Vision and Scope Document

for

QConBridge

Version 1.0 - Final

Prepared by Richard Brice

WSDOT Bridge and Structures Office

March 14, 2000

Revision History

Name	Date	Reason For Changes	Ver./Rev.
R. Brice	2/3/2000	Created Document	1.0 - Draft
R. Brice	3/14/2000	Baselined Document	1.0 - Final

Table of Contents

1. Business Requirements

The business requirements provide the foundation for what we are going to do, and why we are doing it.

1.1. Background

In 1996 the Bridge and Structures Office committed to implementing the AASHTO LRFD Bridge Design Specification. As a first step in developing our LRFD design capability, a software product named QConBridge was developed. This unique software tool enabled WSDOT Bridge Designers to efficiently determine moments and shears in bridge superstructures in accordance with the AASHTO LRFD Bridge Design Specification. QConBridge was a significant milestone in the Bridge Office's transition to the LRFD Specification because live load analysis is very different than in the AASHTO Standard Specification and is essential for all bridge design projects. This software has remained virtually untouched ever since.

Over the past four years several driving factors have emerged:

- The LRFD Specification has changed making the current version of QConBridge out of date.
- Office practice for the computation of live load distribution factors has deviated from LRFD. QConBridge does not reflect current office practice.
- Our LRFD design capabilities have evolved to the point that QConBridge no longer meets our needs. Specifically, when QConBridge was originally developed, our LRFD design capabilities were limited to the design of prestressed girder superstructures. Our design capabilities now include substructure elements.
- Users have provided us with many ideas for enhancements that would improve the software and result in greater design efficiency.

1.2. Business Objectives

The objective of this project is to enhance the LRFD design capability of the Bridge and Structures Office by updating the QConBridge tool to satisfy current needs. Our LRFD design capabilities will be enhanced by:

- The ability to efficiently compute structural actions not currently supported by QConBridge, including live load actions on substructure elements and cambers and deflections.
- Improved efficiency in determining live load moments and shears in major superstructure elements.
- Better modeling of structures to capture the effects of construction sequences.
- Improved interoperability with other programs to share data and enable automation of design calculations.

Enhancing our design capability supports the WSDOT Strategic Plan 1998-2003, the Environmental and Engineering Service Center (EESC) Business Plan and the Business Plan of the Bridge and Structures Office. Upgrading the QConBridge program is aligned with the following WSDOT business objectives:

- Continue to provide/develop technical tools necessary for design excellence - *Bridge Office Business Plan, Action Item 4*
- Investigate and promote the use of appropriate tools and technology - *EESC Business Plan, Theme 6*
- Ensure that the Washington State Department of Transportation has the capability to develop and implement transportation solutions to address needs identified in Washington's Transportation Plan. - *WSDOT Strategic Plan 1998-2003, Roles and Responsibilities Strategic Goal*

1.3. Customer Requirements

We have received a great deal of feedback from both internal and external users of the QConBridge program. Two underlying themes have emerged from their comments. Each of these themes represent shortcomings in the current QConBridge program.

1. **Improve Bridge Modeling Capabilities**. The current bridge-modeling interface is not as effective as it could be. The Section Properties Calculator feature of the program collects a significant amount of bridge description information that is specific to a bridge type. Much of this bridge description information is not retained after computing section properties and live load distribution factors. QConBridge will be more effective with an enhanced bridge-modeling interface.
2. **Improve Structural Analysis Capabilities**. The structural analysis capabilities of QConBridge were designed to meet our needs four years ago. The structural analysis capabilities of QConBridge are lacking in the following areas: modeling of construction sequences, analysis of user defined trucks, computation of reactions on substructure elements, and computations of camber and deflections. QConBridge also lacks the ability to analyze temperature, shrinkage, and settlement loads.

1.4. Value Provided to Customers

The value of this project to WSDOT Bridge Designers, department consultants, and outside users is threefold. Users can expect

- The additional structural analysis capabilities and the improved bridge modeling will improve productivity. Tasks that are currently done by hand will be automated. Bridge description information once discarded by the software will be retained eliminating the inefficient and error-prone re-entering of data.
- The software will conform with current LRFD requirements and WSDOT office practice
- Improved usability compared to the current application

1.5. Business Risks

All software development projects have risk. This project is no exception. The following is a list of items that threaten the success of the project, the source of the risk, and possible mitigation measures.

Risk	It might be more beneficial to work on a different project.
Source	The Bridge and Structures Office does not have a formal plan for developing its LRFD design capabilities.
Mitigation	Actively solicit input and approval from top level managers for project plans. Encourage management to develop a plan for developing our LRFD design capabilities

Risk	There are too many features to implement with current resources.
Source	The long-term vision of the software is very lofty.
	There are several interests to consider, WSDOT designers, outside users, developers
Mitigation	Clearly define the scope of the project

Risk	A software product is built that does not satisfy our needs.
Source	Traditionally, communications between users and developers have been sparse at best.

	Users have not taken an active ownership role in software development.
Mitigation	Seek out product champions from the various classes of users and actively communicate with them.
	Educate these individuals as to the significance of their contributions on the final outcome of the project so they will become willing to actively participate through the project.
	Educate managers as to the critical importance of active involvement by product champions so these individuals can be given adequate time to work on this project.

Since this is a relatively small development project, and resources are scares, a formal risk management plan will not be developed. However, the entire development team will share the responsibility of identifying risks and mitigating them.

