AN ABSTRACT OF THE THESIS OF

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Aesthetics should be emphasized as much as possible in a design project without exceeding scope, budget, or schedule to satisfy the stakeholders involved. There is a rising trend of increased emphasis on aesthetics. This trend of using various techniques to help structures blend in or contribute to the surrounding environment has led to more appreciation for the beauty of bridges among civil engineers as well as the general public.

Aesthetics development is strongly affected by the relationships between the client, engineer and the architect (if involved). Other factors that affect aesthetics are public involvement and client expectations. If certain measures such as defining roles and relationships between the architect and the engineer, outlining public responsibility, and educating the client are taken, then aesthetics can be maximized in bridge design to the satisfaction of all the stakeholders involved.

Key Words: aesthetics, bridge

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Common Factors that Affect Aesthetics in Bridge Design

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I understand that my project will become part of the permanent collection of Oregon State University, University Honors College. My signature below authorizes release of my project to any reader upon request.

Jennifer J. Coe, Author

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INTRODUCTION

Aesthetics, the use of proportion, order, and symmetry to enhance the surrounding environment, should be emphasized as much as possible in a bridge project without exceeding scope, budget, or schedule to satisfy the stakeholders involved. In the past, there has been a strong emphasis on safety, function and serviceability in civil engineering, however, currently there is a trend of increased emphasis on aesthetics. This new inclination to use design techniques to help civil engineering projects blend in or contribute to the surrounding environment has led to more beautiful and appreciated bridges among civil engineers and the general public.

The extent and type of aesthetics in a bridge design are strongly affected by the relationship with the architect, public involvement, and client expectations. If certain measures are taken, then aesthetics can be maximized for individual projects to the satisfaction of all the stakeholders involved. The relationship between the architect (if involved) and the engineer can greatly affect the outcome of a design of a project. If the two teams work well together through defined roles they will be less likely to spend time and money going back and forth between decisions and design elements and more time and money towards aesthetics. An example of this dynamic is the Oswego Canal Bridge. The Willamette River Bridge provides an example for when the public also has

defined roles and responsibilities, and a method to act upon those roles, whereas they can help promote aesthetics to the overall satisfaction of the stakeholders. Finally, if the client's expectations (in terms of schedule, cost, and scope) are managed before and throughout the project's lifetime, then aesthetics can become feasible and more easily implemented throughout the project, as seen in the Sprague River Bridges, the Honeyman State Park Bridge, the Oswego Canal Bridge, and the Gibbs Street Pedestrian Bridge.

BACKGROUND

AESTHETICS DEFINED

In order to discuss aesthetics as related to bridge design, aesthetics itself must be defined. This task is nearly impossible, as aesthetics are a reflection of personal taste and experiences and thus a particular work cannot be aesthetically pleasing for everyone. Furthermore, what may be first viewed as an eyesore can later be viewed as a beautiful piece of civil engineering artwork. However, bridges that have historically been viewed as aesthetically pleasing by engineers and the general public use proportion, order, and symmetry to blend in or contribute to the surrounding environment.

There are two different types of design in which to accomplish this. The first type is structural design which "gives the form to objects that are of relatively large scale and of single use, and the designers see forms as the means of controlling the forces of nature to be resisted" (Billington, 1983). The aesthetics in this type of design are a result of the appearance of the structure's form of carrying loads and resisting forces. This type of design is more common in signature or landmark bridges that are more recognizable because each different location leads to unique designs as a result of the individual restraints and load case. The second type is architectural design which is used to "give form to objects that are relatively small scale and of complex human use, and these designers see forms

as the means of controlling the spaces to be used by people" (Billington, 1983). Examples of this type of design are architectural treatment to concrete and use of lighting and shadows. Structural or architectural design combined with function and serviceability lead to an aesthetically pleasing civil engineering project, as the following quotes demonstrate.

> *"Aesthetics: the branch or philosophy dealing with the nature and perception of the beautiful. Bridge Aesthetics: a structure that is function yet beautiful. A marriage of engineering and architecture." (Minnesota Department of Transportation, 2009)*
>
> *A bridge in the landscape helps us interpret that landscape by providing a scale and a reference to human intervention (RTA Operations Directorship et al., 2009)*
>
> *The successful bridge designer must consider both abstract structural form and the integration of the bridge into the surroundings (Cohos, Evamy, 2005)*

RELEVANCE TO CURRENT TRENDS IN THE INDUSTRY

Civil engineering has a history of being a discipline focused primarily on function and serviceability. However, in recent years there has been a trend to more strongly incorporate aesthetics into civil engineering projects, and bridges in particular. One engineer put it, "…we recognize the need to integrate a structure into its environment, landscape or cityscape, particularly where the dimensional relations and scale are concerned. Many mistakes have been made

during the past decades by placing massive concrete blocks in the heart of older areas of a city…" (Leonhardt, 1991). Furthermore, transportation officials are acknowledging the desire of the general public to have a higher degree of aesthetics involved in engineering projects. "Communities are asking … to be proactive in designing structures that enhance or blend in with their environment." (Iowa Department of Transportation, 2009).

