The Glasgow Science Centre Tower Project

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This case study was adapted to make it a learning resource and might not reflect all historical facts related to this project.

Case Study

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Case Study

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Introduction

The Glasgow Science Centre is built on reclaimed land at Pacific Quay in the heart of Glasgow, Scotland, UK. The site consists of three main buildings: the IMAX Theatre, the Science Mall, and the 341.2 ft (104 m) Glasgow Tower (Strathclyde European Partnership, 2000). Although all three are unique, the first two are the first buildings in the UK and only the second in Europe to be clad in titanium, whereas the Glasgow Science Centre Tower is a one-of-a-kind structure capable of revolving 360° from the ground up (BBC News, June 19, 2001). Its construction has presented a variety of engineering and technical challenges to the project teams involved in its design and construction. Mounted on a turntable, the reed-slim building rotates with the wind, similar to a weather vane, to keep it from whipping around. Challenged planning has marred an otherwise incredible design and construction effort. This, in turn, has caused serious constraint tradeoffs between cost and scope. As a result, it took more than 10 years for overall implementation of the Glasgow Tower project, including its completion and opening to the public. Furthermore, there has been a bitter public feud between the design architect and the owner, and charges of possible safety issues.

Rising above the River Clyde in Glasgow, Scotland, the Glasgow Science Centre Tower is the tallest freestanding structure in the country, boasting 20-mile views over the city and surroundings. Built in conjunction with the Glasgow Science Centre, the tower is part of a project aimed to promote Glasgow as a major high-tech center, as well as to revitalize the River Clyde dock area. Stunningly designed, it was expected to become a famous landmark. However, technical problems and concerns about safety of the tower caused delays in its opening. This case study analyzes the project management practices employed on the Glasgow Science Centre Tower project and studies the overall efforts of the project management team.

The case study covers various Project Management Knowledge Areas (Project Management Institute, 2004) within four project phases: inception, development, implementation, and closeout. Within each project phase, the activities, accomplishments, and shortcomings of performance in the processes of Initiating, Planning, Executing, Monitoring and Controlling, and Closing are discussed. The case study is structured to allow an evaluation of the appropriate processes of various Project Management Knowledge Areas at the end of each phase. An overall assessment of performance is then conducted, resulting in a numeric evaluation of the management of this project, including areas of strength, opportunities for improvement, and lessons learned.

In the inception phase, the discussion focuses on the historical background of the project, its overall objectives, problem definition, concerns, political climate, and the selected solution. In the development phase, the discussion addresses the overall planning, feasibility studies, funding, and conceptual design. In the implementation phase, the discussion addresses detailed design, construction, and commissioning. Finally, in the closeout phase, the discussion reflects on overall project performance, and project evaluation.

The Inception Phase

The Glasgow tower project presents an interesting exercise in managing the major elements of project objectives and constraints. Careful tradeoffs among these elements were particularly important in this project.

The first objective of the tower project was to place a viewing cabin on top of a slender tower 330 ft (100.58 m) above the River Clyde. The second objective was to provide a place to house the telecommunications links of the Science Centre. The third objective was for the tower to be an exhibition center in its own right (Liddell & Heppel, 2001; University of Glasgow, 1997).

It appeared that there was an urgent demand to put together the entire Science Centre, including the tower, and to ensure that there was maximum publicity concerning it. Challenged scope planning and definition during the early phases of the project showed up later in the extended closure of the tower and the safety issues that plagued the Centre.

The Glasgow Science Centre originally allocated US$12 million to the tower project. The Centre, in turn, receives its funding from a diverse collection of sources ranging from the sale of National Lottery tickets to budgetary allocation by the European Union (Dennis, 2001). The tower project funding was allocated at the time of design, before complete costs were fully understood.

The schedule appeared to have been very loose. Some of this "looseness" was due to lack of initial funding (Pearman, 2001). After funding was allocated, there were no published completion and public opening target dates through the early stages of the project.

