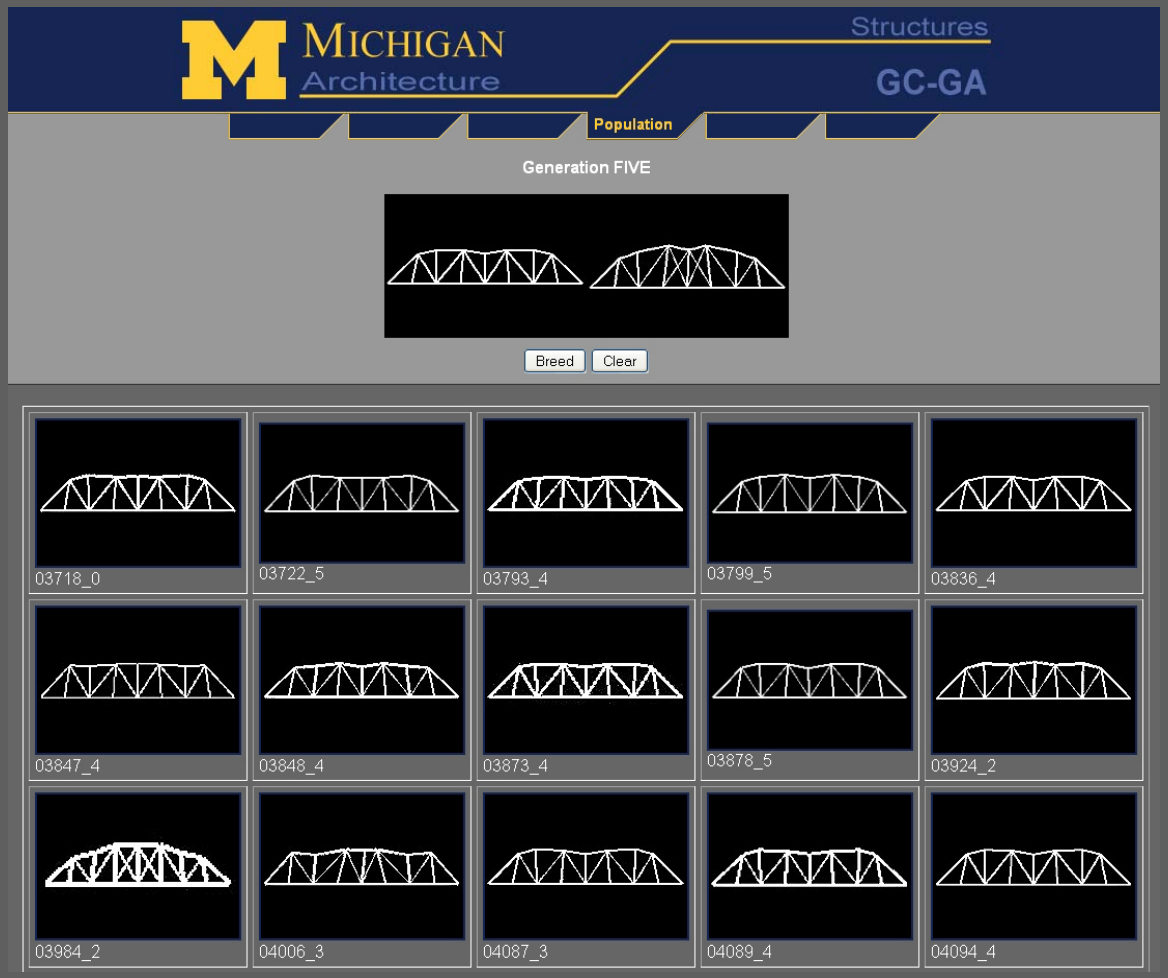
The GC-GA

Applied to the Exploration of Architectural Trussed Structural Systems

A Form Exploration
Tool for Early Design



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University of Michigan

Evolutionary Exploration

Purposeful

directed – not merely random

Goal Oriented

search to find good solution

Creative

seeks *new* solutions

Ill Structured Problem

problem space not fully defined

cannot solve directly – cyclic

exploration needed

Traditional Optimization

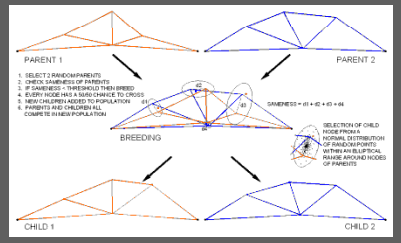
Evolutionary Exploration

csv

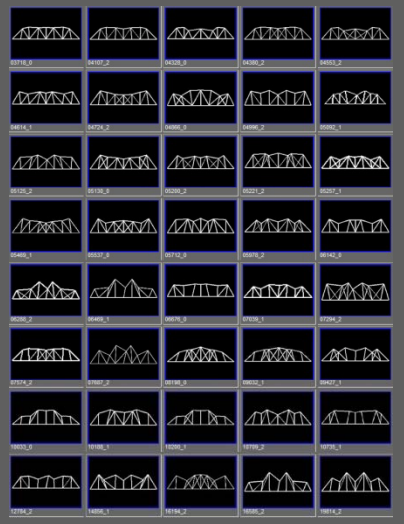
Select

20 Best

Breed



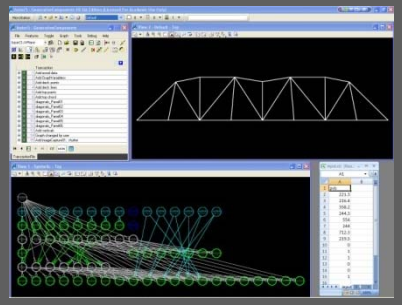
Rank



Excel

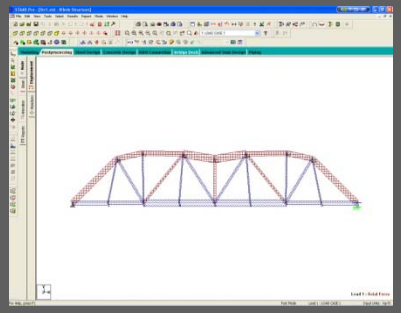
GC-GA

Grow



Evaluate

DXF



weight

The Trial

Subject

- redesign of Foster Bridge
- Wrought Iron Bridge Co. 1890
- Ann Arbor, Michigan

Span:

