running the media wall may not be too shocking; nevertheless, the focus should not be on the monetary value, but rather the environmental aspect. UBC is striving to become a greener campus ("sustain.ubc.ca", n.d.) and it is important to minimize power consumption on campus as a whole.

4.3.4 Image Quality

The IMW is next to a large window that allows sunlight to shine onto it. The additional light causes reflections to appear on the glass encasing the projection screens. These reflections degrade the overall appearance. These artifacts could be eliminated by replacing the current glass with an anti-reflective counterpart, such as made by SCHOTT ("Indoor Anti-reflective Glass & Museum-Quality Glass", n.d.). The display also suffers from a low frame rate, causing the content to appear lagged. This could be caused due to the high resolution of the final system and the hardware limitations of the Maxtron M9188 graphics card.

5.0 IDEA 1: SHORT THROW PROJECTORS

Many of the problems found in the current system are due to using many projectors. For example, *edge blending* becomes computationally more difficult as the number of intersections increases. Other problems such as energy consumption and maintenance costs are directly related to the number of projectors as well.

There are two main advantages of utilizing as much as six projectors. Firstly, *throw distance* is allowed to be minimal for a given total screen size and this make a small room suitable for storage of projectors. This can be explained by the rule that size of projection is dependent on *throw distance.* Secondly, total resolutions of multiple projectors provide a high-resolution composition. This increases visual quality.

As it is not practical to extend the projector room with construction, using less number of projectors from greater distance for the same size of screen is not an option. However, there is a special type of projector used for larger projections from smaller distances named *short throw* (ST) *projectors.* Replacing current projectors by these will reduce the total number of projectors down to two.

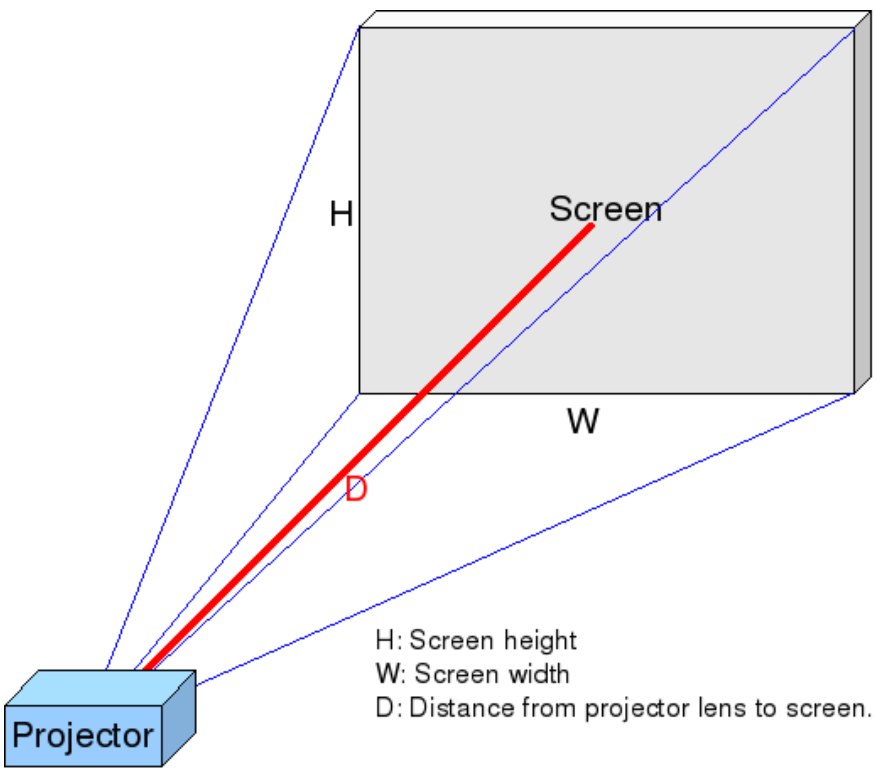

Figure 3: Throw ratio is defined as D/W.

