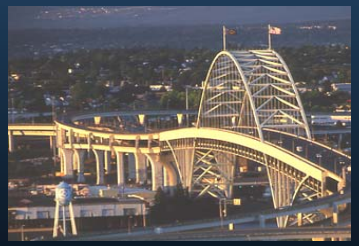
Western Bridge Engineers' Seminar

Presentation

Management Information Systems In Structural Engineering



Presented By

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T.Y. LIN INTERNATIONAL

engineers | planners | scientists

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Presentation Outline

- What is MIS
- Structural Design Process
- MIS in support of Structural Engineering
- Example of MIS concepts in Design
- Summary

What is Management Information Systems (MIS)

- A huge field of study that encompasses every aspect of business.
- It's origins date back thousands of years to the dawn of civilization.
- Computerization has brought about the good and the bad.
  - The Good = speed, efficiency & new ways to look at relationships.
  - The Bad = Information overload "Paralysis of the Analysis".

What is Management Information Systems (MIS)

The Short Definition

"(MIS) is a planned system of the collecting, processing, storing and disseminating data in the form of information needed to carry out the functions of management."

(Ref: Wikipedia)

What is Management Information Systems (MIS)

The Long Definition

Computer-based or manual system that transforms data into information useful in the support of decision making. MIS can be classified as performing three functions:

(1) To generate reports-for example, financial statements, inventory status reports, or performance reports needed for routine or non-routine purposes.

(2) To answer what-if questions asked by management. For example, questions such as "What would happen to cash flow if the company changes its credit term for its customers?" can be answered by MIS. This type of MIS can be called Simulation.

(3) To support decision making. This type of MIS is appropriately called Decision Support System (DSS). DSS attempts to integrate the decision maker, the data base, and the quantitative models being used.

(Ref: Ask.com)

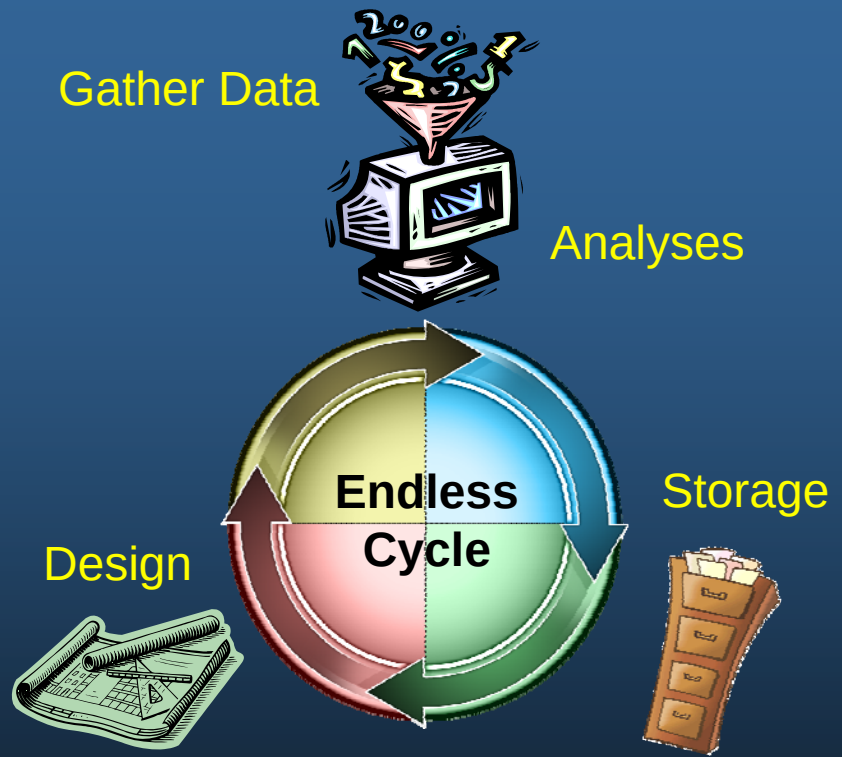
The Structural Design Process

Data – Can be anything
- material properties, test results, etc.

Analyses
- Computer, hand calculations, filtering methods, etc.

Storage
- Computer, Hard copies

Design
- Codes, Engineering Judgment, Decisions, etc.