Critical technical risks inherent in the tower project were identified, and knowledgeable analysts were chosen to perform the risk analysis in a timely fashion. However, there was no attempt at managing risk from a strategic perspective. Normally, towers are built only six or seven times as tall as they are wide, but the Glasgow Science Centre Tower was designed to be 10 times taller than its base width. This was the biggest technical challenge of the tower project. According to the project manager, the construction contractor had to undertake a huge dewatering procedure—"during the construction of the caisson we pumped more than one million gallons" (Naysmith, 2001).

Current quality standards and regulations relevant to the tower project were identified and addressed. A "Code of Business Conduct" was made available to contractors to help provide guidelines on how to successfully implement the tower project. However, the project was affected by challenged quality of project management and insufficient planning.

During the tower project's inception phase, teamwork was running smoothly and communication was strong. The entire Glasgow Science Centre was envisioned to someday be the hallmark of Scottish science, business, and commerce. It was the largest undertaking in Scotland with regards to the Millennium celebration. The original architect was delighted that the tower was finally going to be built. There was no clear indication of future problems that would plague and embarrass the project.

Assessment and Analysis

1. Please complete your evaluation of project management during this phase, using the following grid:

Rating Scale: 5–Excellent, 4–Very Good, 3–Good, 2–Poor, 1–Very Poor

Project Management Area	Inception Phase
Scope Management	
Time Management	
Cost Management	
Quality Management	
Human Resource Management	
Communications Management	
Risk Management	
Procurement Management	
Integration Management	

2. Please highlight the major areas of strength in the management of this phase of the project:

3. Please highlight the major opportunities for improvement in the management of this phase of the project:

The Development Phase

Design and construction of the Glasgow Tower presented the major challenges of the project. Such a tall and slender building would be subject to buffeting and turbulence by the wind, which would provide an unpleasant experience for visitors (Hart, 2001; Liddell & Heppel, 2001). The tower was designed as the first such structure in the world to rotate 360° from the ground up, into the prevailing wind. The tower resembled a wing on end, and was mounted on a turntable. The "wing" is made up of airfoil-shaped outriggers blending into the stair tower. The reinforced-concrete base of the tower contained the roller bearing turntable. The root structure was solid steel contained in a reinforced concrete housing that extended 65 ft. (19.81 m) below ground level (Hart, 2001). As a result, there was an extensive "dewatering" element built into this project, as the tower sat on the bank of the River Clyde (Louden, 2001).

Construction could not start until a proof of concept and a variety of wind tunnel tests were completed. Wind forces at the Glasgow Airport and mean hourly wind speeds along the river basin were used to measure the aerodynamic effects on the tower. As a result, the final design would allow visitors to feel movement similar to that of riding in a subway, and closure of the tower due to high winds would only amount to approximately six days a year. Additional wind tunnel testing had to be performed when a change in the elevator system specifications was made, and final design of the tower components was performed using computational fluid dynamics programming (Liddell & Heppel, 2001). Once the design contract was awarded, proper studies were conducted to ensure that the design would work. Unfortunately, proof of concept started after the award of the design contract.

The funding was allocated at the time of design award; it was clear by the time the proof of concept work was completed that the final product would exceed the budgeted cost. The challenged estimates were undoubtedly the result of the political desire to get the project in the news to promote the emergence of Scotland on the cutting edge of modern technology. Far too much effort may have been expended on public relations and probably not enough on the overall planning and estimating. Because proof of concept and testing were required, much of the funding was used. This caused an overrun before actual construction began.

Scheduling problems may have been due, in part, to challenged initial planning and, in part, to the need to resolve tradeoffs among objectives and constraints once the scope and cost issues became apparent. Actual development work did not begin until two years after the initial tower project was awarded. Although the original design was awarded in 1992, the proof of concept was not started until 1994 (Hart, 2001).

Overall, the project management team did a good job in selecting the contractors from the pool of more than 70 strong, international companies. One of the criteria for contractor selection was certification to the appropriate ISO standard.

Experts performed effective risk assessment and evaluation. Technical risks were assessed qualitatively and quantitatively, and simulation was also used. Technical risks were addressed to the fullest extent. However, schedule risk was not addressed at all. A contractor undertook groundwater flow modeling to assess the feasibility of the tower project, and was also required to assess potential risks such as liquefaction (i.e., when the strength and stiffness of soil is reduced by an earthquake shaking or other rapid loading), as well as piping, contingency measures, and appropriate instrumentation and monitoring that would be required during the dewatering operation. Furthermore, the contractor conducted a review of geology, analysis of the test pumping data, development of a conceptual model and computer model, and simulation of alternative scenarios.