(Source: http://en.wikipedia.org/wiki/Throw_(projector))

The distance from the projectors to the wall is found to be approximately 4.5m(14.76ft) using the data sheet for the current projectors provided by the stakeholder (Chatterton, 2013). The goal for the replacement system being 2 projectors, we require a minimum of 1.13:1 *throw ratio* (TR) as compared to 2.1:1

ratio of current projectors. This can be calculated using the fact that the screen is 26ft wide and 7ft long and the throw distance is 14.76ft.

$$TR = \frac{number\ of\ projectors * throw\ distance}{total\ width} = \frac{2 * 14.76}{26} = 1.13$$

With the addition of a wide-angle lens such as Panasonic ET-DLE150, throw ratio of current projectors can be improved down only to 1.3:1 ("Panasonic ET-DLE150 Power Zoom Lens", n.d.). Since it is above the requirement, projector replacement is necessary. One being economical and other being of higher quality, two possible replacement options are explained below.

5.1 Viewsonic PJD8633WS

Being in the ST projector class, this device is able to project a 250'' image from two meters. It is possible to form a screen sized eight tenth of the current Media Wall with two of such projectors. The setup for this configuration can be seen in Figure 4. One of this brand and model projector costs $1,230 making the initial cost reasonable.

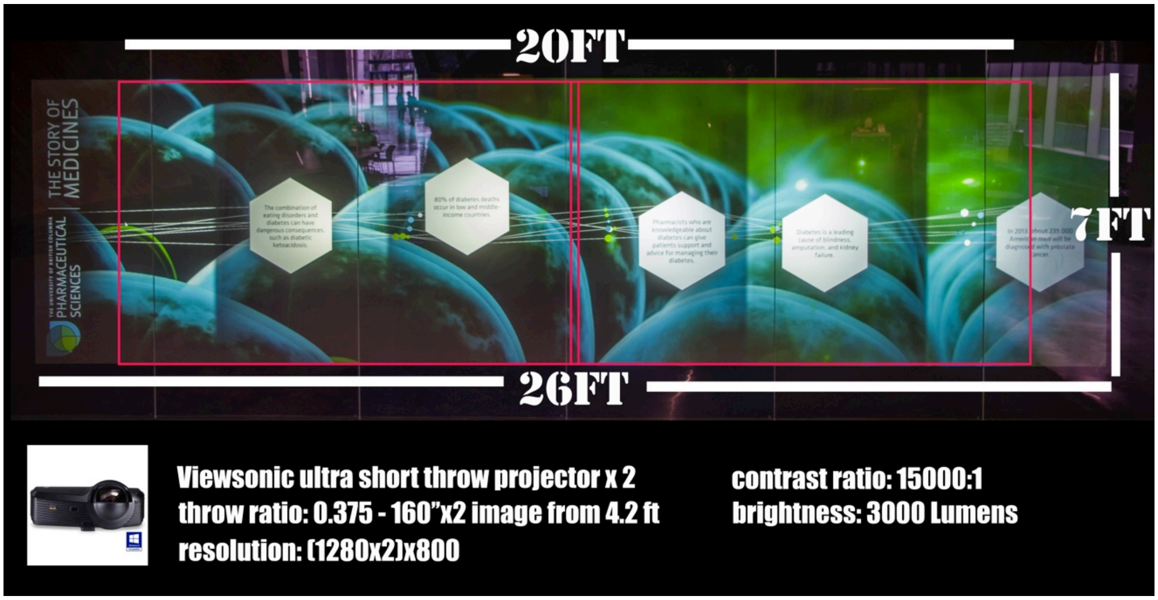

Figure 4: Viewsonic short throw projectors are able to occupy 80% of Media Wall

Projector image: http://www.viewsonic.com/us/projectors/short-ultra-short-throw/pjd8633ws.html)

There are many advantages of reducing the number of projectors as initially mentioned. With this configuration, edge blending and *graphic rendering* will require less computing power and this will help to achieve a high-*fps* seamless composition. This is a result of decrease in total resolution and the number of projection intersections. Also, having a moderate resolution makes it possible to work with standard high-res graphics that are commercially available on the Internet to update the content of the Media Wall. For higher resolutions it is necessary to work with *vector* images.

Besides visual advantages, this configuration has significant economic advantages over current setup. Because these projectors use single lamp, compared to double lamps used in each projector in current setup, they have significantly lower energy consumption. Total energy consumption of Viewsonic projectors is 2 x 350 W = 700W and that of current Panasonic projectors is 6 x 790 W = 4740W. The energy consumption of the computer and edge blender totals for 600W + 100 W= 700 W for both systems.