The Structural Design Process

- A huge field of study that encompasses every aspect of civilization
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The MIS in support of Structural Design

The Long Definition

Computer-based or manual system that transforms data into information useful in the support of Design. MIS in Structural Design can be classified as performing three functions:

(1) To generate reports - for example, Charpy V-notch test results on proposed 3" thick HPS70 Q/T Steel.

(2) To answer what-if questions asked by Lead Designers. For example, a question such as "What would happen if 10% damping were used instead of 5% damping in a seismic analysis?" can be answered with the help of MIS. This type of MIS can be called Simulation.

(3) To support decision making. This type of MIS is appropriately called Decision Support System (DSS). DSS attempts to integrate the Designer, the data base, and the quantitative models being used.

Example of MIS Concepts in Structural Design

- Design of an Edge Girder of a Cable Stay Bridge for an Extreme Event.
- The Loss of 1 cable
- Use the Post-Tensioning Institute - One Cable Loss Load Case

$$1.1\,DC + 1.35\,DW + 0.75(LL + IM) + 1.1\,CLDF$$

DC = Dead Load Structural Components
DW = Dead Load Wearing Surface, Utilities, etc.
LL = Truck + Lane Load
CLDF = Cable Loss Dynamic Force

Example of MIS Concepts in Structural Design

- Girder Length = 850 m long.
- The Girder is broken up into 264 FE Members.
- Number of Cables = 76.

Example of MIS Concepts in Structural Design

- Obtain Member Forces for ends and midspan of each FE Member for each cable loss.
- Remove one cable at a time and analyze girder.
- Store Max. & Min. Force or Moment plus associated forces and moments for each member location for each cable loss.

  EX. Max Fx associated Fy Fz Mx My Mz

  Total = 12 controlling force/moment sets

Example of MIS Concepts in Structural Design

- 264 x 3 x 76 x 12 =

  722,304 lines or records

- Each record contains
  - ID
  - Location
  - Cable Lost
  - 3 Forces
  - 3 Moments

IT GETS WORSE!

- 722,304 x 9 =

  6,500,736 pieces of data or information

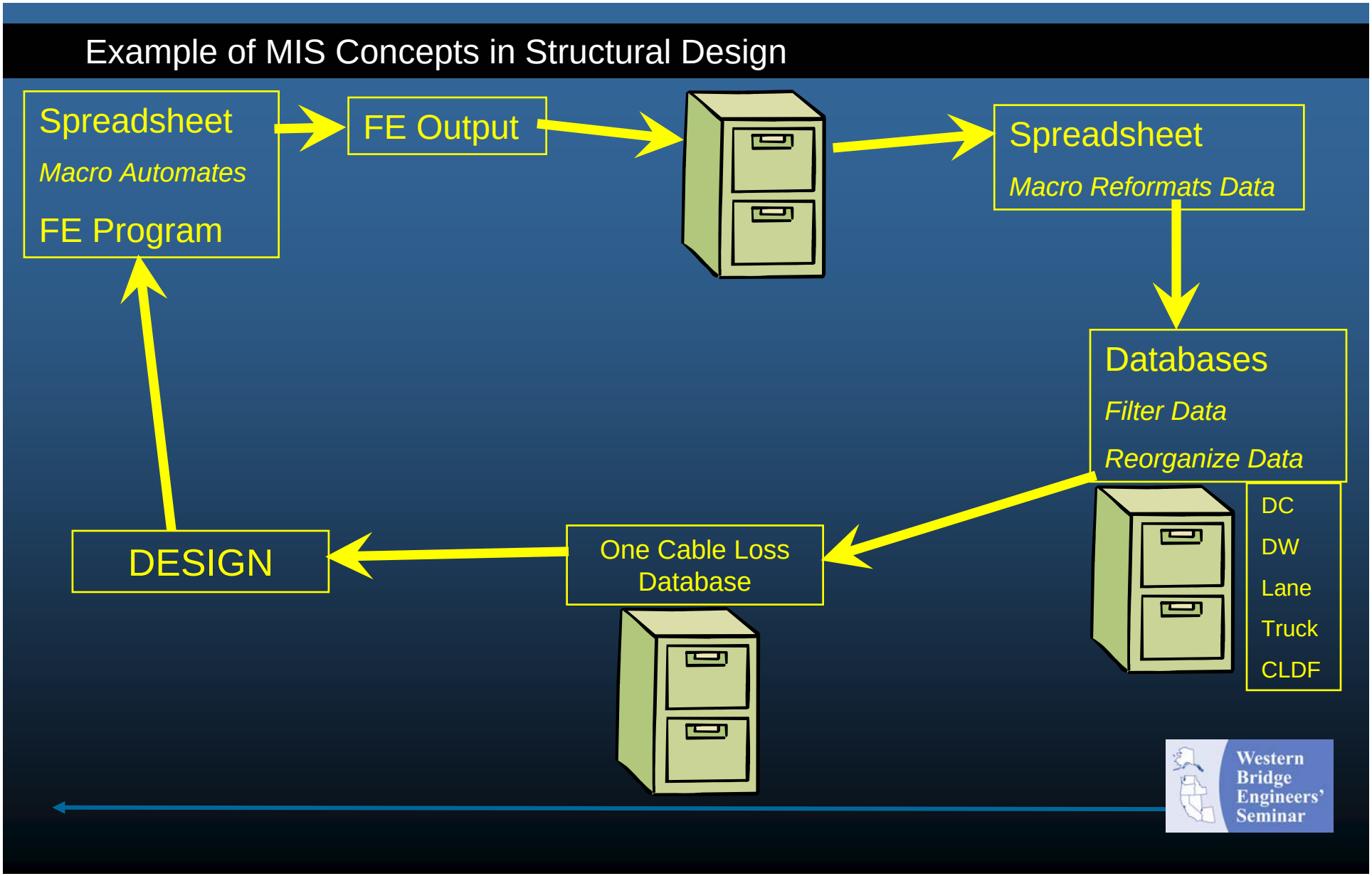
Example of MIS Concepts in Structural Design