As for post-completion external risks, the team conducted a thorough study of weather-related risks and their impact on the tower. The analysis revealed that the tower should have to be closed only because of high winds about six days a year (*Civil Engineering Magazine*, 1999; Liddell & Heppel, 2001).

Overall objectives and goals of the project were well defined, which helped significantly in defining quality. The tower was to become Glasgow's global symbol—as the Eiffel Tower is to Paris. Yet, there were arguments over the quality of the tower's design. The architectural firm that developed the structure and later withdrew from the project claimed that its design was modified to stay within budget. The architect said, "Everything has to be in proportion, and I'm quite upset that they haven't followed through with it" (Dennis, 2001). The architect said that he thought the tower lacked finesse and that precision had been lost (Pearman, 2001). There was a general lack of formal quality planning, but since contractors performed most of the work, the quality management activities become part of the contractors' responsibilities. However, the potential impact of the quality cost does not appear to have been properly considered.

During the development phase of the tower project, teamwork started to suffer. Many different multinational companies were involved with the tower's construction and the Glasgow Science Centre had a complex history with regards to teamwork. The most obvious problem was the very public dispute between the Centre's owner and the first architect. The tower project had two sets of architectural firms. One architect was working out of Glasgow; the other was London-based and was the original designer of the tower. The London-based architect withdrew in protest at what he saw as dilution of his original concept; therefore, the tower was built under the direction of the Glasgow architect.

During the development phase, communications management started to slip somewhat. During this phase, the project management team started to become involved with problem solving. The main issues during this phase included the first series of the proof-of-concept tests. To reduce costs, the owners and project management team made changes to the initial tower design, which started to affect the relationship with the original architect and may have helped create a chain reaction of subsequent problems.

Assessment and Analysis

1. Please complete your evaluation of project management during this phase, using the following grid:

Rating Scale: 5–Excellent, 4–Very Good, 3–Good, 2–Poor, 1–Very Poor

Project Management Area	Development Phase
Scope Management	
Time Management	
Cost Management	
Quality Management	
Human Resource Management	
Communications Management	
Risk Management	
Procurement Management	
Integration Management	

2. Please highlight the major areas of strength in the management of this phase of the project:

3. Please highlight the major opportunities for improvement in the management of this phase of the project:

The Implementation Phase

The original scope of the tower included a pod-shaped, glass viewing cabin topped by a 130 ft. (39.62 m) steel mast. It was subsequently determined that that the glass pod would become uncomfortably hot in the sun and would be difficult to clean. The steel mast was declared too tall and heavy for the tower. The final design for the cabin was a metal composite with a slit-like viewing window. The mast was reduced to 82 ft. (24.99 m) and constructed of a carbon-fiber material (Dennis, 2001). The exhibition area at the base was expanded by an extra 1,600 square feet (148.64 m^2). Additionally, the horizontal bearing mechanism was moved from the underground container to near the public elevator entrances (Gadher, 1999; Reina, 2001).

These changes resulted in conflicts between the owner of the Glasgow Science Centre and its architects. The architectural firm's objections to the multiple changes to its design erupted into a public feud and ultimately the firm was removed from the project and replaced by another architectural firm (Reina, 2001). The original firm publicly stated that the tower was, at best, dreadful and, at worst, unsafe (Dennis, 2001; Gadher, 1999). Indeed, the changes made to the elevator design resulted in a major problem that kept the tower closed to the public for an extended period of time. The elevators appeared to be too heavy for the mechanisms that ran them.

Construction was slow getting off the mark, but, once under way, it seemed to proceed quickly. Unfortunately, it appears that some of the scope changes resulted in major delays in the completion of the tower.