In addition to energy savings, the maintenance cost also decreases with the reduction of projectors. New projectors need a lamp replacement per 3500 hours, which equals one year with current Media Wall operation hours. Each lamp for this kind of projector costs $329 ("RLC-090 - PJD8633ws Replacement Lamp Module", n.d.). The expected improvement is from 12 x $231 to 2 x $329 maintenance cost per year (Chatterton, 2013). The projectors come with a 3-year warranty which can be considered as the minimum lifespan.

Nevertheless, this configuration has some serious disadvantages. Use of one lamp per projector compared to two, will reduce brightness from 6000 Lumens to 3000 Lumens. The rear projection film used on the current Media Wall is designed for a brightness of 6000 Lumens and it will need being replaced to support new configuration. There are *high gain films* produced specifically for low brightness projectors that can be investigated further ("Rear Projection Film | Pro Display").

Within our recent conversations with the stakeholders, we have been informed that they strongly prefer a high-resolution screen, even though it means significantly higher initial costs. However, suggested configuration provides a decent image quality from reasonable distances. As a result of physical limits of human eye, the perceived resolution is a function of distance from the screen (Westerink, 1987, p. 113-119). Figure 5 shows that for an average viewing distance of 6 meters and display size of approximately 100'', human eye cannot distinguish resolutions above 720p. Suggested Viewsonic configuration consists of two 160'' projected screens each having 800p of resolution – slightly below the limits of human vision.

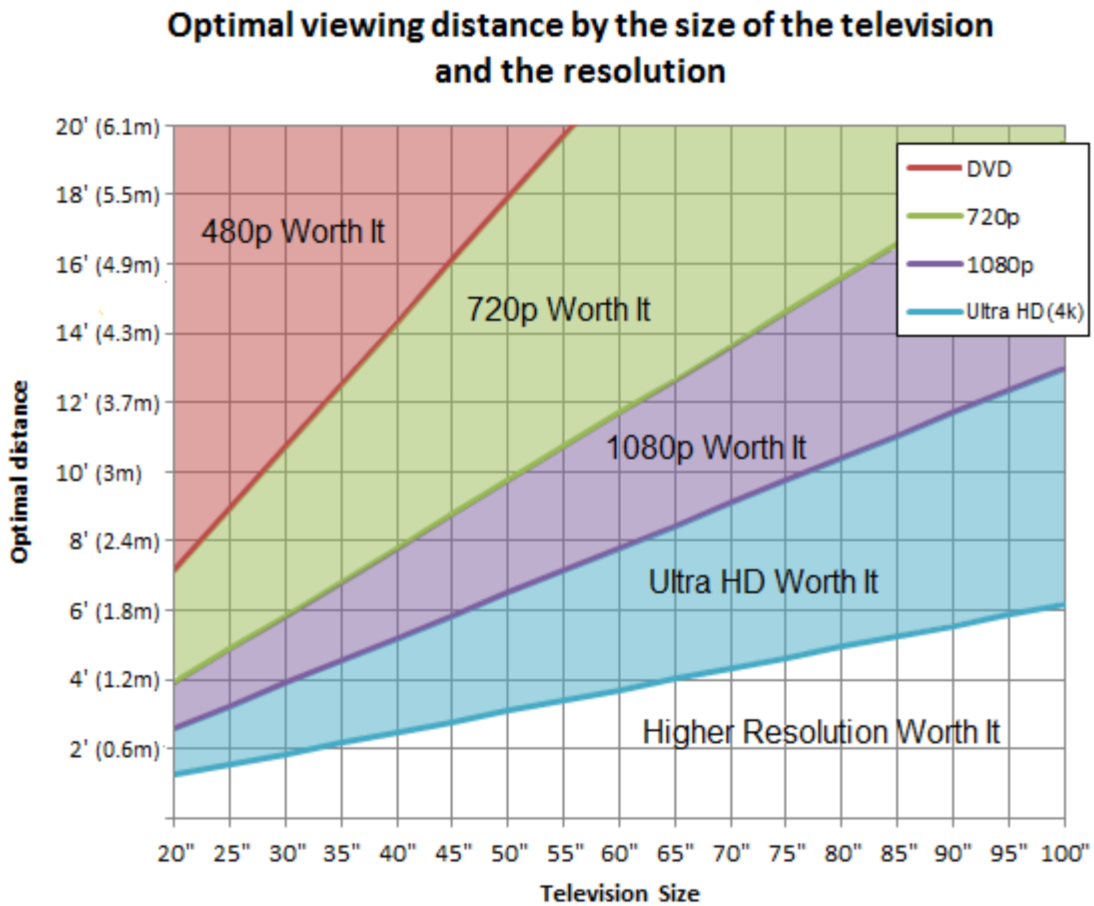

Figure 5: As distance from the screen increases higher resolutions become indistinguishable.