- 118.7 ft [36.2 m]

ASHHTO Lane Load

- HS-20
- 650 PLF

Steel

- HSS steel tubing

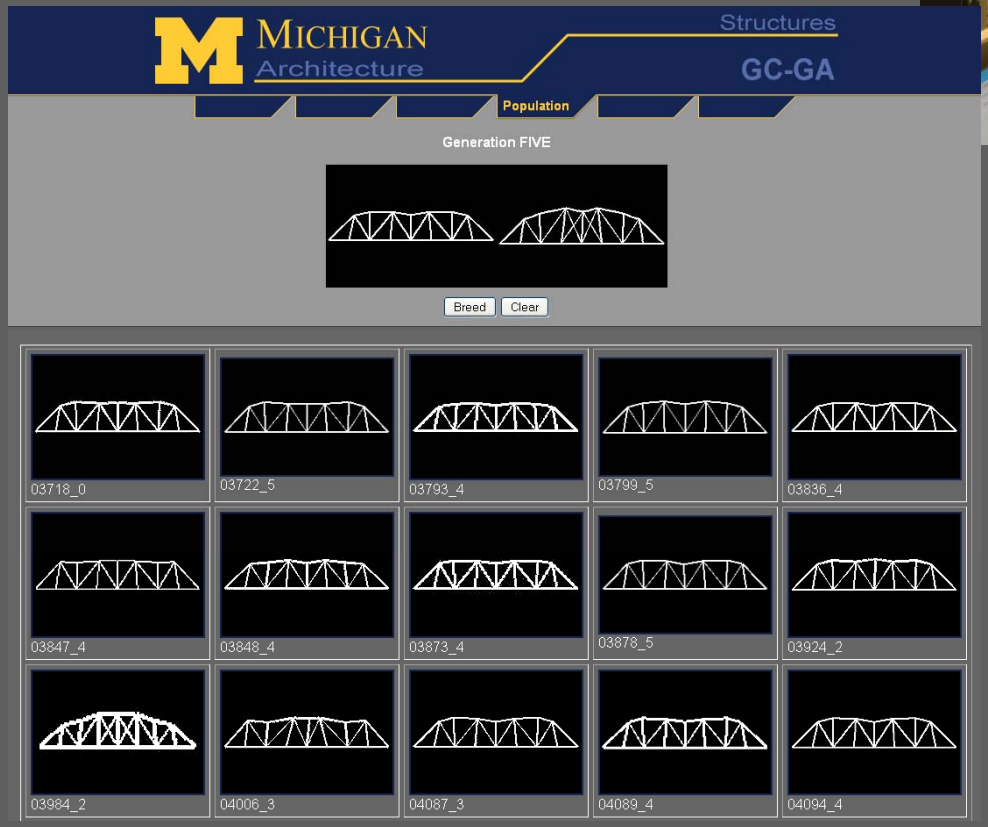
Selection

- Least weight
- Designers preference

1. Selection

Interactive web interface

The designer's selection is made based on visual (aesthetic) criteria. This potentially allows the GA to explore solutions more in tune with the designer's intentions.