By early 1999, just as construction of the tower base was getting started, the project was determined to be over budget and put on hold while the owners considered cancellation. Additional wind tunnel tests were conducted to determine how much structural steel could be eliminated (Reina, 1999). The original architectural firm and the structural contractors reduced the number of trusses required (*Civil Engineering*, 1999). The Glasgow Science Centre insisted that the tower be "engineered down to budget," despite the fact that they also demanded extra exhibition space (Reina, 1999; Gadher, 1999). This 14% reduction demand also required changes to the cabin and mast, and caused the open rift between the Science Centre project team and the architectural firm, which felt that safety had been compromised. Further, the Science Centre project team felt that the beauty and quality of its design had been sacrificed for the sake of the exhibition hall. The architectural firm continued to claim it still was owed money from the Science Centre. The Centre's counterclaim was that the exhibition hall work was part of the original design and that it acted responsibly in managing public funding (Gadher, 1999; Dennis, 2001). The cost overrun required scope adjustments and, ultimately, caused implementation delays.

The cost and scope change issues brought the project to a halt in 1999. At that time, construction only on the tower base was in progress (Reina, 2001). Construction on the tower began in March of 2000, with a scheduled April 2001 completion as the opening date (Denholm, 2000; Reina 1999).

Actual tower construction proceeded quickly, and the construction work seemed to have met the target. To speed up construction and ensure accuracy, the tower was assembled in Poland before being dismantled and shipped to Glasgow (*CITB ConstructionSkills*, 2003). However, a series of power failures and elevator issues caused continued problems in completion. The opening date became a moving target. A final opening date was determined for June 2001 (Dalton, 2001). Afterward, the Centre continued its claim that the tower would open "in two weeks" (Wade, 2001).

Despite some miscommunications and the need for some rework, most contractors seemed to have a clear understanding of the concept of the tower project, performed to specifications, and fulfilled their requirements properly. As an example, one contractor was hired to supply and install integrated building, fire, and security systems for the entire Glasgow Science Centre, including the tower. By selecting a single vendor, the tower project benefited from having a single point of contact at all phases of the project, from planning to installation through training and maintenance, which was completed using the appropriate ISO standards.

Probably the most well documented problem of this project was when the July 2001 tower opening was delayed because it was discovered that the tower's elevators were too heavy. Managers were furious and started examining penalty clauses in their contract with a Swedish elevator manufacturer. According to a spokesman for the project, "they were contracted to supply working lifts on time and clearly they haven't" (Wade, 2001). The problem could not be fixed because the elevator manufacturer had sent most of its workers on summer holidays. "Engineers from the company have left the site, and work on modifications needed for the design has stopped at the company's base in Sweden" (*Scottish Daily Record*, 2001, July). This resulted in another three-week delay.

The elevator manufacturer had a distinguished record with regards to unique situations on the international level. The company participated in the restoration of the Eiffel Tower in Paris, France, in the construction of the Channel Tunnel (Chunnel), in the renovation of the Statute of Liberty in New York City, USA, in 1984, and in the renovation of the Washington Monument in Washington, DC, USA, in 2000. It is possible that cultural differences, such as holiday schedules and the degree of flexibility associated with them, may not have been factored into the master schedule. It is also possible that project manager(s) did not ensure that all project participants reviewed and committed to that master schedule.

Some surprises came up during the course of the tower project, but most of them were a result of inadequate planning rather than poor risk management. Schedule risk was not properly addressed, but it should be stressed that most of the schedule-related problems were a result of insufficient planning. Aside from the elevator problem, another example of the mistakes in the course of the tower project was that management failed to secure a public entertainment license from Glasgow City Council, which also postponed the grand opening. Another delay in the opening occurred because of software problems. The tower remained closed after the opening of the science mall on June 21, 2001. Various delays in completion prevented the debut of the tower during the official opening of the science centre by the Queen of the United Kingdom in July and when the South African President later toured the centre with the Duke of York (Oldham, 2001).

With regards to security, there were some unexpected worries about the safety of barriers (*Scottish Daily Record*, 2001, October). As for on-site safety during construction, despite the complexities and safety risks involved in building such a tall tower, the only reported incident occurred on the ground when a worker tripped and hurt himself (Louden, 2001).

Quality standards were established, including the relevant ISO standards, and adhered to by the contractors on the project. However, there was no clear indication of how quality was managed, and some rework was required. In terms of quality of the final deliverable, there were several setbacks. Problems with software and a sensor designed to ensure that the tower's glass lifts were not overloaded required rework. Furthermore, some details could have been better handled. "The chamfered entrance corner is distressingly clumsy, betraying the jewel-like quality promised by the titanium" (Louden, 2001).