Source: http://www.rtings.com/info/television-size-to-distance-relationship)

As a matter of sustainability, Viewsonic provides a back-mail program where they receive old products and completely ("Recycle+ Program", n. d.). However, like most of the lamp producers, they do not accept lamps for recycling. For lamp recycling, free services such as the one provided by the Canadian company named 'Projector Lamp Source' can be used ("Projector Lamp Source", n.d.).

The current computer used for the Media Wall is Dell branded (Chatterton, 2013). A brief Internet research shows that Dell has been forcing long working hours to factory workers with unacceptable conditions ("Dell faces scrutiny for alleged labor violations", 2013). We recommend using a less known hardware manufacturer with smaller factories such as SUPER PC LLC ("SUPER PC | Multiple Monitor Computers", n.d.). Similar research does not show any sign of poor conditions in Viewsonic factories.

5.2 Eiki LC-HDT700 + Eiki AH-32013 Fixed Lens

Figure 6: Eiki Projector costs $10,500.

Source: http://www.focusedtechnology.com/eiki-lchdt700-projector.html)

As a solution for brightness and resolution shortcomings of Viewsonic projectors, this projector model and a short throw lens can be used. The device is equipped with 7000 Lumens of brightness and 1080p of resolution. Two of these projectors can be setup in a very similar manner to the one recommended for Viewsonic solution. Yet, due to their high-brightness projections, the film replacement is unnecessary.

This kind of upgrade in visual quality is relatively expensive. The associated costs are $10,500 for a projector, $3,695 for a lens and $750 for a lamp ("Replacement Lamps", n.d.). As a contrast, the energy consumption is 380W and similar to that of Viewsonic solution.

It is important to note that this second option is here for information purposes only and not a part of our triple bottom line analysis.

6.0 IDEA 2: LCD/LED Video Wall

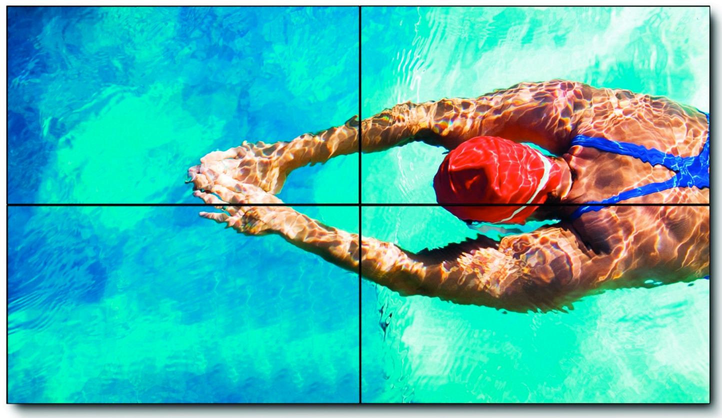

Figure 7: Paneled Video Wall.

(Source: http://www.edcom.ca/wp-content/uploads/2013/10/NEC-Videowall.jpg)

A video wall is a set of multiple projectors or displays that, put together, form one larger screen. In this section, we will study the applicability of a LCD/LED television media wall to substitute the current media wall from pharmacy building, which is formed by a set of 6 projectors.

Because it is formed by LED TVs, all the characteristics of the video wall depend on the characteristics of the display selected. Most common displays range from 45" to 55", but there are also smaller and much larger ones. Regular home televisions can be used, but it is not recommended for the following reasons:

- They are not designed to function for so long periods. Excessive use will significantly decrease the lifespan and will cause the product to lose its guarantee for misuse.

- Bezel sizes are normally much larger, which means the video wall will not have a seamless appearance, as they are supposed to have.
- They are not designed to function on large and well-lit rooms. To compensate this, the brightness of the screen will constantly have to be higher than normal, which will greatly increase power consumption.
- They normally include features that will be useless to a video wall such as an embedded sound system on each display and 3D capability.

Video wall displays are designed to work 24/7 in larger areas, with a higher brightness, having an easier setup and being optimized to consume less energy in those conditions, but they cost much more than regular home televisions. For this reason, they have not been discarded from the analysis.