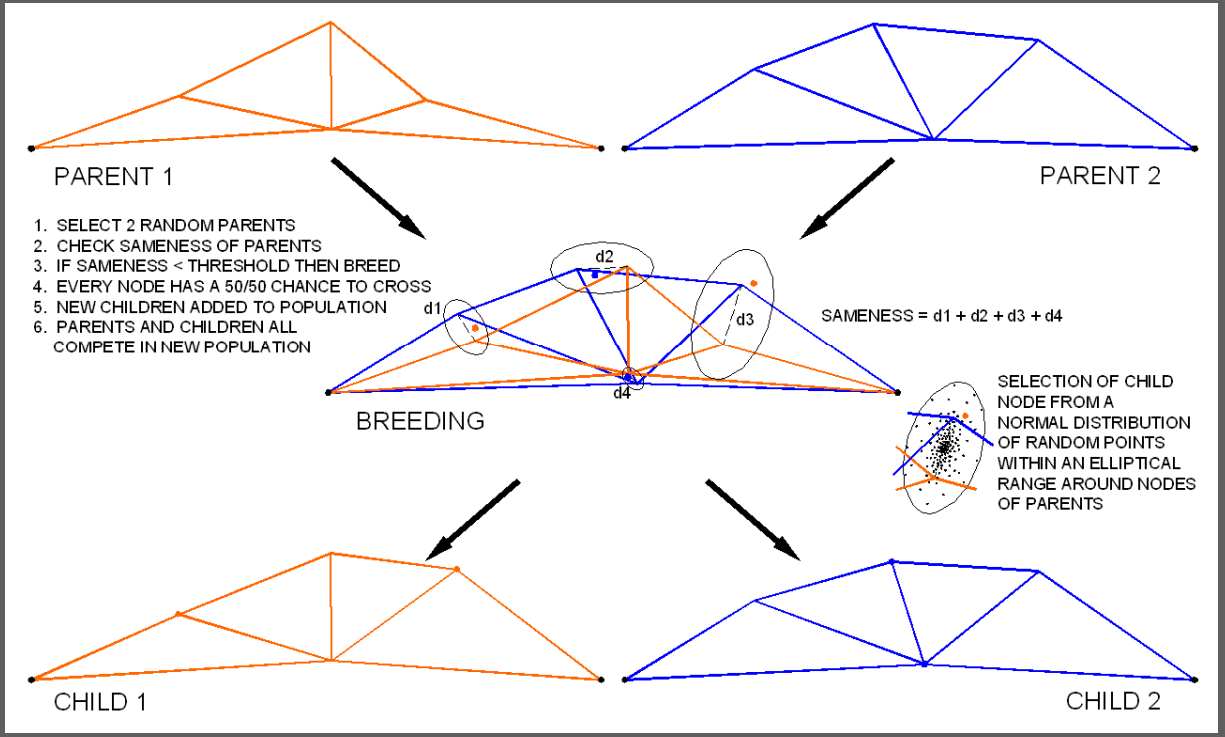
2. Breeding

Crossover of ASCII strings

Output Excel cvs

PvB-1
221.3
216.4
358.2
244.3
554
244
712.3
219.5
0
1
1
0
0
1

PvB-2
237.2
213.8
342.2
257.1
565
312
698.2
237.5