Oregon has not been left out of this trend. Conde B. McCullough spent much of the 1920's and 1930's "transforming the state's bridge building into a regional, national, and increasingly international showcase" (Hadlow, 2001). He did this by using efficient and economical bridges with several aesthetically pleasing characteristics. This trend is not one that will go away anytime soon, and should constantly be on the minds of the engineers involved in bridge projects which can efficiently and economically include aesthetics in their designs. Several bridges with aesthetic characteristics that are currently in design, construction, or were recently completed in Oregon will be examined in this text.

THE COST OF AESTHETICS

As aesthetics becomes a larger focal point of bridge design, it is important to evaluate the cost of this trend. The cost of the design and construction for unique signature and landmark bridges are substantially greater that a typical style

design. Although it is hard to make comparisons between different bridges, a usual cost for a steel span or concrete girder ranges from $100 to $200 per square foot, while aesthetically pleasing cable-stayed bridges typically range from $400 to $800 per square foot (Giroux, 2007). Furthermore, the cost of operations and maintenance are usually higher for signature bridges. It has been argued that using aesthetics to drive a design is uneconomical and inefficient. Paul Giroux writes in his article "Building Better Bridges":

> *Overall bridge value should drive the selection process; not aesthetics, if we are to protect future generations from a disproportionately high bridge infrastructure expense. So, as bridge people, we are rightly proud of our collective accomplishments and contribution to society. Moving forward, it should be our collective goal, to dream, design, and build the best bridges we can, properly balancing form and function.*

A focus on aesthetics comes at an additional price and it is important to minimize that additional price, without sacrificing safety, to get the most value out of money allocated for bridge projects. David Billington writes in his book The Tower and the Bridge, "Minimum cost (economy) is an essential discipline for the creation of structural art. Economy stimulates creativity. Without the discipline of cost there can be no structural art." However, Billington also goes on to write, "But it is in principle impossible to determine the least expensive design because cost is a social measure and not a scientific one. Cost depends not upon some laws of nature but rather upon patterns in society; it depends upon time and place". Therefore, the extent of aesthetics in a bridge should be a direct representation of what is economically viable and efficient, as well as a

representation of what purpose the community wants the bridge to serve, and what it is willing to pay for.

BENEFICIAL EFFECTS OF AESTHETICS IN BRIDGE PROJECTS

As long as the aesthetics do not cause a bridge project to go out of scope, budget, or schedule, an artistic focus can provide numerous beneficial effects. The use of aesthetics can help a bridge fulfill its purpose, whether that is to blend into the environment or make a statement of some kind, as in the case of a signature or landmark bridge. It can also improve the public view of a project when it contributes to demonstrating what is important to that community.

Professional and personal satisfaction can also be a beneficial effect from an engineering standpoint when working on a project with an aesthetic focus. Many of the aesthetic bridges are very distinctive and can thus be challenging to work on. There can be constraints that the engineer is not used to working around, but finding the engineering solutions which are unique to each situation can be professionally satisfying. Also, being able to contribute to a community in a positive way, that is to help give the community a beautiful and unique design that fits the environment, can offer personal satisfaction that many engineers feel is beneficial to theirs and others' lives.

RESEARCH

Research was conducted primarily through interviews of engineers working in Oregon with experience in bridge design. From these interviews, five bridges were identified to be used as supporting examples for this thesis. The following is an overview of the five main bridges examined.

SPRAGUE RIVER BRIDGE

Figure 1. Sprague River Bridge II (Historic Bridges of the United States, 2008a)

The Sprague River Bridges, one of which is shown in Figure 1, are a series of three bridges located in South Central Oregon in Oregon Department of Transportation Region Four as shown in Figure 2. The bridges support two lanes of roadways (rural major collectors) that are used by wide and heavy trucks. The bridges range in length from 190′ to 260′, and were due for replacements because of the "poor structural conditions" of the original bridges (Oregon Department of Transportation, 2003a,b,c). The total costs were $2.079 million, $2.789 million, and $2.874 million (in order of shortest to longest) (Larsen, 2009).