The image quality can be very high because the individual LED displays commonly have a high resolution with good color contrast. The LEDs located on the back of the screen increase the brightness and its uniformity, as shown in Figure 8.

Figure 8: LED backlight.

(Source: http://www.necdisplay.com/videowalls/LED-VideoWall.jpg)

The problem with this system, however, is that there is always a gap between the screens. The size of this gap is determined by the bezel size of the displays and it has a great influence on their prices. If the bezel sizes are not very small, the final output will not be a seamless high quality video wall.

For comparison, we have selected a few different models of displays and retrieved some characteristics of them. The first two options are regular home displays and we can see that the price difference is very clear. Their average power consumption is also lower, but this information was collected based on normal use of this equipment which, for these displays, mean small rooms with a low brightness. The costs are an average of prices found on online shopping companies (Amazon and Provantage) and the other data was retrieved from technical specification documents for each of the products.

Model	Size (")	Power consumption (W)	Average Cost	Number of Displays	Size of the new wall		Total cost
					Width (cm)	Height (cm)	
LG 50ln5700	49	54	$ 1,180.00	21	795.2	198.3	$ 24,780.00
Samsung EH6000	49.5	53	$ 700.00	21	800.1	201.9	$ 14,700.00
Sony FWD55B2	55	130	$ 3,500.00	18	746.8	215.3	$ 63,000.00
LG 55WV70	55	210	$ 5,300.00	18	729.0	205.8	$ 95,400.00
Samsung UE55C	55	103	$ 3,200.00	18	733.1	207.8	$ 57,600.00

Table 2- Displays Comparison

In our analysis, we have selected the Samsung UE55C model to better study because there was plenty of information available for it, it was designed for video walls and it appears to be the best option based on the total cost and power consumption. This product eliminates the need to buy a pc or media player because there is an embedded media platform with capacity to support the image display. The image quality of it is very high (HD1080p, which means good resolution for the whole video wall. The bezel size of this model is only 5.5mm between screens, such small measure can provide a great seamless composition.

Regarding the lifespan, most TV manufacturers claim that LCD/LED TVs have a lifespan of 60,000 continuous hours (Fredman, n.d.), but Samsung and other big companies like Sony claim that theirs last 100.000 because of the high quality control of pieces used in their products. If we assume that it will last 50.000 hours and that it will be turned on for 15h daily and 7 days a week, which is clearly super estimated, the lifespan of the LED screens would still be 9 year. This means the TVs will probably fail because of another minor component instead of the screen itself.

Compared to the currently used projectors, there will be a great economy in maintenance cost because there is no need to buy lamps and the lifespan of the displays are about twice the lifespan of the projectors, currently estimated in 4 years according to Phil Chatterton, UBC Director of Digital Media Technologies. Although 18 displays will be needed, their power consumption is also lower than the current. With the same using conditions described above and assuming a cost of

8 cents per kWh, the total annual cost of power consumption would be around 760 dollars.

For the installation of the LED display media wall in the pharmacy building, it would be required to adapt the current wall for it. Further study should be conducted in order to find the best solution, but probably some of the glass panels will have to be removed and a simple metal structure will have to be constructed behind the wall to support the Displays. This structure can be build using products like the Chief Fusion Micro-Adjustable Pull-Out Mount, displayed in Figure 9, it provides fine tuning of height, levelling and plumb adjustment that will align all the displays properly to form a seamless video wall. The estimated price for buying all the displays is about 57.600 dollars, but as there are 18 of them, it is very likely that there will be a great discount, which can compensate for the installation costs.

Figure 9: Display structure mount. (Source: https://d1rztaqenlornr.cloudfront.net/chiefProducts/flatPanel/LSMVU1.jpg)

When the products reach the end of their lifespan they can be recycled, Samsung currently has a partnership with Global Electric Electronic Processing (GEEP). The user takes the product to a specific location and, once there, it will be broken apart and almost all parts will be recycled.

7.0 COMPARISON

In this section, the analysed alternatives will be compared in each of the three categories of the Triple Bottom Line analysis using the indicators mentioned in section 3.0. In order to facilitate it, the information was formatted into tables.