0
0
1
1
0
0

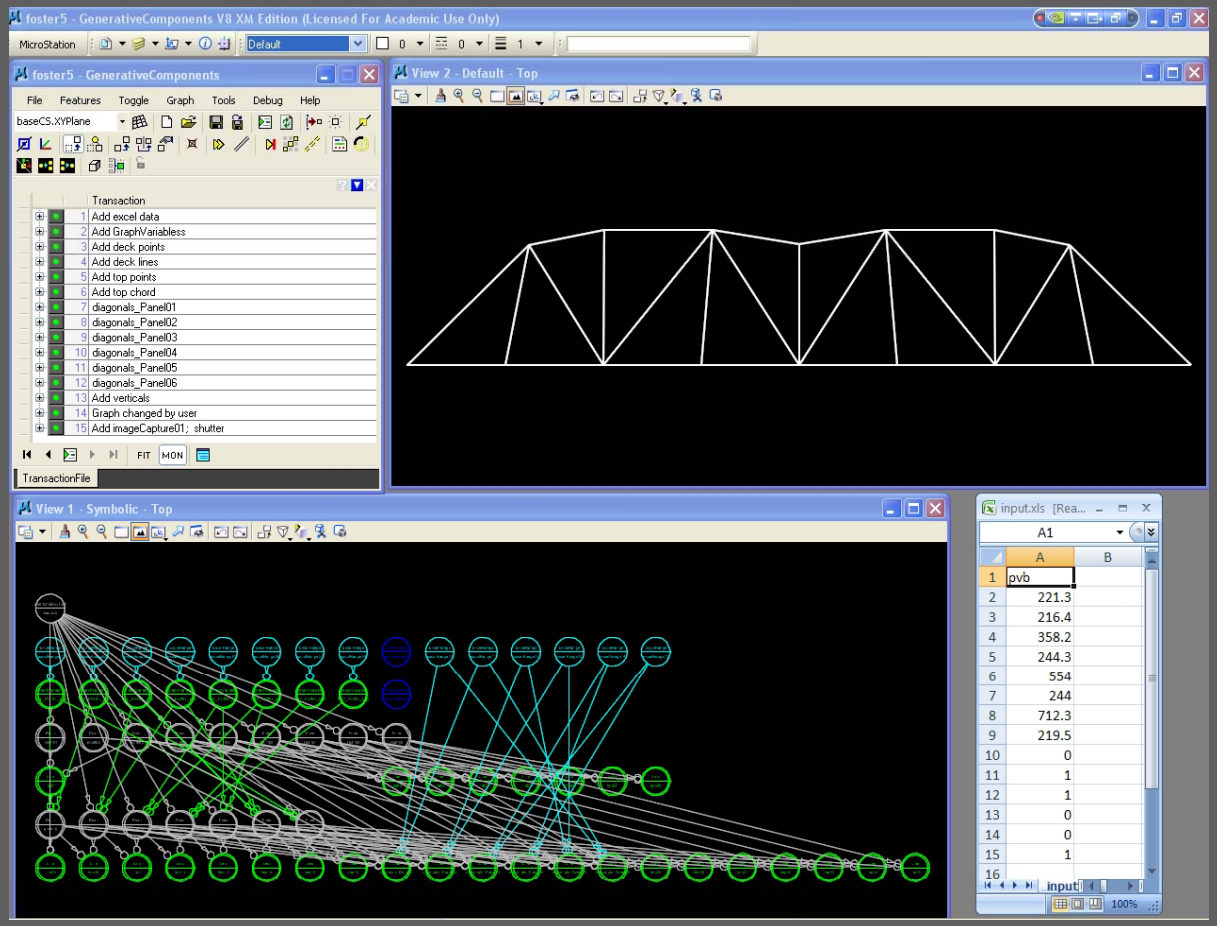


3. Grow the Form

Run GC with Excel input

Generate form

Output dxf file



4. Evaluate Form

Read into STAAD – Pro

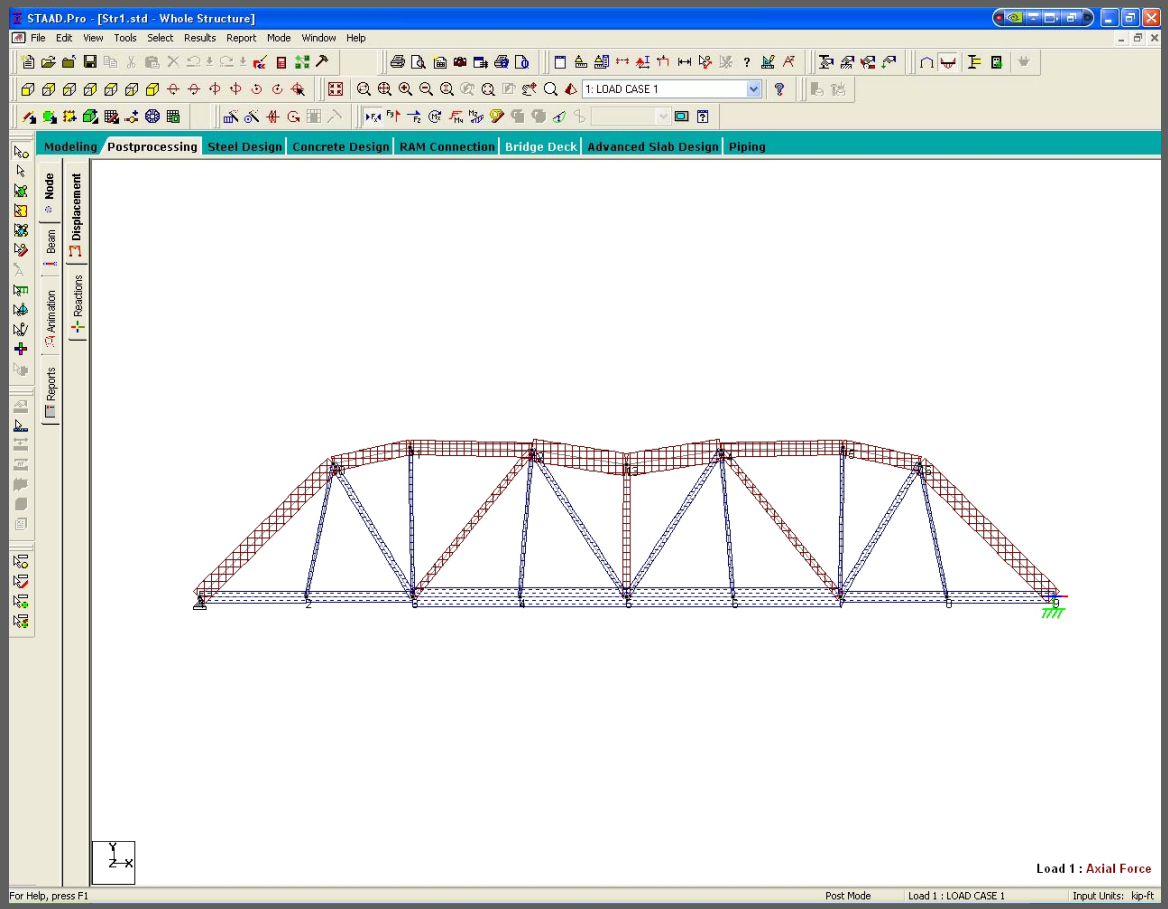