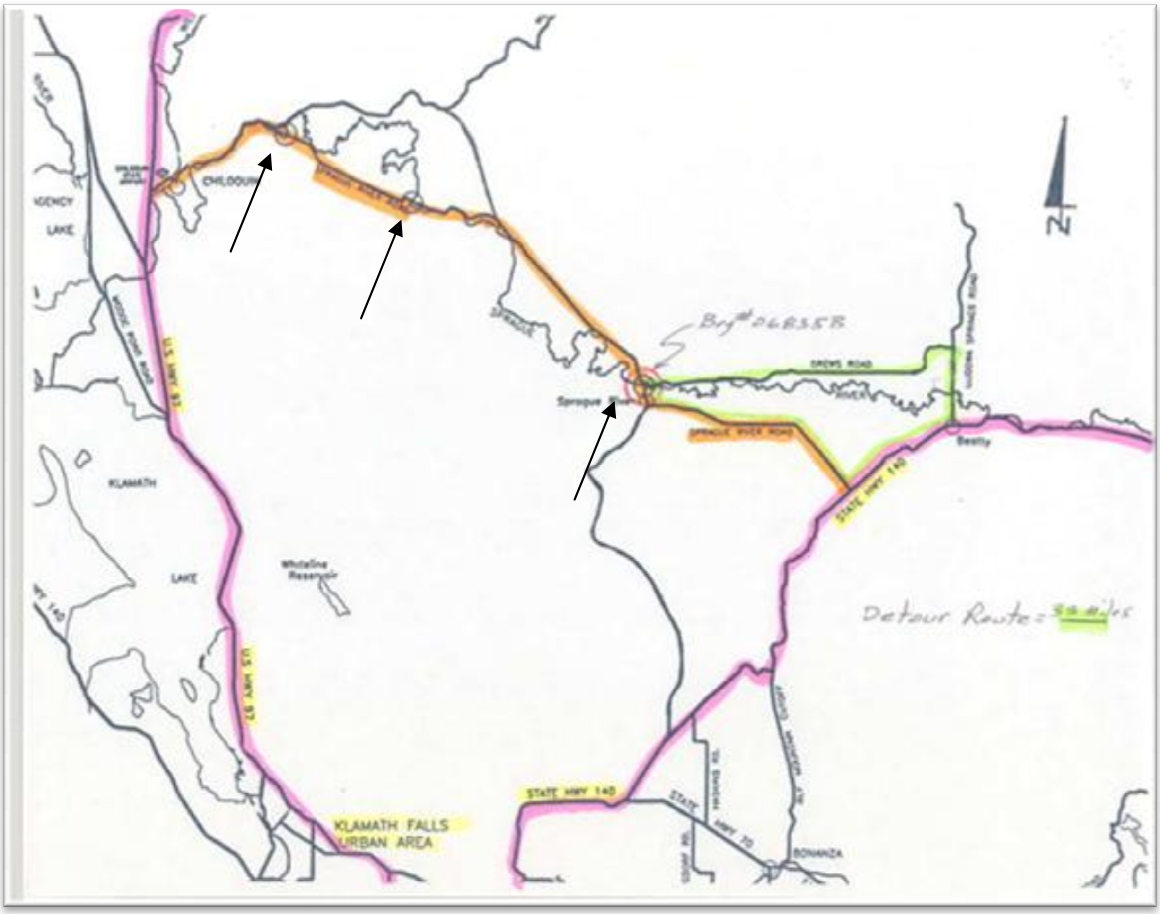

Figure 2. Locations of Sprague River Bridges (Oregon Department of Transportation, 2003c)

Stakeholders in this project included, but were not limited to the Oregon Department of Transportation, Klamath County, Klamath Tribe, Sprague River Road users, and OBEC, Consulting Engineers.

Figure 3. Sprague River Bridge Pictograms (Historic Bridges of the United States, 2008b)

Aesthetics became an issue because of the historical significance of the Native American pictograms on the original bridges from the construction in the 1940's, as seen in Figure 3. Due to federal regulations, the presence of the Klamath Tribes had to also be kept in the replacement bridges. In order to accomplish this, the project team worked with the local tribes to create an architectural design of traditional basket weaving patterns placed on the bridges in similar locations as

the original pictograms. These were actually a better representation of the tribe's traditions than the original pictograms.

HONEYMAN STATE PARK BRIDGE

Figure 4. Honeyman State Park Bridge" (Larsen, 2009)

The Honeyman State Park Bridge, shown in Figure 4, crosses US Highway 101 approximately halfway up the Oregon coast, shown in Figure 5. The purpose of the bridge is to provide safe access across the highway for pedestrian and bicycle

users of Honeyman State Park. The cost for this project ended was $607,000 with $43,000 for the architectural treatment (Larsen, 2009).

Figure 5. Location of Honeyman State Park Bridge

Stakeholders in this project included, but were not limited to the Oregon Parks and Recreation Department, Oregon Department of Transportation, OBEC Consulting Engineers, and Honeyman State Park users (Larsen, 2009).

Figure 6. Honeyman State Park Bridge Aesthetics (Larsen, 2009)

Aesthetics were an important component to the project because the client (the Oregon Parks and Recreation Department) wanted the bridge to adhere to the local environment and not disrupt the natural surroundings of the park. The design team decided that the most efficient and effective way to meet the client's needs was to apply architectural design to the concrete in the bridge and retaining walls through the use of molded concrete that appeared similar to the natural surrounding textures in the park. They also applied architectural design to the railings in order to help them blend in with the natural environment, as shown in Figure 6 (Larsen, 2009).