7.1 Environmental Index

ENVIRONMENTAL INDEX

	materials/ processes	Recyclability	energy use	Total
CURRENT	-2000h lamp life =Projectors have relatively low impact 3/5	-Projectors: recyling programs in province --Lamps: up to consumer 2/5	Projectors: 6 x 790 W Computer: 600 W Total: 5340 W 1.5/5	6.6/15 fail
IDEA 1	-3500h lamp life =Projectors have relatively low impact 3.5/5	+Projectors: back mail program, all recycled --Lamps: up to consumer 3/5	Projectors: 2 * 350 W Computer:600 W Total: 1300 W 4/5	10.5/15 good
IDEA 2	++60.000h image half life - 18 displays combined will have high impact 3/5	= user takes the product to recycling partner. =mostly recycled 3.5/5	Monitors :18 x 103 W Server: 600 W Total: 2454 W 3.5/5	10/15 good

Figure 10: Environmental index comparison.

In order to compare two ideas and the current setup, energy use, recyclability and material impacts are set to be the three main indicators. For the projectors, lamp life and their production methods are compared. For the LED displays, image half-life is the relevant factor. When comparing their environmental effects due to production processes, it is assumed that the large number of LED displays (18) compared to a few projectors will have more significant effect on environment. On the other hand, Mercury content of projector lamps makes it important to consider lifespan and recycling options of the lamps. Energy use is shown on maximum power basis and total power costs can be obtained from Figure 11.

7.2 Economical Index

Year	1	2	3	4	5	6	7	8	Total
Current									
Product cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Installation cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Energy	$ 2,030.40	$ 2,030.40	$ 2,030.40	$ 2,030.40	$ 2,030.40	$ 2,030.40	$ 2,030.40	$ 2,030.40	$ 16,243.20
Maintenance cost	$ 2,772.00	$ 2,772.00	$ 2,772.00	$ 2,772.00	$ 2,772.00	$ 2,772.00	$ 2,772.00	$ 2,772.00	$ 22,176.00
Product replacement	$ -	$ -	$ -	$ -	$ 24,000.00	$ -	$ -	$ -	$ 24,000.00
Total	$ 4,802.40	$ 4,802.40	$ 4,802.40	$ 4,802.40	$ 28,802.40	$ 4,802.40	$ 4,802.40	$ 4,802.40	$ 62,419.20
Short Throw Projectors									
Product cost	$ 3,355.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,355.00
Installation cost	$ 2,000.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,000.00
Energy	$ 552.40	$ 552.40	$ 552.40	$ 552.40	$ 552.40	$ 552.40	$ 552.40	$ 552.40	$ 4,419.20
Maintenance cost	$ 658.00	$ 658.00	$ 658.00	$ 658.00	$ 658.00	$ 658.00	$ 658.00	$ 658.00	$ 5,264.00
Product replacement	$ -	$ -	$ -	$ -	$ 2,460.00	$ -	$ -	$ -	$ 2,460.00
Total	$ 6,565.40	$ 1,210.40	$ 1,210.40	$ 1,210.40	$ 3,670.40	$ 1,210.40	$ 1,210.40	$ 1,210.40	$ 17,498.20
LED Video Wall									
Product cost	$ 50,000.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 50,000.00
Installation cost	$ 10,000.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 10,000.00
Energy	$ 938.70	$ 938.70	$ 938.70	$ 938.70	$ 938.70	$ 938.70	$ 938.70	$ 938.70	$ 7,509.60
Maintenance cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Product replacement	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total	$ 60,938.70	$ 938.70	$ 938.70	$ 938.70	$ 938.70	$ 938.70	$ 938.70	$ 938.70	$ 67,509.60

Figure 11: Long term financial analysis.

On Figure 11, the indicators are divided into three main groups namely initial cost, recurring costs and product replacement cost. The initial cost refers to the hardware and installation costs whereas recurring costs include the energy costs to run the system and the maintenance costs. Product replacement cost is the cost for purchasing new projectors or displays when they reach the end of their lifespan. The period analysed is 8 years, these costs are estimates based on the data presented in the previous sections and the characteristics of each option.

ECONOMIC INDEX

IDEA 2	IDEA 1	CURRENT	
$67,509 3/5	$17,498 5/5	$62,419 3/5	Total 4-year Cost

Figure 12: Economic index comparison.