Attach loading

Find force and deflection

Size members

Determine weight

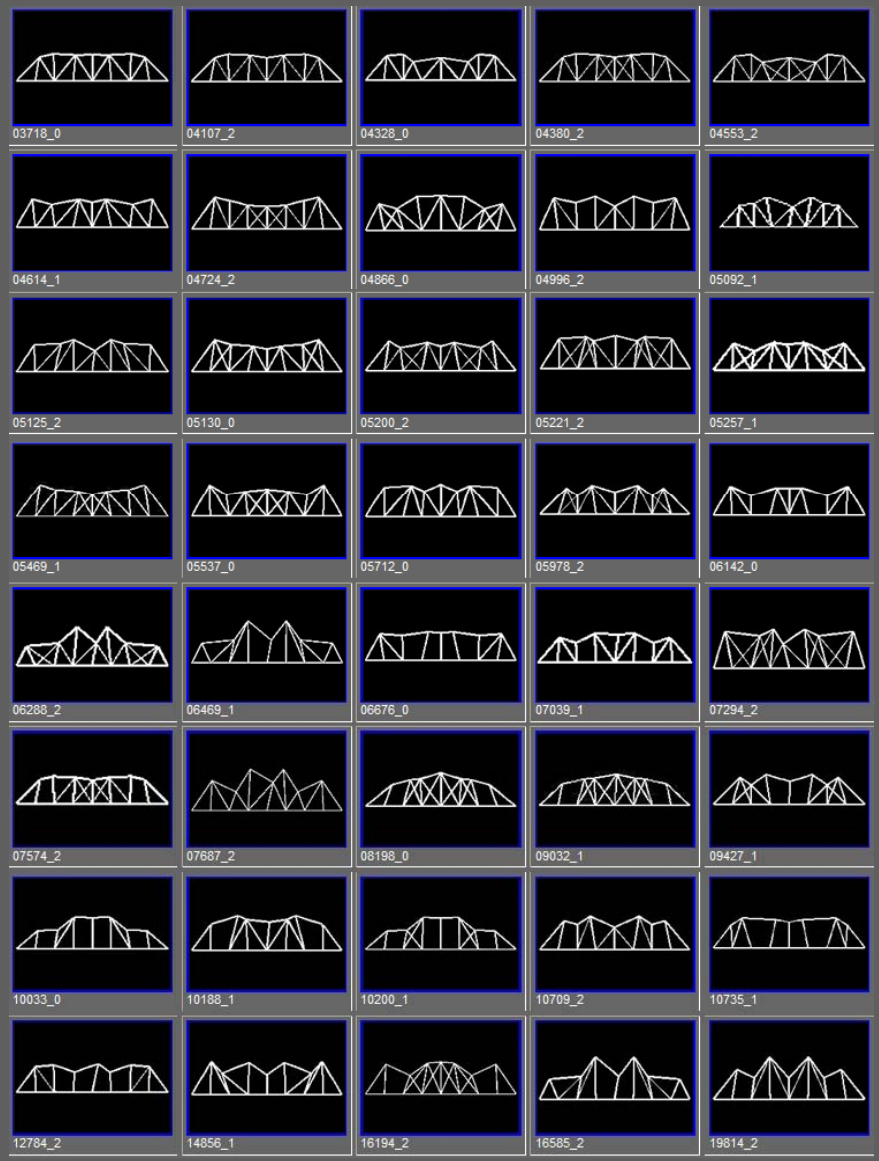
Output csv + weight



5. Ranking

Sort by weight

Kill off the heavier solutions