WILLAMETTE RIVER BRIDGE

Figure 7. Willamette River Bridge (Oregon Department of Transportation, 2009)

The Willamette River Bridge, shown in Figure 7, will serve as the replacement for the previously existing bridge that served as a link for Interstate 5 over the Willamette River and provided connectivity between Eugene and Springfield, Oregon (seen in Figure 8). Shear cracks were identified in the existing structure in 2002. Weight limits were enforced and the bridge was decommissioned as a result. A temporary bridge was constructed, but was not designed to withstand earthquake loads and is not within standards for permanent interstate bridges. The bridge will support six lanes of traffic, three lanes in each direction. A budget of about $70 million is designated for the bridge, with about $10 million designated towards aesthetics (Oregon Department of Transportation, 2009)

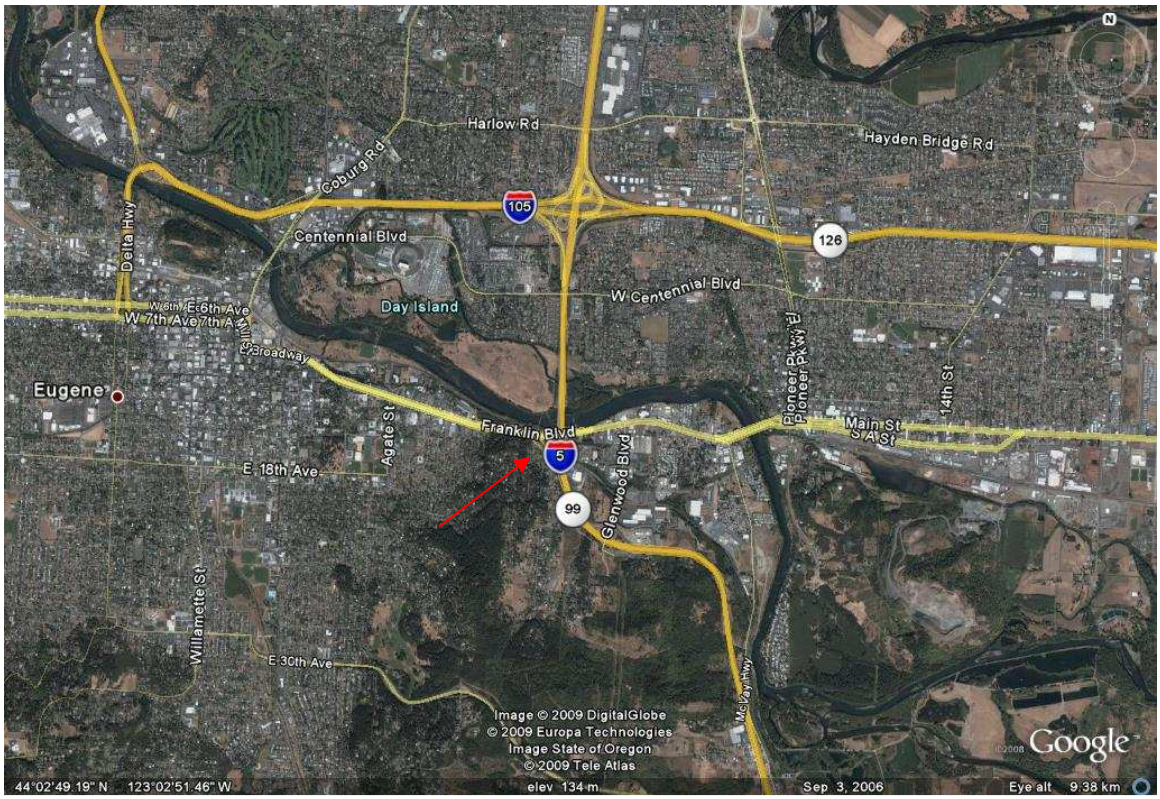

Figure 8. Location of Willamette River Bridge

Stakeholders in this project include, but are not limited to the Oregon Department of Transportation, the communities of Eugene and Springfield, Lane County, and TY Lin International.

Aesthetics were designated as being a key feature in the bridge. Goal Four in the Environmental Analysis for the Willamette River Bridge by the Federal Highway Administration and the Oregon Department of Transportation for the project states:

Goal 4: *Provide an aesthetically pleasing solution that recognizes the scenic beauty and community significance of the project area.*

- *Objective 4A: Design and construct a bridge that can enhance the views from the river and surrounding areas.*

- *Objective 4B: Design and construct an aesthetically pleasing bridge that is a signature or landmark bridge – a unique and special bridge that represents the community.*
- *Objective 4C: Design and construct a bridge that is aesthetically pleasing when viewed from the underside – where most people will see it.*

In order to accomplish these objectives both structural design and architectural design is going to be used. Structurally, the use of arches provides an elegant and aesthetically pleasing view of the bridge. Architecturally, many ideas have been contemplated by the engineers. To help them decide the best architectural treatment, the public has become involved to help guide the design. A committee of stakeholders within the community was assembled to give input on aesthetics and other issues that would impact the community (Ferguson et al., 2009).