- Live Load is a combination of Lane and Trucks
- Lane Loads
  - Can be continuous or discontinuous
  - Do not include portions of lane that are beneficial
  - In this example lane loading broken up into 13 segments
  - Finding the controlling set of segments for each location on the girder for each cable loss requires approximately 264 x 3 x 200 = 158,400 x 76 cables = 12,038,400 temporary records that need to filtered down to 60,192 records.
- Truck Loads
  - In lieu of a moving load analysis, I used 206 truck positions along girder.
  - 264 x 3 x 206 = 163,152 x 76 cables = 12,399,552 temporary records filtered to 60,192 records

Example of MIS Concepts in Structural Design

- By using some engineering experience and judgment we can reduce the problem down to about half.
- 38 Cable Losses
- Analyze half the edge girder
- Eliminate two force sets since for the girder design they are not significant
- Max. flexibility and transparency all loads analyzed and stored separately.
- Example uses 3 programs.
  - Spreadsheet (Excel),
  - FE (Larsa) and
  - Database (Access)

Example of MIS Concepts in Structural Design

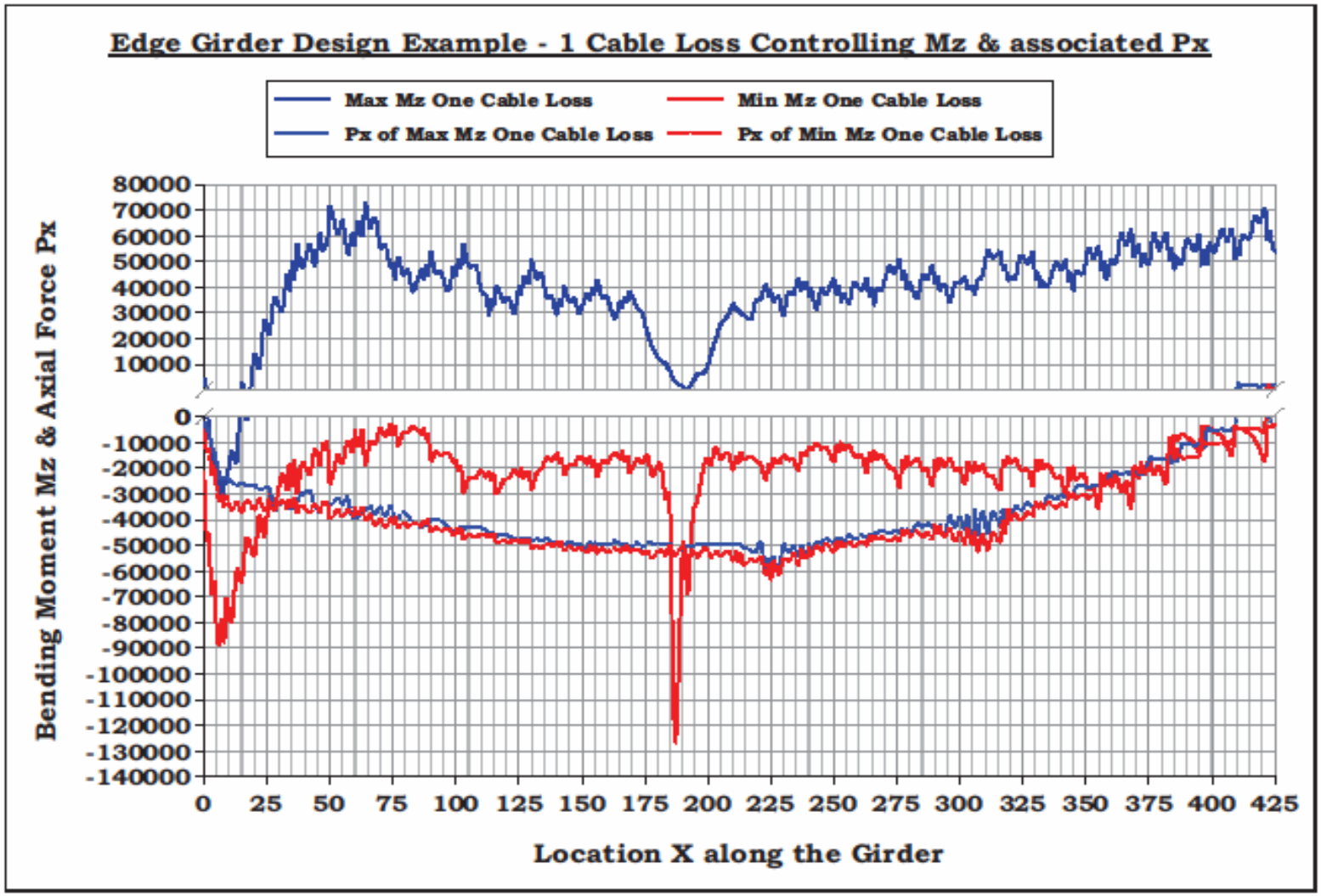


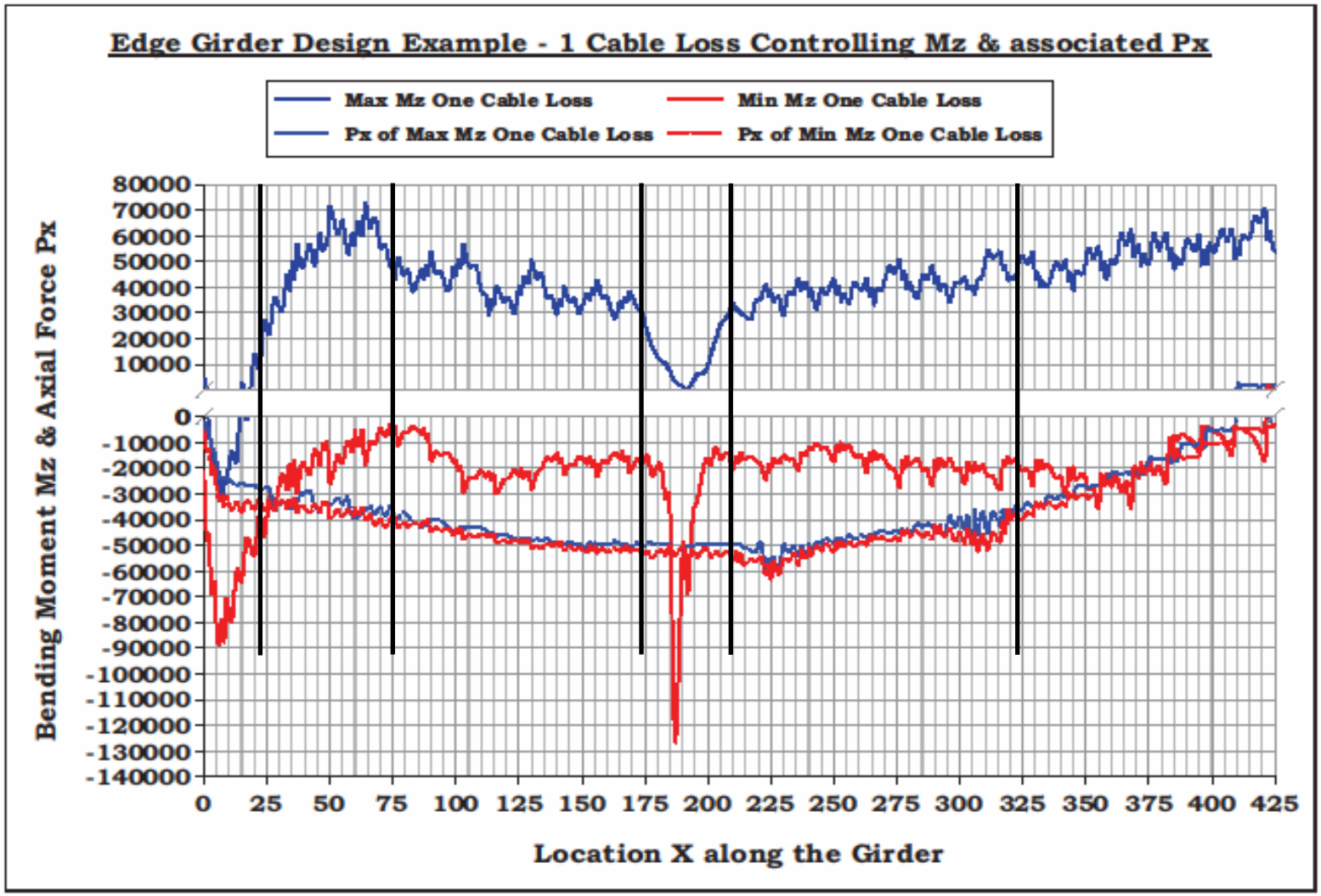
Example of MIS Concepts in Structural Design