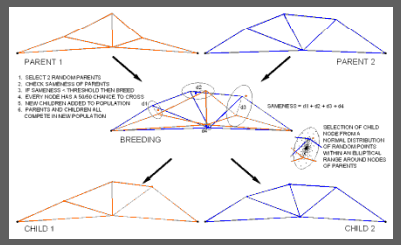
6. Cycle Repeats

Select

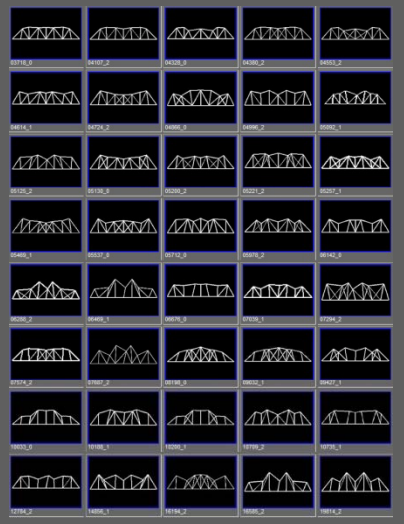
20 Best

CSV

Breed



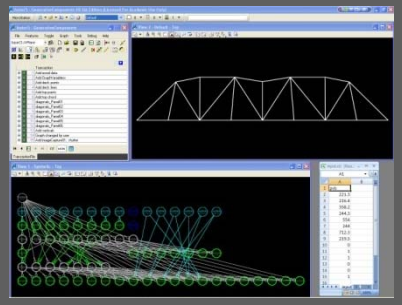
Rank



Excel

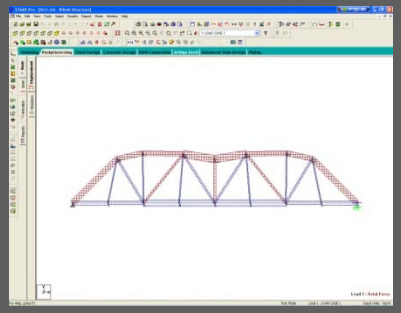