Scope changes, communications, and cultural differences may have affected teamwork. A contractor conducted the wind tunnel testing with two sets of steady tests, in which aerodynamic forces were measured for all incidences. A second series of tests was required because of the change in form following the selection of a different elevator system, which was provided by a Swedish firm. Components of the twin lifts were completed in Italy and Sweden, and readied for shipping to the project site. The tower superstructure itself was fabricated in Poland before being trial assembled horizontally on a factory floor. The uppermost tower elements—the observation cabin and the carbon-fiber mast—were being produced in Stockport and Southampton, UK, respectively. Other teamwork problems occurred when the project manager viewed the elevator manufacturer as not adhering to the project's master schedule.

One could argue that teamwork problems were a direct result of ineffective communications. It seems that from the beginning (1992), the original architect envisioned the tower to be a spectacular landmark in St. Enoch's Square—not on the banks of the Clyde, but in the city center. However, due to a downturn in the national economy, the concept was shelved. It was mainly due to the inception of a national lottery and the Science Centre that the tower was finally constructed. So, from the beginning, the primary architect had specific ideas that turned out to be different from the ideas of the owner of the tower. There is no documentation supporting the notion that the warring architects allowed their egos to dictate their actions, but one can assume that when the owners started to suggest changes to the original tower design, the original architect was not entirely pleased (Pearman, 2001). During the implementation phase, communication started to improve, as the tower project needed to be coordinated with many subcontracting companies. Some problems occurred, such as the communications breakdown between the elevator manufacturer and the project management team, which resulted in schedule delays and other problems.

The lead project management company contracted to work on the Glasgow Science Centre Tower project was based in Leeds, UK. Project management on this unique project proved to be challenging. During the implementation phase, issues started to escalate into real problems, starting with the departure of the original architect, and the proof-of-concept requirements to address safety issues. The project management team was forced to hire a new lead architect during this critical period when major design changes to the tower were being made. It was also during this phase where other problems started to surface, including embarrassing problems with computers, software, and elevator performance.

The Glasgow Science Centre was designed to be Scotland's highest profile project for the new millennium, as well as to showcase Glasgow as a leading science and technology center. The project management team maintained a flexible approach because of the changes to the tower's design during the implementation phase of construction. The project management office did not consider the schedule as a primary constraint, until after repeated public openings had to be canceled and rescheduled. This newly realized schedule constraint was forced by the negative global publicity that the project was starting to get. Finally, most of the problems were addressed, the tower was completed, and it was opened in October 2001 (Dalton, 2001).

Assessment and Analysis

1. Please complete your evaluation of project management during this phase, using the following grid:

Rating Scale: 5–Excellent, 4–Very Good, 3–Good, 2–Poor, 1–Very Poor

Project Management Area	Implementation Phase
Scope Management	
Time Management	
Cost Management	
Quality Management	
Human Resource Management	
Communications Management	
Risk Management	
Procurement Management	
Integration Management	

2. Please highlight the major areas of strength in the management of this phase of the project:

3. Please highlight the major opportunities for improvement in the management of this phase of the project:

The Closeout Phase

Although the original architectural firm's design formed the basis of the Glasgow Tower scope, it was clear that scope was only moderately constrained compared to cost. Final closeout remained elusive for some time as problems with the elevators and resulting legal wrangling continued.

The tower project still managed to end up with a cost overrun of more than US$15 million (Liddell & Heppel, 2001). Despite this overrun, cost was the most constrained of the project parameters. Funding and problems with the elevator contractor remained as open issues when the tower ultimately opened. It is possible that cost problems could have been avoided had the original tower project only involved design and proof of concept. A new project for construction could have been implemented with new funding.