7.3 Social Index

SOCIAL INDEX

	Image quality	suitability	factory conditions	Total
CURRENT	+High resolution =Standard contrast -Low frame rate -Bad edge blending 5/8	++Good wall integration -No interactivity / sensors -Hard to update content =Standard screen size 5/8	Panasonic: -Poor working con. Dell: --Very poor working con. 1/5	11/21 fail
IDEA 1	=Standard resolution =Standard contrast +High frame rate +Good edge blending 6.5/8	++Good wall integration =Possible interacitivity +Easy to update content -Smaller screen size 6/8	Viewsonic: =Standard working con. SUPER PC: =Standard working con. 3/5	15.5/21 good
IDEA 2	++ Very high resolution +Good contrast +High frame rate -Bezels 7.5/8	=OK wall integration =Possible interacitivity -Hard to update content -Smaller screen size 5/8	Samsung: -Poor working con. 2/5	14.5/21 good

Figure 13: Social index comparison.

As mentioned in previous sections, stakeholders value image quality more than other indicators. This is reflected in comparison table. The frame rate is directly related to total resolution and computation power of the system. Currently the configuration has only one computer to drive six projectors whereas only two projectors are driven in IDEA1. This results in higher frame rate. Similarly, each Samsung display in IDEA2 has its own player, which also results in higher resolution.

Suitability is a combination of all factors related to physical compatibility of the configurations with high standards of the building. It is indicated that higher resolution systems will require vector graphics whereas lower resolution ones can use standard high definition images. This gives the advantage of easy updates of content with many online graphic options. Screen size is another factor to consider. The slight reduction in screen size seen in IDEA1 and IDEA2 reduces their marks. However, the possible integration of sensors for interactivity to these two systems increases their marks. Finally, wall integration is here to reflect the quality of transition from screen to wall and vice versa. Obviously, LED panels will have some imperfections on the surface.

For the third social indicator, a research on working conditions in the factories of relevant manufacturers shows that Samsung, Panasonic and Dell have poor conditions (Mari, 2013). Buying from these manufacturers will have overall negative social impacts and representative scores of this fact can be seen.

8 CONCLUSIONS

Having analysed the options in each of the three concepts of the Triple Bottom Line and comparing their characteristics through the predefined indicators, it can be clearly seen that there is a great distinction between the LED Video Wall and the Short Throw Projectors. While the LED displays an image of very high quality, resolution and brightness, its cost is higher than the other options because of the great initial cost of having to buy 18 displays. In contrast, Short Throw Projectors offer a very accessible solution by cutting the projectors to one third of the current number, but even though they are cost effective, they deliver only an average image quality.

Regarding the costs, the power consumption cost of the two projectors will be low if compared to the 18 TVs, but they will still need replacement for the lamps while the LED economizes a lot on not having to buy it. In the end, it comes down to deciding whether the most important factor is the image quality or the price. If either of the options is chosen, there will be advantages comparing it to the current equipment, which has a very high maintenance cost, average visual quality and short lifespan. An important fact to note is that the projectors are estimated to last only 4 years and replacement cost is high. Consequently, the LED displays, which once seemed to be out of the budget, start to look like a feasible option in economical terms.

It is up to the stakeholders to decide whether they want better quality or lower costs. In any of the cases there will be better outcomes compared to the current technology. We conclude that both are feasible options for the implementation designs for the new sustainable media wall.

REFERENCES

55WV70 Special Display Digital Signage Specs. (n.d.). Retrieved 2013, from *http://www.lg.com/global/products/digital-signage/special-display/LG-55WV70.jsp*

BC Hydro - Business Rates Prices. (n.d.). Retrieved from https://www.bchydro.com/accounts-billing/customer-service-business/business-rates-overview/business-rates-prices.html

C2-2450A Operation Manual. ((n.d.)). Retrieved from http://www.true-colours.net/products/manufacturer/TV-One/documents/Manual-C2-2450-2.7.pdf

Chatterton, P. (11 October 2013). Email Message.

Dell faces scrutiny for alleged labor violations at factories in China | PCWorld. (2013). Retrieved from *http://www.pcworld.com/article/2061780/dell-faces-scrutiny-for-alleged-labor-violations-at-factories-in-china.html*

Dell Precision T3500 Workstation Technical Guide. ((n.d.)). Retrieved from http://www.dell.com/downloads/emea/edb/Dell_Precision_T3500_Technical_Guide.pdf

Exhibits | UBC Pharmaceutical Sciences. (n.d.). Retrieved 2013 from http://www.pharmacy.ubc.ca/aboutus/som/exhibits

Fredman, J. (n.d.)*. LED Television's Life Expectancy | eHow*. Retrieved 2013 from http://www.ehow.com/info_12195923_led-televisions-life-expectancy.html