GC-GA

Grow



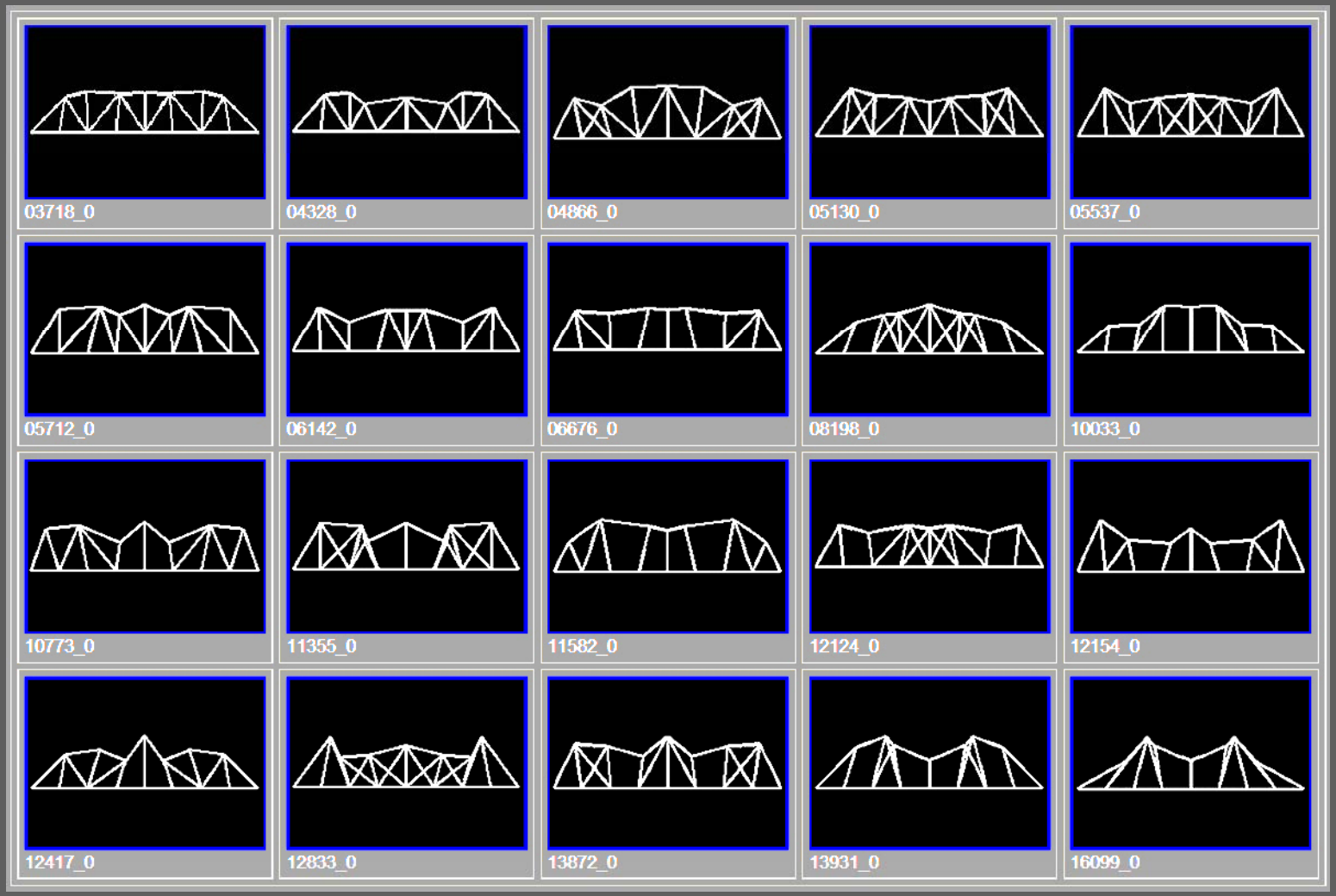
Evaluate

DXF

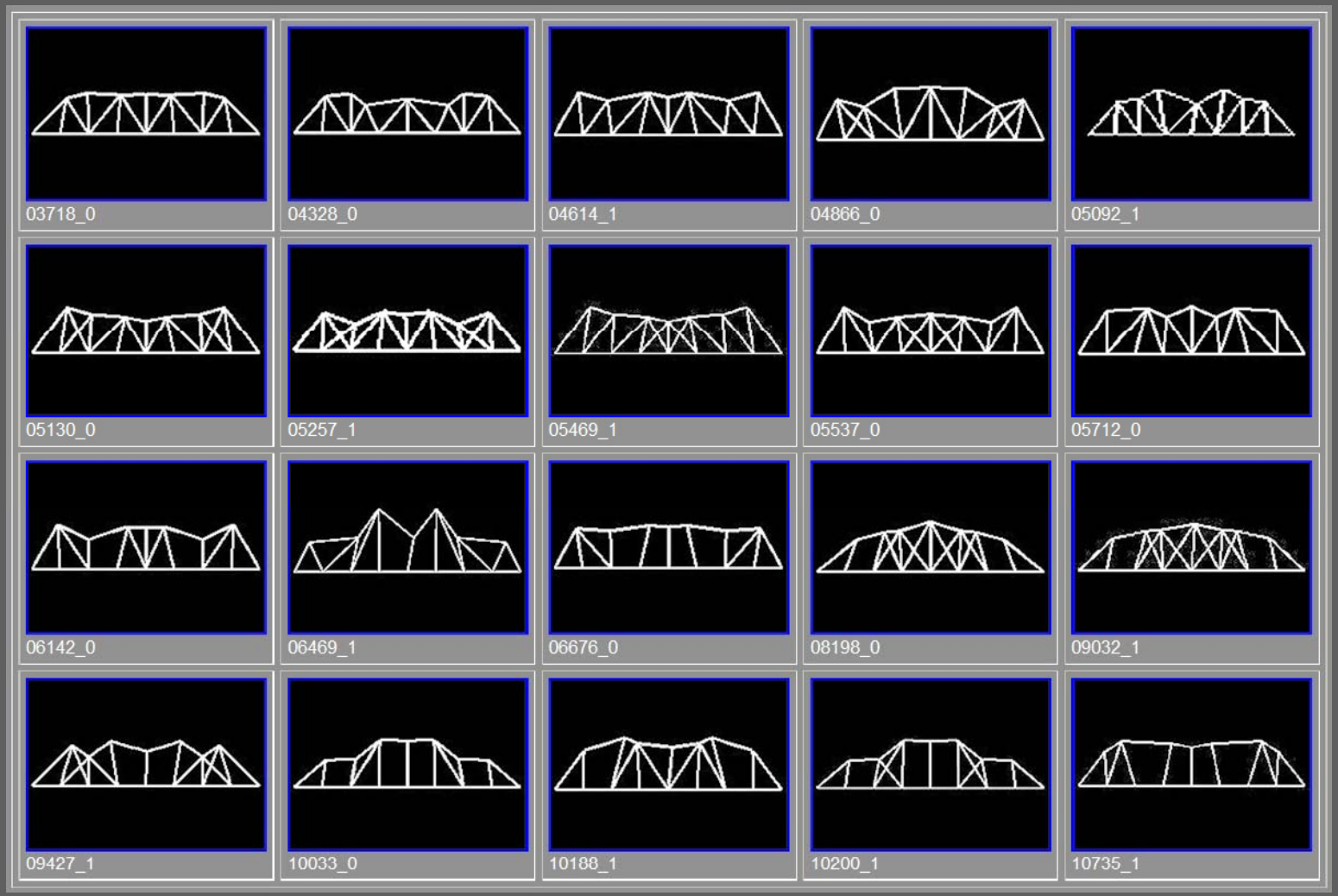


weight

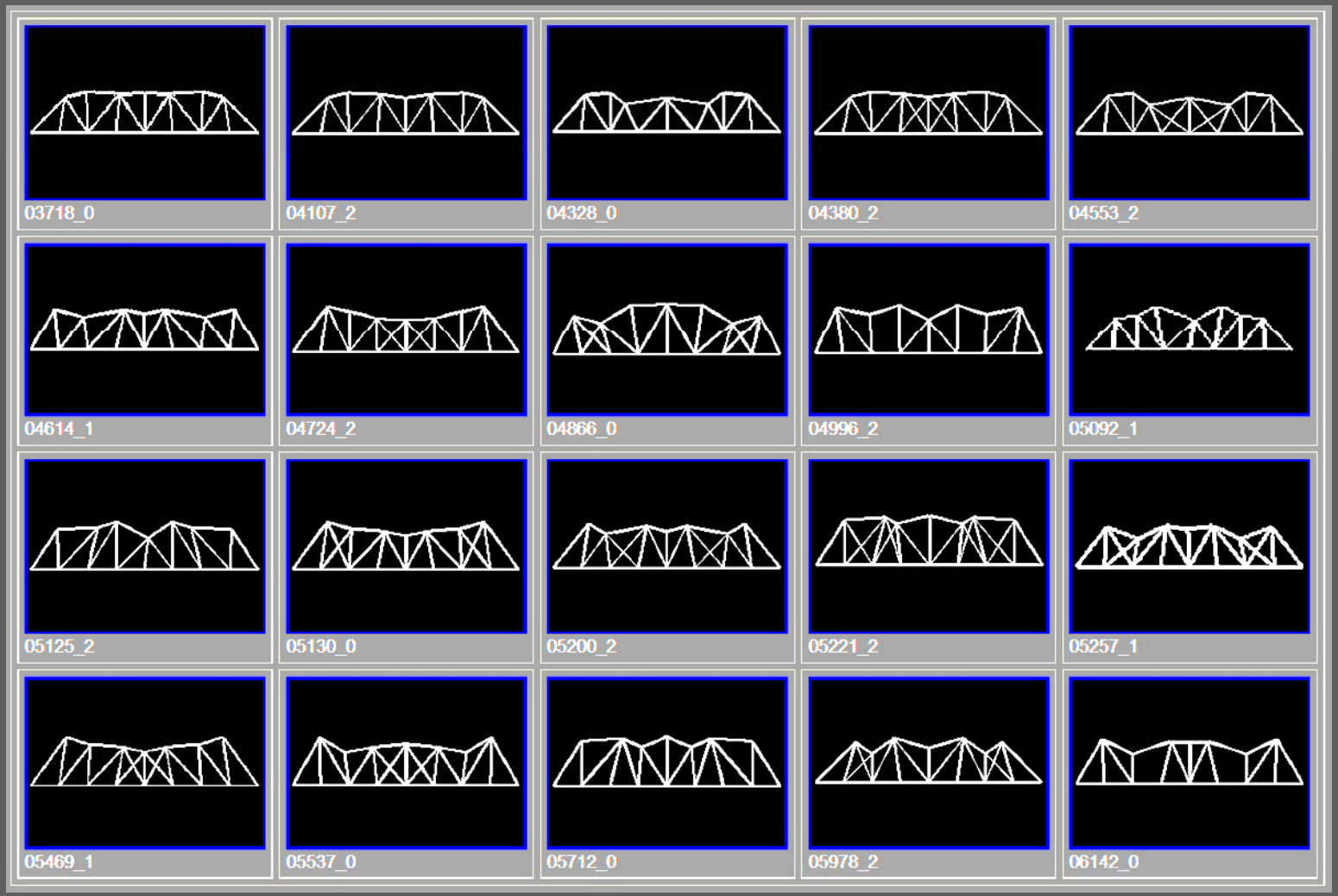
Generation 1



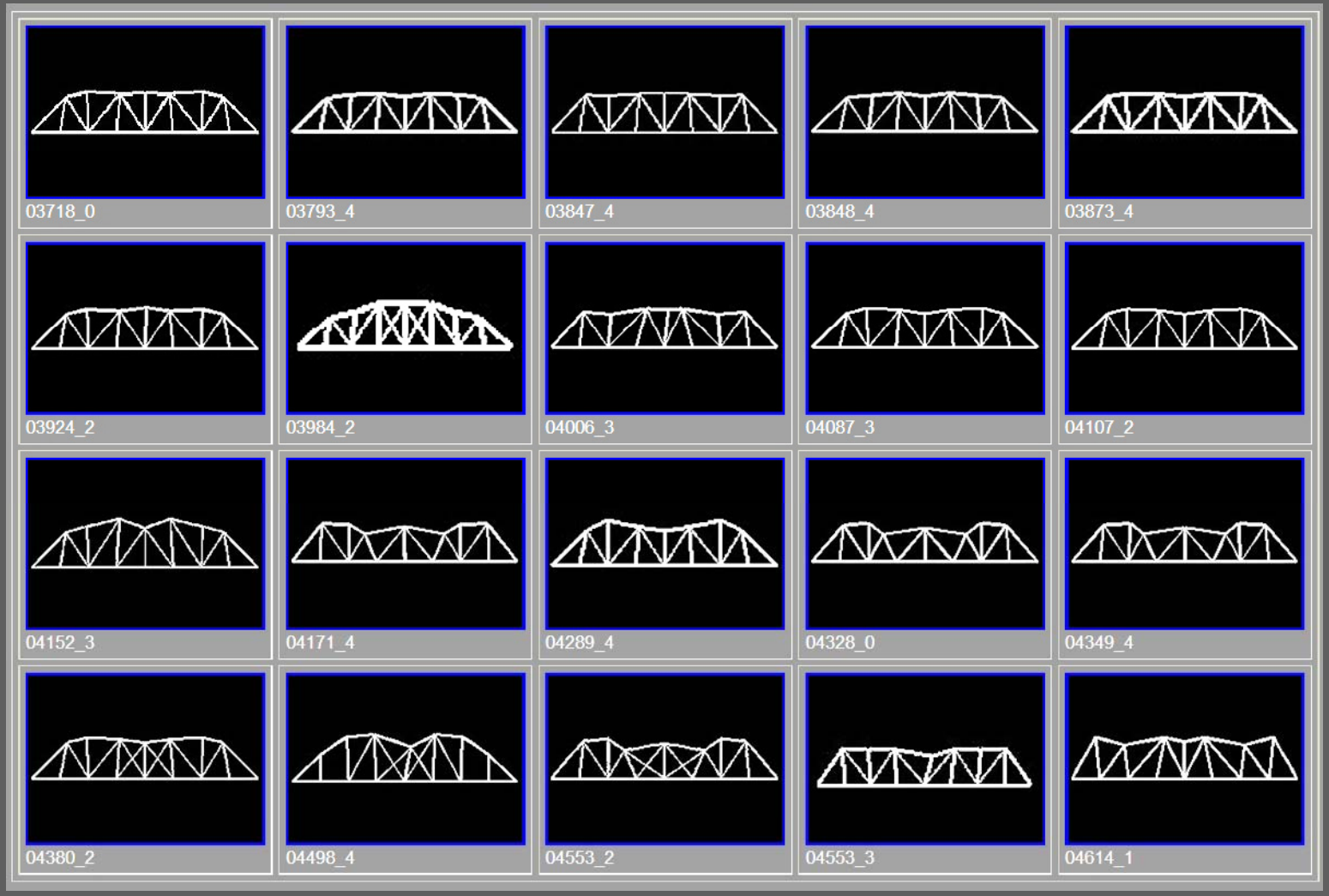