- Data from FE stored in files whose names indicate cable loss.

  EX. 23D_N1 = Cable 23 lost, Girder D, North Tower 1

- FE stored files are comma delimited and can imported to just about any program.
- Since all loads are separated, it is possible to trace back through data.
- If a particular load has errors or needs to be changed it is not necessary to rerun all loads again.
- If a particular cable loss needs to be run again or a simulation performed it is not necessary to rerun all cables.


Edge Girder Design Example - 1 Cable Loss Controlling Mz & associated Px
Max Mz One Cable Loss
Min Mz One Cable Loss
Px of Max Mz One Cable Loss
Px of Min Mz One Cable Loss
Bending Moment Mz & Axial Force Px
80000
70000
60000
50000
40000
30000
20000
10000
0
-10000
-20000
-30000
-40000
-50000
-60000
-70000
-80000
-90000
-100000
-110000
-120000
-130000
-140000
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
425
Location X along the Girder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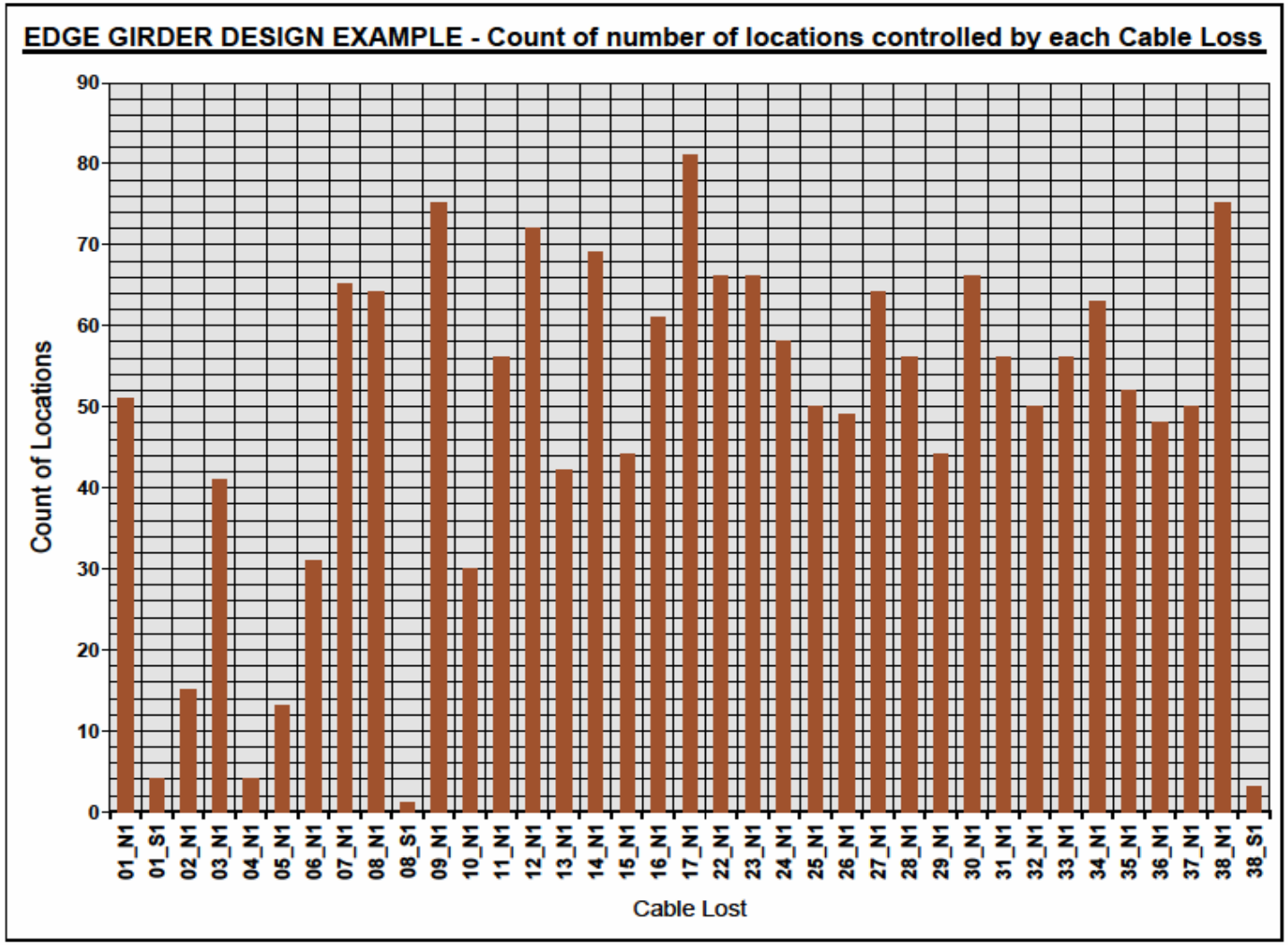
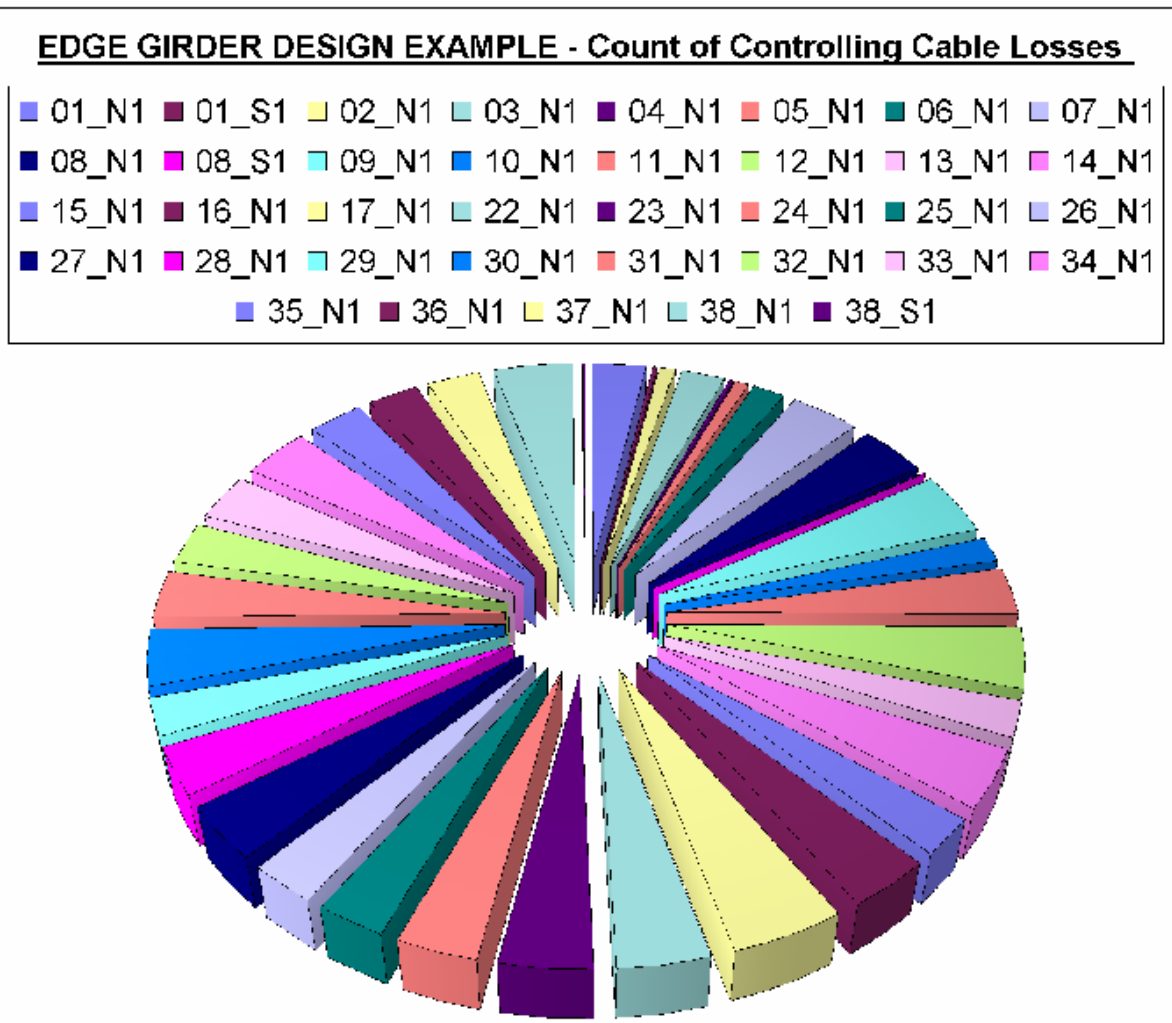
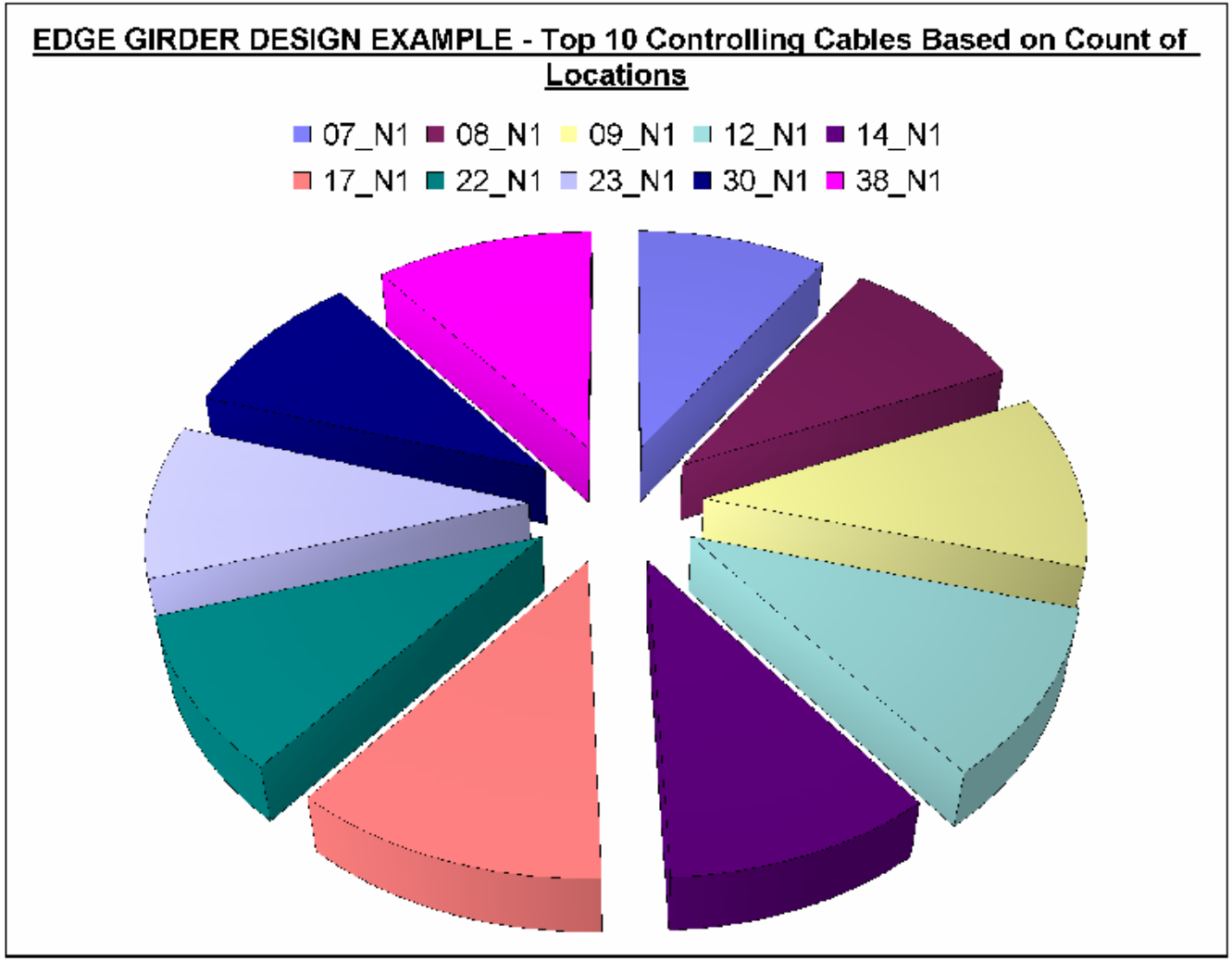
80000
70000
60000
50000
40000
30000
20000
10000
0
-10000
-20000
-30000
-40000
-50000
-60000
-70000
-80000
-90000
-100000
-110000
-120000
-130000
-140000
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
425
Location X along the Girder