The Glasgow Science Centre was officially opened by the Queen of the United Kingdom accompanied by the Duke of Edinburgh on July 5, 2001 (BBC News, July 5, 2001; BDP, 2001). An opening ceremony, complete with dignitaries, was scheduled for October 2001, but was cancelled when the heavy-glass elevators failed again (Scottish Daily Record, 2001, October). Ultimately, the tower was officially opened in October 2001. It remained in operation for fewer than 100 days since its opening (Murray, 2002). Engineers shut the attraction down for an extended period of time to repair the broken bearings at the base of the tower and to install and test a replacement bearing that was manufactured in Germany. The tower was closed to the public in February 2002 and remained out of use until August 2004 when it was opened for a two-week period and shut down again for maintenance (BBC News, 2004). The Centre's management had to reduce staffing in the summer of 2002 to help pay debts related to the project, and considered legal action in a bid to recover lost revenue from the closure of the tower. On January 29, 2005, both elevators failed, trapping ten people—including four children—almost halfway up the structure. Several hours later, they were brought down safely and an inquiry began into the failure of the tower's elevators (BBC News, 2005).

Despite the legal disputes that followed the completion of the tower, it seems that the contract management side of the project was relatively well handled. The above problems may have resulted from challenged initial planning, cost estimating, and risk assessment and management by all parties involved in the project. Public opening of the tower and actual closeout of this project sustained numerous delays. The design may have been determined without full consideration of the cost and schedule constraints. Between the budget battles and the public feuding, some may consider it amazing that the tower went up and was opened at all. Some individuals may feel uncomfortable as potential visitors to the tower, and are probably unhappy as taxpayers.

Although there were some mishaps in the overall management of the tower project, they were, for the most part, a result of challenged planning, coordination, and communication. The critical technical and external risks were addressed with due care. Because their impact extends far beyond the completion of the project, they are probably more important to the ultimate performance of the project.

Quality performance criteria were met for the most part of the project, and the client was satisfied with some aspects of the project. However, after cost overruns, technical problems, substantial delays to the completion of the project, and consideration of legal action, perceptions of the management of the project turned negative. Although there is no clear indication that appropriate tools were effectively used in managing the quality of the project, many of the desired results were achieved. What seemed to be lacking quality was the management of the final deliverable of the project.

Due to the high visibility of the tower project and the problems that plagued it, teamwork actually improved during the final phases. The tower project had many problems, some of which could be related to the challenges to teamwork during the development and implementation phases. It seems that if proper project management methodologies had been used, teamwork would not have been as much an issue as it was. However, the overall coordination, cooperation, and teamwork of so many international companies working on such a unique structure were very good.

The overall communications management of the tower project was actually quite good, considering that cultural and personal differences must have played an important role in such a large-scale project. During the closeout phase, communications improved further, probably due to the extensive publicity associated with this project.

It is difficult to fully appreciate project management issues of the tower project. Airing of "dirty laundry" is not necessarily considered by some to be appropriate or in the public's right to know. The tower was finally debuted to the public, but even on its grand opening day, a software problem caused delay and embarrassment.

The Glasgow Science Centre is a truly unique, complex structure whose design, construction, and management faced significant challenges and problems. But, in the end, the city of Glasgow now has a state-of-the-art science and technology center of which it can be proud.

Assessment and Analysis

1. Please complete your evaluation of project management during this phase, using the following grid:

Rating Scale: 5–Excellent, 4–Very Good, 3–Good, 2–Poor, 1–Very Poor

Project Management Area	Closeout Phase
Scope Management	
Time Management	
Cost Management	
Quality Management	
Human Resource Management	
Communications Management	
Risk Management	
Procurement Management	
Integration Management	

2. Please highlight the major areas of strength in the management of this phase of the project:

3. Please highlight the major opportunities for improvement in the management of this phase of the project:

Summary of Project Assessment and Analysis

1. Please complete your evaluation of project management for this project and calculate the average rating, using the following grid:

Rating Scale: 5–Excellent, 4–Very Good, 3–Good, 2–Poor, 1–Very Poor

Project Management Area	Inception Phase	Development Phase	Implementation Phase	Closeout Phase	Average
Scope Management					
Time Management					
Cost Management					
Quality Management					
Human Resource Management					
Communications Management					
Risk Management					
Procurement Management					
Integration Management					
Average					

2. Please highlight the major areas of strength in the management of this project:

3. Please highlight the major opportunities for improvement in the management of this project:

4. Please highlight the major project management lessons learned from this project:

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