OSWEGO CANAL BRIDGE

Figure 9. Oswego Canal Bridge (Good, 2009)

The Oswego Canal Bridge spans a stream with cast-in-place concrete abutments and columns, precast concrete spans, and steel rails as seen in Figure 9. The bridge is located in Lake Oswego, Oregon as seen in Figure 9. Two lanes of traffic as well as two sidewalks are supported by the new bridge, replacing a 71-year old bridge in the same location. The project was funded by the State of Oregon and the City Street Fund (Lake Oswego Engineering, 2009).

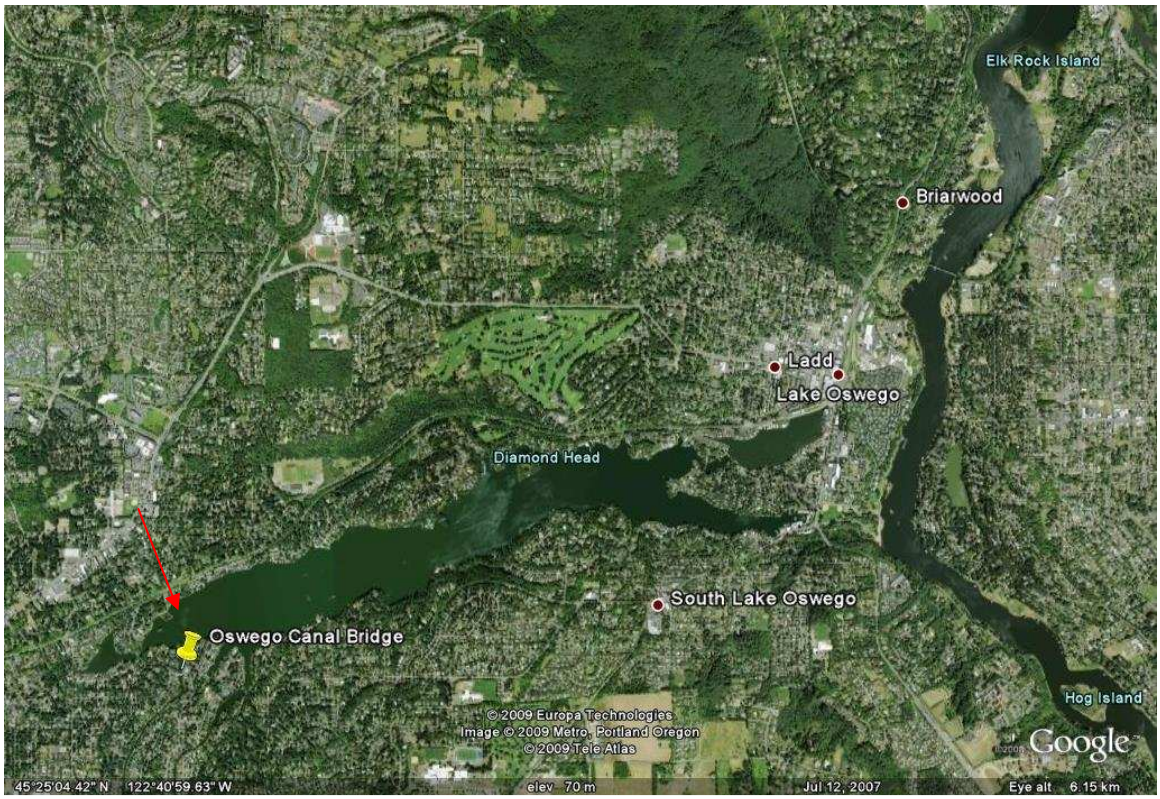

Figure 10. Location of Oswego Canal Bridge

Stakeholders in this project included, but were not limited to, the City of Lake Oswego, Oregon Department of Transportation, CH2M Hill, Nathan Good (architect), and members of the local community.

Figure 11. "Oswego Canal Bridge Aesthetics" (Good, 2009)

Aesthetics were a key feature in this project because it was important to the stakeholders to integrate historical and contemporary imagery while still leaving the functionality of the bridge for future users and not exceeding the budget for the project (Hwee, 2009). In order to accomplish this, both architectural design and structural design were used, guided by input from a steering committee made up of community members. Architecturally, railings and lanterns were used to emphasize a contemporary feel; structurally, on the other hand, the stone

abutments emphasized the historical significance as seen in Figure 11 (Good, 2009).

