Tacoma Narrows Bridge Collapse

Cause Map™ Diagram

The original Tacoma Narrows Bridge was opened for traffic on July 1, 1940. The suspension bridge spanned over a mile and had a unique elegant, slender design that resulted in large up and down bridge movement on windy days. The bridge was quickly nicknamed "Galloping Gertie".

On the morning of November 7, 1940, the movement of the Tacoma Narrows bridge changed from the usual longitudinal motion to a never before seen twisting mode. The peak twisting motion is estimated to have been 25 ft from crest to valley. The bridge was closed to traffic due to the unsafe conditions. The violent twisting motion continued to increased for about an hour until the suspender cables snapped and 600 ft of the roadbed was dropped into the river below. The Tacoma Narrows Bridge was destroyed a little more than four months after it opened.

1 Problem

What	The Issue(s)	Tacoma Narrows Bridge Collapse
When	Date	14922
	Time	~10:00 am
	Differences	Extremely narrow relative to length, windy day
Where	Physical Location	Spanned Puget Sound, 8 miles west of Tacoma
	Process location	Bridge in service

Impact to the Goals

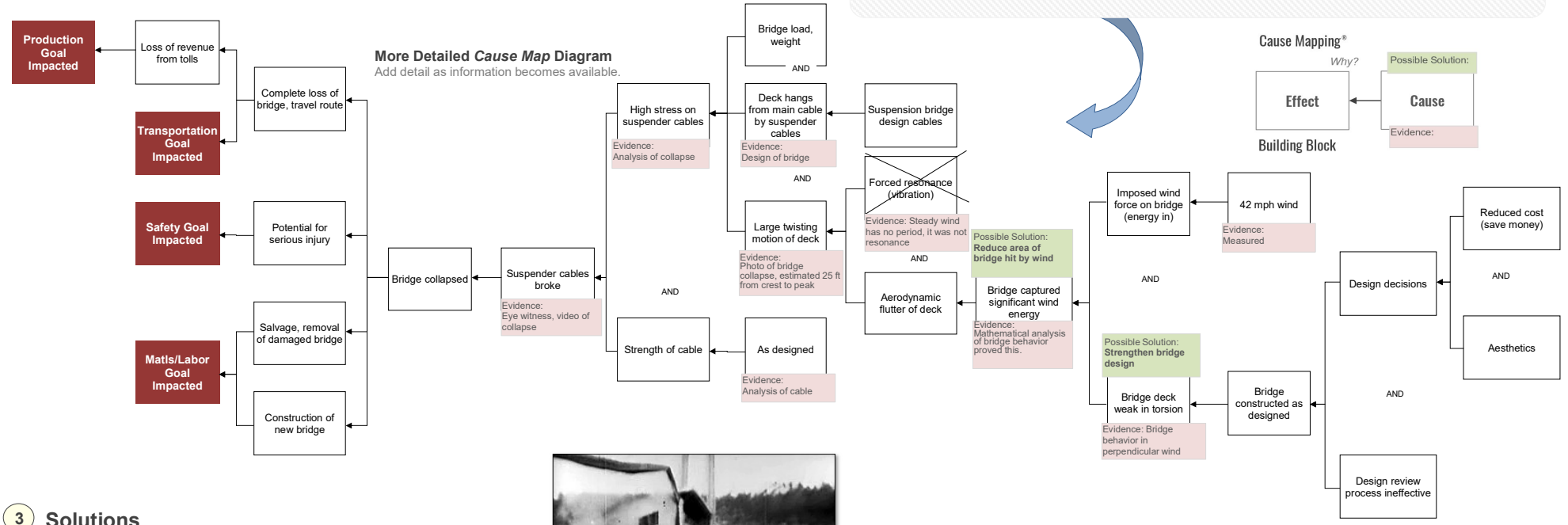
Safety	None, potential for serious issue		
Transportation	Complete loss of bridge, travel route	$	6,000,000
Production-Schedule	Loss of revenue from tolls	$	1,600,000
Materials, Labor	Salvage, removal of damaged bridge ?	$	350,000
	Construction of new bridge ?	$	11,200,000
	This incident	$	19,150,000
Frequency	1x in US	1	
	Annualized Total	$	19,150,000

2 Analysis

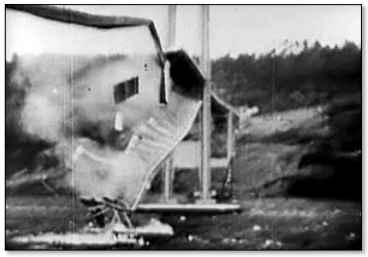
Basic *Cause Map* Diagram - Start with simple Why? questions.

More Detailed *Cause Map* Diagram

Add detail as information becomes available.



Cause Mapping®



3 Solutions

Ref.	Possible Solution	Cause
1	Wider roadbed	Narrow in relation to length
2	Stiffening struts	Roadbed was too flexible
3	Open lattice trusses	Solid trusses

As the Cause Map diagram demonstrates there were many causes that contributed to the collapse of the bridge. Wind was one of the more obvious causes. On the day the bridge failed, the wind was blowing across the roadbed at 42 mph, the strongest wind the bridge had experienced. Another cause was the design of the bridge. The Tacoma Narrows Bridge was particularly narrow relative to its length, making the roadbed more flexible than other suspension bridges. Additionally, the bridge had shallow girders and was relatively weak in torsion compared to other suspension bridges built around the same time. The overall design of the bridge resulted in a structure that was weak in torsion and moved relatively easily in the wind.

In addition to the mechanical causes that contributed to the failure, there were a number of issues with the design process. One of the primary drivers behind the bridge design was cost reduction. The first design proposed for the Tacoma Narrows Bridge was a conventional suspension bridge that was estimated to cost $11 million. The price of the bridge design that was actually built was of $3 millions dollars cheaper. Additionally, the approved design was considered to be much more elegant and aesthetically pleasing. As in the case of all designs that failure, the design review process was also ineffective or the design flaws that contributed to the bridge collapse would have been identified prior to construction.

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