2. Vision of the Solution

This section captures the long-term vision of the system that we intend to build. This vision will provide a context for making decisions. The vision statement and major features represent the goals for this project in a perfect world where resources are unlimited. It is important to capture this grand perspective so we don't loose sight of our goals. The next major section of this document, Scope and Limitations, will bring these pie-in-the-sky ideas back to the reality of what we are going to build during this development cycle.

2.1. Vision Statement

QConBridge will be an analysis tool for typical bridge structures that satisfies virtually every structural analysis need of a practicing bridge engineer. With this tool, engineers will be able to predict the response of a typical bridge structure to a myriad of loading conditions including dead load, live load, and lateral forces.

QConBridge will also be an extensible framework to which many structural design and analysis capabilities can be added. "Add-ins" might include an elastomeric bearing pad design module, a steel girder design module, or a module to estimate quantities and prepare cost estimates.

2.2. Major Features

This section presents a high level view of the *ultimate* feature set envisioned for QConBridge. The major features include:

1. Structural analysis of superstructure and substructure elements for dead load, HL93 live load, user defined live load, pedestrian live load, breaking force, centrifugal force, wind load, wind on live load, temperature, shrinkage, impact, ice, stream flow, and seismic forces.
2. Interactive structural modeling through a graphical user interface that supports direct manipulation and instant user feedback.
3. Graphical and tabular presentation of analysis results
4. Animation to depict dynamic properties and response of a structure
5. Support for third-party add-in components that will enhance and extend the capabilities of the software
6. Support for scripts to enable users to extend the capabilities of the software and automate routine tasks.

7. Compatibility with OLE Automation so that QConBridge can be accessed from other applications like Excel or MathCAD.

2.3. Assumptions and Dependencies

The following assumptions have been made during the development of this document:

- The Bridge and Structures Office will remain committed to developing its LRFD design capabilities
- The Bridge and Structures Office will remain committed to developing software tools to satisfy its needs.
- The LRFD Bridge Design Specification and WSDOT practice will not change significantly as it pertains to structural analysis requirements and live load distribution factors.

The QConBridge project depends on the following factors:

- The Bridge and Structures Office can provide adequate resources to ensure the successful delivery of this project
- Key personnel remain committed to developing these software tools
- The Bridge Design Sections will be actively involved in the development of this product

3. Scope and Limitations

Given the pie-in-the-sky vision for QConBridge, it is obvious that all of the envisioned capabilities cannot be delivered at once. In the sections that follow, the scope of this project will be defined in terms of major features that will be implemented and those that will not.

The fundamental goal of this development cycle is to deliver those features that will satisfy our immediate needs while positioning the product so that it can be enhanced to meet our future needs.

3.1. Scope

The scope of this development cycle is characterized by the functionality listed below. A detailed Software Requirements Specification (SRS) will be developed to capture the specific requirements for this project.

The major features that will be implemented in QConBridge Version 2 are:

1. Plane frame structural analysis capabilities for bridge structures that conform to the requirements of LRFD 4.6.2 Approximate Method of Analysis.
2. Enhanced modeling capabilities for Box Girder, Prestressed Girder, and Built-up and Rolled Steel Girder bridges.
3. Construction Sequence Modeling
4. Computation of reactions
5. Analysis for uniform temperature rise and fall
6. Analysis for differential support settlement
7. Analysis results for both interior and exterior girders can be obtained from one QConBridge project. (Currently, two separate projects need to be created)
8. Calculation of Min/Max Moments and Associated Shears
9. Calculation of Min/Max Shears and Associated Moments
10. User defined live load

11. User defined load cases and combinations
12. An OLE Automation compatible object model so QConBridge can be controlled by external programs such as Microsoft Excel or MathCAD.

3.2. Limitations and Exclusions

It is impossible to list everything that will not be implemented in QConBridge Version 2 as the list is infinite. This section identifies desirable features that might be anticipated by customers and stakeholders, but are outside of the scope of this project.

QConBridge Version 2 will not have the following capabilities:

1. 3D analytical modeling of bridge structures
2. Analysis in accordance with LRFD 4.6.3, Refined Method of Analysis
3. Modeling of bents
4. Detailed modeling of structural components (i.e. type, size, and location of reinforcing steel). Modeling is limited to that which will produce adequate information to perform the required structural analysis.
5. Analysis for longitudinal forces (i.e. braking force, centrifugal force, seismic, etc)
6. Analysis for transverse forces (i.e. wind, wind on live load, seismic, etc)
7. Analysis for non-linear temperature gradient

4. Project Success Factors

This section will define success for this project and how success will be measured. Factors that are likely to have the greatest impact on achieving success will be identified. By defining success and specifying a way to measure it, we will have a much better chance of achieving it.

4.1. Success Defined

For this project, we define success as:

> Delivery of a bridge engineering software program that meets the needs of its core users, is widely accepted in the bridge engineering community as a valuable and reliable tool, is easy to use and is effective for bridge designers of all experience levels.

4.2. Success Factors

The following factors are essential for this project to be successful:

- Open and Frequent Communications between Developers and Stakeholders
- Open and Frequent Communications between WSDOT and the greater bridge engineering community
- Clear Scope of Work
- Clear, unambiguous, complete and mutually agreed upon requirements
- Team members taking an ownership in the outcome of the project