GIBBS STREET BRIDGE

Figure 12. (City of Portland, 2009)

The Gibbs Street Bridge is a 700 foot long, 20 foot wide pedestrian bridge located in Portland, Oregon as shown in Figure 12. The bridge is an "extradosed" design, defined as a mixture of box-girder and cable-stayed bridge techniques. It will provide access between local neighborhoods and the South Waterfront District. It will span Interstate 405 and Interstate 5 underneath an existing tram system that is located in the same area (seen in Figure 13). The design is scheduled to be

completed by July 2009, and the construction bidding process is scheduled to begin by August 2009 (City of Portland, 2009)

Figure 13. Location of Gibbs Street Bridge (City of Portland, 2009)

Stakeholders in this project include, but are not limited to the City of Portland, Oregon Department of Transportation, CH2M Hill, users of Interstate 5 and Interstate 405, and local community members.

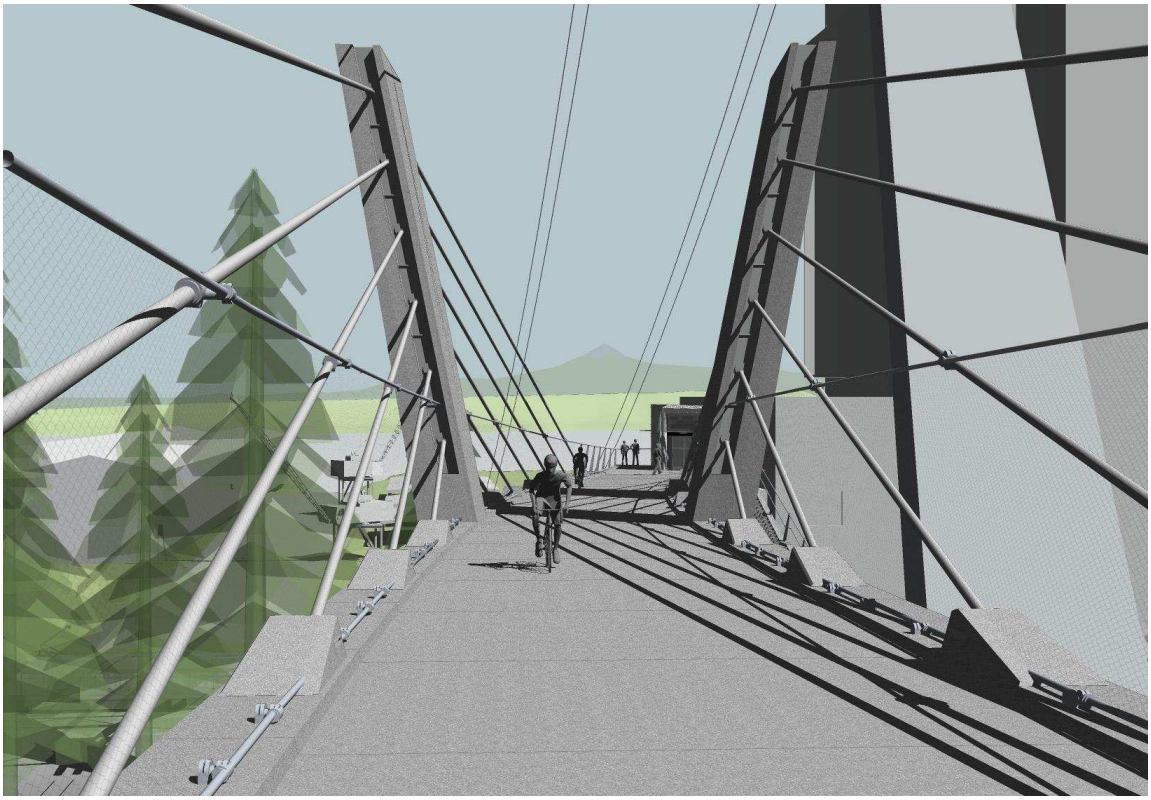

Figure 14. Gibbs Street Bridge Aesthetics (City of Portland, 2009)

Aesthetics were identified as a key focus in the project along with constructability and cost. In order to address this, a Community Advisory Committee (CAG) comprised of neighborhood, business, and interest group representatives was formed in order to offer guidance for the design of the project (City of Portland, 2009). The group was able to offer feedback on different possible designs and acknowledge the emphasis that was put on aesthetics by the public. To address this, structural design was used. The cable-stayed portion of the design and the splayed columns will contribute to the surrounding environment, as seen in Figure 14 (Bartholomew, 2009).

RELATIONSHIP BETWEEN ARCHITECT AND ENGINEER

The relationship between the architect and the engineer on a project can greatly affect the extent of aesthetics in a bridge design. In a bridge, a "horizontal design" project, the engineer usually takes the leadership role. In a "vertical design" project, however, the architect is the one who takes the lead. This reversal of roles and the relationship that ensues makes a large impact on the project as a whole, as well as the extent of aesthetics included in the design.