EDGE GIRDER DESIGN EXAMPLE - Count of number of locations controlled by each Cable Loss
Count of Locations
0
10
20
30
40
50
60
70
80
90
01_N1
01_S1
02_N1
03_N1
04_N1
05_N1
06_N1
07_N1
08_N1
08_S1
09_N1
10_N1
11_N1
12_N1
13_N1
14_N1
15_N1
16_N1
17_N1
22_N1
23_N1
24_N1
25_N1
26_N1
27_N1
28_N1
29_N1
30_N1
31_N1
32_N1
33_N1
34_N1
35_N1
36_N1
37_N1
38_N1
38_S1
Cable Lost

EDGE GIRDER DESIGN EXAMPLE - Count of Controlling Cable Losses




EDGE GIRDER DESIGN EXAMPLE - Top 10 Controlling Cables Based on Count of Locations
07_N1
08_N1
09_N1
12_N1
14_N1
17_N1
22_N1
23_N1
30_N1
38_N1

Summary

1. Transference

- Not too long ago (<15 yrs) it was very difficult to transfer data from one program to another.
- Today data flows like water from program to program which makes design easy and hard.
  - The easy part is we don't have to think too much about the transfer; it's a click of a button.
  - The hard part is that it's very easy to magnify mistakes due to the speed and ease of transfer.

Summary

2. Data Volume

- Before the advent of PC's and computerized design when most tasks were done by hand, engineers worked with limited amounts of data and had limited choices for design.

- Today PC's, the internet, and hi-tech communications have allowed us to be more exacting in our designs. The result of this sophistication is an enormous amount of data to contend with.

- The fear is that we can very easily lose control of our data and in turn lose confidence in our designs.

Summary

3. MIS

- Today we are seeing more and more attempts to control data through various means available (dedicated servers, e-rooms, Rivet, etc.)
- Engineers are using database programs like MS Access more and more.
- What I don't see is an effort to learn MIS or to consult with MIS experts. (Engineers for the most part are poor programmers).
- My fear is that Engineers will repeat the mistakes that Business learned long ago.

Summary

4. Finally

- 15 years ago I received an MBA with a major in MIS.
- At the time, I got minor criticism for getting an MBA
- I got Major league criticism for majoring in MIS ("What's that for?").
- Looking back, I'd like to think that I was clairvoyant rather than just having dumb luck.
- Now, I lean more towards Dumb Luck.

THANKYOU!