Generation 2



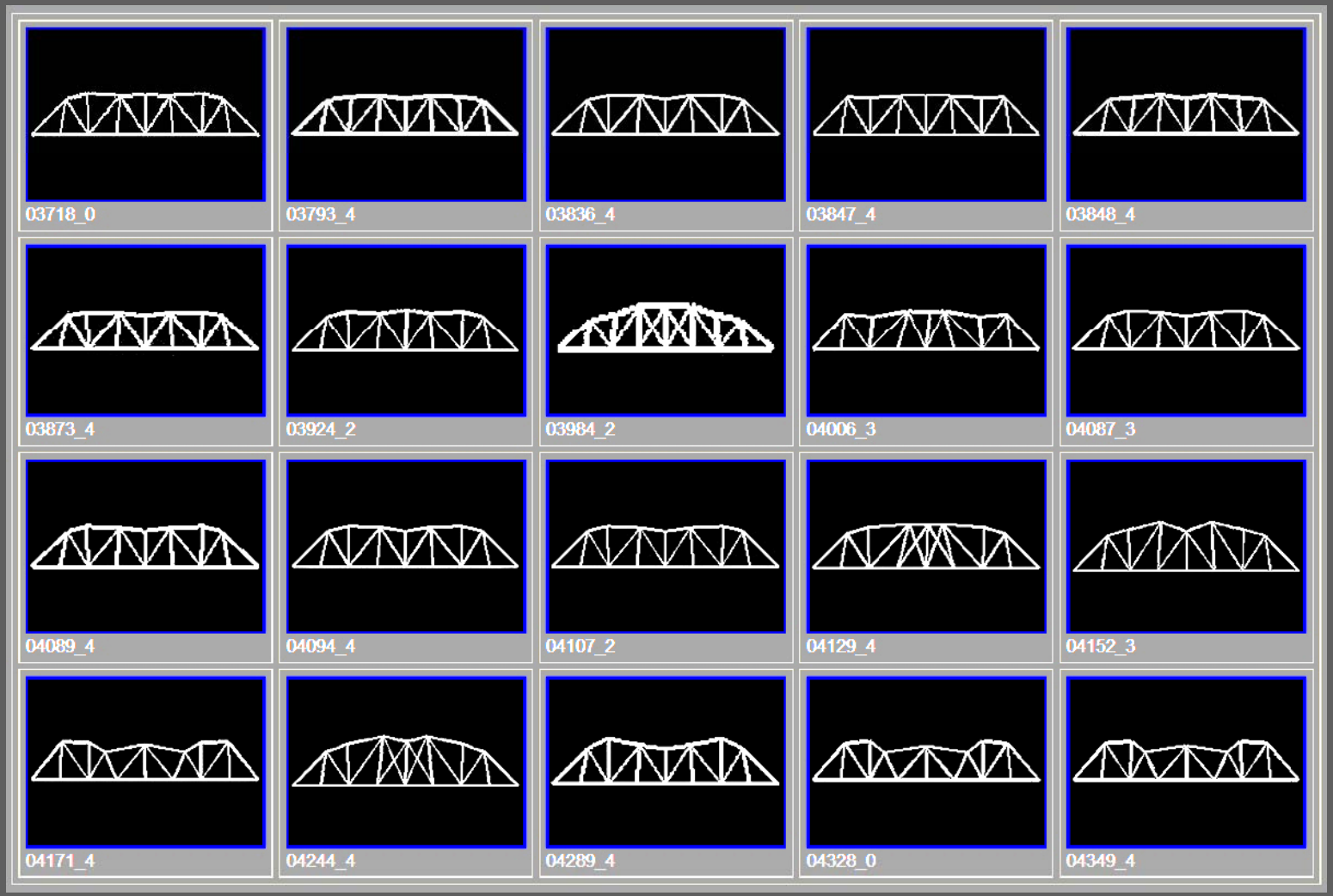
Generation 3



Generation 4



Generation 5



Participants

ARCH 514 – Frame Structures

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