It is generally the structural engineer's job to define what is feasible to the architect, both structurally and financially. It goes without saying that it is the engineer's responsibility to design a bridge that is safe to the public, but it is also their role to help focus the architect towards safe and reasonable design. If discussions between the architect and the engineer occur early in order to define their roles and responsibilities, and changes to the design don't occur late in the process, then the relationship between the architect and the engineer can be more successful in contributing to a job done on time, within budget, and within the client's scope, all the while maintaining a focus on aesthetics. Furthermore, it is the engineer's responsibility to help define what is financially feasible to the architect. If a box-girder bridge is more economical than an aesthetically pleasing suspension bridge, the engineer needs to ensure that the architect considers a

box-girder bridge, and focuses on making that design as aesthetically pleasing as possible.

An example of this is the Gibbs Street Bridge. Late in the design process the architect wanted to change the depth of the curb on the bridge to achieve a more aesthetically pleasing appearance through the use of shadows. To make this possible the engineers had to go back and update their calculations for the changes in design this caused. They also had to go back and change all of the drawings that were completed to show the new depth of the curb. Both of these actions contributed to putting the design of the bridge behind schedule (Bartholomew, 2009). Had the roles and responsibilities been better defined between the engineer and the architect, they could have decided to make the change sooner, decreasing the impact the change had on the schedule, or decided not to make them at all. It is extremely important to understand the relationship between the two parties before starting on a project so that preventative actions can take place to keep a project on schedule, in budget, and within scope. If this is done, there is far more likelihood that more time can be spent focusing on aesthetics, and as a result the stakeholders involved will be satisfied with the final product.

PUBLIC INVOLVEMENT

The level of public involvement that is required as defined in the goals and objectives of a project can make a significant impact upon the extent and type of aesthetics in the design. When involving the public it is important to lay groundwork to make their roles and responsibilities clear. Throughout the design process the roles and responsibilities will need to be reiterated and managed to maintain a respectful relationship, keep control of expectations, provide technical support, and provide feedback to their decisions. Finally, it is important to give proper recognition to the involved public at the milestones of a project. If all of these guidelines are followed there is far more likelihood that the stakeholders in a project will be satisfied and more time can be spent focusing on aesthetic design (Ferguson, et al., 2009).

In order to maximize the positive impact that the public can have in the design of a project, it is pertinent to lay initial groundwork. This should establish what type of input there will be (e.g. committees, public forums, information sessions), how extensive the input will be (i.e. if input will be considered as recommendations or decisions), and when the public is expected to be involved (i.e. for the entire length of the design or initially) (Hwee, 2009). The design team and the client should first make these decisions internally and then make those roles and responsibilities clear to the public. This will maximize the effectiveness

of the public and minimize any complications that could occur further along the project schedule. The engineering team and the client should also gain endorsement from the public after outlining their roles and responsibilities in order to minimize complications if the public tries to go beyond their specific duties (Bartholomew, 2009).

By gaining endorsement from the public in the beginning of the design process and laying the necessary groundwork, incorporation of the public will be easier and more effective throughout the entire project. It will be easier to manage their expectations and maintain respectful relationships. Furthermore, any additional technical support that is required throughout the project will be easier to foresee and provide. When any recommendations or decisions are made by the public it will also be necessary to provide feedback throughout the design process. The engineer should act as the voice of reason about what is and isn't technically and financially feasible, and should provide this feedback in a non-technical manner in order to maximize the public's understanding and appreciation for the response given. In addition, when a decision is made that affects the public's role, whether as a response to one of their decisions or one that the engineering team made, they should be informed and approval should be gained if possible in order to minimize future complications (Ferguson, et al., 2009). If these management guidelines are followed throughout the project, there is far more

likelihood that the public's involvement will result in a successful outcome regarding aesthetics and satisfies stakeholders.

A good example of these guidelines working effectively is the Willamette River Bridge, where the client and the engineering team worked together to establish the role of the public. They decided that organizing a Community Advisory Group (CAG) including "representatives of key community organizations" with the responsibility of giving inputs to the development team, would be the most effective way to involve the public in the design process (Oregon Department of Transportation, 2009). Furthermore, the engineering team provided workshops which the CAG team was invited to attend. The intended purpose was "to explore options for enhancing architectural design within the bridge area and to identify opportunities for art" (Community Advisory Group, 2009). The engineering team also offered their technical support, judgment of feasibility on ideas, and provided feedback and approval on any decisions that were made throughout the design process. The highly productive level of public involvement has led to a plan that uses structural and architectural design to reflect the community to the overall satisfaction of the stakeholders (Ferguson et al., 2009).

CLIENT EXPECATIONS

The extent and type of aesthetics in a project are dominated by the client's expectations. Any previous experiences of a client influence their expectations and can help promote aesthetics through the understanding of the potential opportunities in a project. The client's expectations, as expressed in a project's goals and objectives can promote aesthetics. This usually takes place in the form of specified schedule, cost, and scope.