Indoor Anti-reflective Glass & Museum-Quality Glass | SCHOTT North America. (n.d.). Retrieved from http://www.us.schott.com/architecture/english/applications/interior/anti-reflective-glass.html

LED display prices on Amazon online shopping. Retrieved 2013 from *http://www.amazon.com.*

LED display prices on Provantage online shopping. Retrieved 2013 from *http://www.provantage.com*

LG 50LN5700: 50 inch Class TV| LG USA Specs. (n.d.). Retrieved 2013, from *http://www.lg.com/us/tvs/lg-50LN5700-led-tv*

LSMVU - Large FUSION™ Micro-Adjustable Pull-Out Mount. (2013). Retrieved 2013 from *http://www.chiefmfg.com/Series/LSMVU*

Mari, A. (2013, August 16). *Samsung is sued over poor working conditions in Brazil | ZDNet*. Retrieved from http://www.zdnet.com/samsung-is-sued-over-poor-working-conditions-in-brazil-7000019470/

Matrox M-Series. ((n.d.)). Retrieved from http://www.matrox.com/graphics/media/pdf/products/graphics_cards/m_series/en_mseries_guide.pdf

Optional Lenses. (n.d.). Retrieved 2013, from *http://www.eiki.com/usa/products/eiki-accessories/optional-lenses*

Panasonic ET-DLE150 Power Zoom Lens ET-DLE150 BH Photo Video. (n.d.). Retrieved 2013, from *www.bhphotovideo.com/c/product/629272-REG/Panasonic_ET_DLE150_ET_DLE150_Power_Zoom_Lens.html*

Panasonic Projectors: Panasonic PT-DW6300ULS DLP projector. (n.d.). Retrieved from http://www.projectorcentral.com/Panasonic-PT-DW6300ULS.htm

Panasonic PT-DW6300ULS *User Manual.* ((n.d.)). Retrieved from ftp://ftp.panasonic.com/pub/Panasonic/business/projectors/manuals/D6Series_operatinginstructions.pdf

Projector Lamp Source lowest projector lamp and bulb prices in Canada with Free

Rear Projection Film | Pro Display. (n.d.). Retrieved 2013, from *http://www.prodisplay.com/rear-projection-film-high-brightness.html*

Recycle+ Program. (n.d.). Retrieved 2013, from *http://www.viewsonic.com/us/company/green/recycle-program/recycle-program*

Recycling. (n.d.). Retrieved 2013, from*http://www.projectorlampsource.ca/projector_bulb_recycling.html*

Replacement Lamp Module for Panasonic ET-LAD60 Projectors. (n.d.). Retrieved 2013 from http://www.amazon.ca/Replacement-Panasonic-ET-LAD60-Projectors-Includes/dp/B00DE4H54S

Replacement Lamps. (n.d.). Retrieved 2013, from *http://www.eiki.com/usa/products/eiki-accessories*
RLC-090 - PJD8633ws Replacement Lamp Module. (n.d.). Retrieved 2013, from *http://www.viewsonic.com/us/rlc-090.html*

Samsung Recycling Direct. (n.d.). Retrieved 2013 from http://pages.samsung.com/ca/green/English/

Shaw, G. (2012). *UBC's new faculty building a showcase for digital technology; giant video screen exhibit creates highly personalized, interactive journey*. *The Vancouver Sun*, Retrieved from http://search.proquest.com.ezproxy.library.ubc.ca/docview/1080590147

Specs - 55" UEC Series Display-Large Format Display-Video Wall | SAMSUNG. (n.d.). Retrieved 2013, from *http://www.samsung.com/ca/business/business-products/large-format-display/video-wall/LH55UECPLGC/ZA-spec*

Specs - FWD55B2 55"Pro Display. (n.d.). Retrieved 2013 from *http://pro.sony.com/bbsc/ssr/product-FWD55B2/*

Specs - LED TV UN50EH6000F | Samsung TVs. (n.d.). Retrieved 2013 from *http://www.samsung.com/us/video/tvs/UN50EH6000FXZA-specs*

SUPER PC | Multiple Monitor Computers and Display Solutions! (n.d.). Retrieved from *http://www.multi-monitors.com/*

Westerink, J. (1987). Subjective image quality as a function of viewing distance, resolution and picture size. *SMPTE journal*, *98*(2), 113-119.