The client's previous experience in regards to aesthetics will help minimize any misunderstandings and misconceptions about aesthetics. If the client has previously dealt with projects that have included aesthetics, they will be more likely to understand the feasibility of this aspect of the design. As an example, in the Sprague River Bridges, the client did not have significant experience in dealing with aesthetics in a bridge design. In this case, the aesthetics were required by federal regulations and thus were an aspect of the project that had to be dealt with. The design team had to provide a reality check to the client so that they understood the additional cost, time, and scope changes due to aesthetics. Had the client had previous experience, they could have been prepared to mitigate these changes in a more effective way, and possibly increased the extent of aesthetics in the bridge (Larsen, 2009).

The client's expectations in regards to the time to design and construct a bridge can also affect the extent and type of aesthetics. As an example, for the Oswego Canal Bridge, the goal was to have the public involved in the aesthetic design. However, due partly to constraints on the schedule, the public's involvement had to be limited to advising between different options that were preconceived by the design team (Hwee, 2009). If the public were allowed more time and freedom to be involved, the extent and type of aesthetics in the final design could have been different.

The budget of a project that a client is expecting to maintain can also affect the aesthetics in a bridge design. In general, clients will try to maximize the extent of aesthetics that are incorporated in their projects with the amount of money in their budget. This is not to say that aesthetics will become a priority in most projects, but rather that clients prefer that the money budgeted towards aesthetics be used as effectively as possible. Furthermore, a client who expects a large amount of aesthetic emphasis in a project to begin with will have a bigger budget, and will obviously stress aesthetics in the design to a greater extent.

The Honeyman State Park Bridge is an example of this. The client knew that the bridge was going to have an aesthetic emphasis due to the location of the bridge (in a state park and over Highway 101 on the Oregon coast). They were then able to budget more money towards the project so that architectural treatments to the

concrete and railings were financially feasible. As a result the bridge contributes to the surrounding environment and blends in with the setting of the structure (Larsen, 2009).

If aesthetics are expected to be a focus in the scope of work, then the type and extent of this artistic expression will be greatly influenced. Furthermore, the client's schedule and budget for the project will also reflect this focal point. As an example, if a bridge's scope requires it to blend into the environment or be a signature or landmark structure, then the client should expect to budget and schedule for this accordingly.

The Oswego Canal Bridge is a good illustration of this point. The scope of work outlined a goal of building an iconic bridge in the community. The client expected to emphasize aesthetics and budgeted and scheduled accordingly. As a result the design included both structural and architectural design components of aesthetics (Hwee, 2009).

Another illustration of this point is the Sprague River Bridge. In this case an emphasis on aesthetics was not initially in the scope of work, but when aesthetics was discovered to be a requirement (due to historical significance), the scope of work was modified. Because the client did not expect this, the bridge design was less efficient in regards to maximizing the focus on aesthetics (Larsen, 2009).

Figure 15. Horizontal Curvature of the Gibbs Street Bridge (City of Portland, 2009)

Finally, constraints in the scope of work of a project can greatly influence the final design of a project and thus the aesthetics in a project. The Gibbs Street Bridge is a good example of this. A large component of the aesthetics in this project is due to the structural design of the bridge. The cable stayed portion of the extradosed structure contributes to the surrounding environment by acting as a signature bridge to one of the entrances to Portland. When the design team evaluated the alternatives, which also included a steel box girder and a concrete box girder bridge, the extradosed bridge was selected as the preferable alternative. This was due not only to the inherent aesthetics that it contained but because the towers were short enough to accommodate the tram above, and the bridge would have a low impact on Interstate 5 and Interstate 405 during

construction (City of Portland, 2009). Furthermore, the horizontal curvature in the bridge, as seen in Figure 15, is required due to the location of several right of way constraints such as the tram tower locations. The curvature allows the columns in the bridge to be splayed, as seen in Figure 16. These splayed columns contribute to the aesthetics of the bridge from the view of the pedestrians on the bridge, and structurally would not be possible if not for the constraints on the scope of work to make a bridge fit in the limited area (Bartholomew, 2009).

Figure 16. Gibbs Street Bridge Columns (City of Portland, 2009)

The extent of aesthetics in a project is dominated by the client's expectations. Any previous experience of a client influences their expectations and can help promote aesthetics through the understanding of the potential opportunities in a

project. The goals and objectives, in terms of schedule, cost, scope, and constraints that a client has stated can also help promote or exclude aesthetics in bridge design.

CONCLUSIONS

Aesthetics should be emphasized as much as possible in a bridge project without exceeding scope, budget, or schedule, all with the aim of satisfying the stakeholders involved. There is a history within civil engineering of focusing on function and serviceability, but in recent years a trend to focus on aesthetics has made it clear that the surrounding environment is important to consider when designing a bridge. This trend has led to more beautiful and socially appreciable bridges among civil engineers and the general public.

Aesthetics are strongly affected by the relationship between the architect and the engineer, the public involvement on a project, and the client's expectations of that project in terms of schedule, budget, scope, and constraints. If measures are taken before, as well as during the design process of a bridge, aesthetics can be maximized to the greatest overall satisfaction of each of the stakeholders of the design.

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