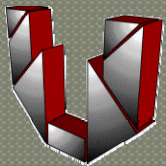


Registering ***Space Requirements*** of Construction Operations Using Site-PECASO (*Part of VIRCON Project*)

Presented by:
Zaki Mallasi



University of
Teesside

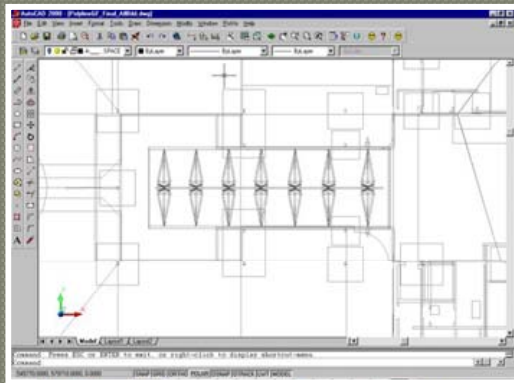
CIB w78 Conference 2002
Aarhus School of Architecture, 12 – 14 June 2002

Presentation Outline

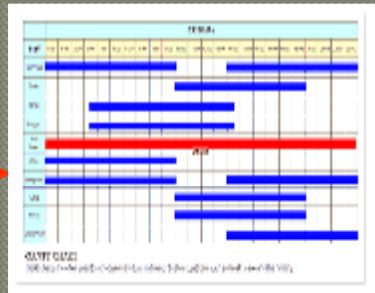
- *Research Motivation and Background*
- *Research Problem*
- *Proposed Research*
- *Site-PECASO Model Architecture*
- *Registering Space Requirements (the concept)*
- *Site-PECASO Simulation (on going)*
- *Conclusion and Future Development*

Motivation and Background

1) On site construction operations shape complex spaces, especially in large projects



CAD Drawings



Project Schedule



Site congestions



Crowded areas



Access blockage



2) On-site Productivity Field Study:

Purpose:

- To **observe** on site work activities.
- To analyse the effect of work activities progress on **space availability**
- To measure **productivity** and performance by activity sampling using CALIBRE tool.
- To understand **space-time** conflicts issues



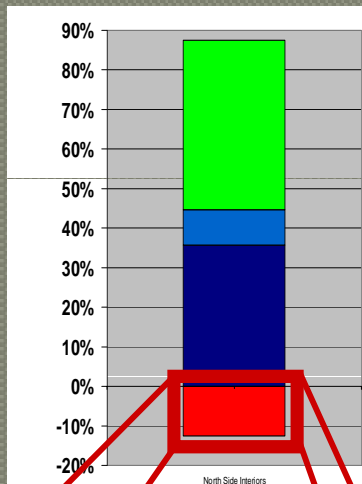
- School of Health
- University of Teesside
- £ 8 million pounds

Findings:

- The study indicated **30%** on average non-productive result.
- Loss of productivity arises from the **interruptions** or **sequencing problems**.
- **Space congestion** occurs due to insufficient information about space in a project schedule.

Productivity Analysis (example 1):

■ A/C duct space obstructing partitioning job

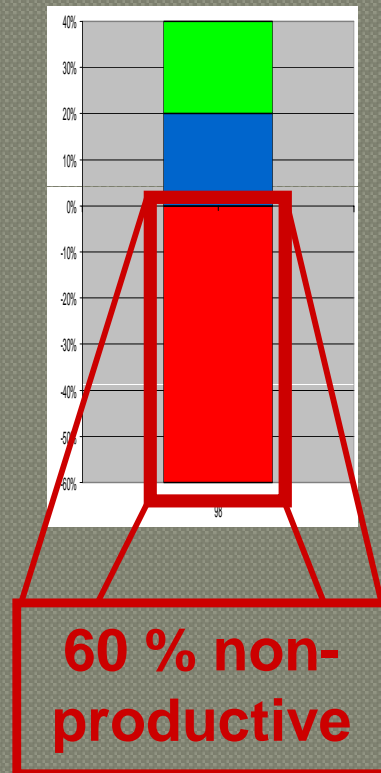


12 % non-productive



Productivity Analysis (example 2):

- **Poor site utilisation causes work interruptions**



3) Review of previous and current state-of-art research in project planning.

4) Influence of Information Technology:

- Recent **4D (3D + time)** technology providing the user with additional project schedule visualisations.
- Advancements in communication tools among a project team that **simulate progress** of construction project.

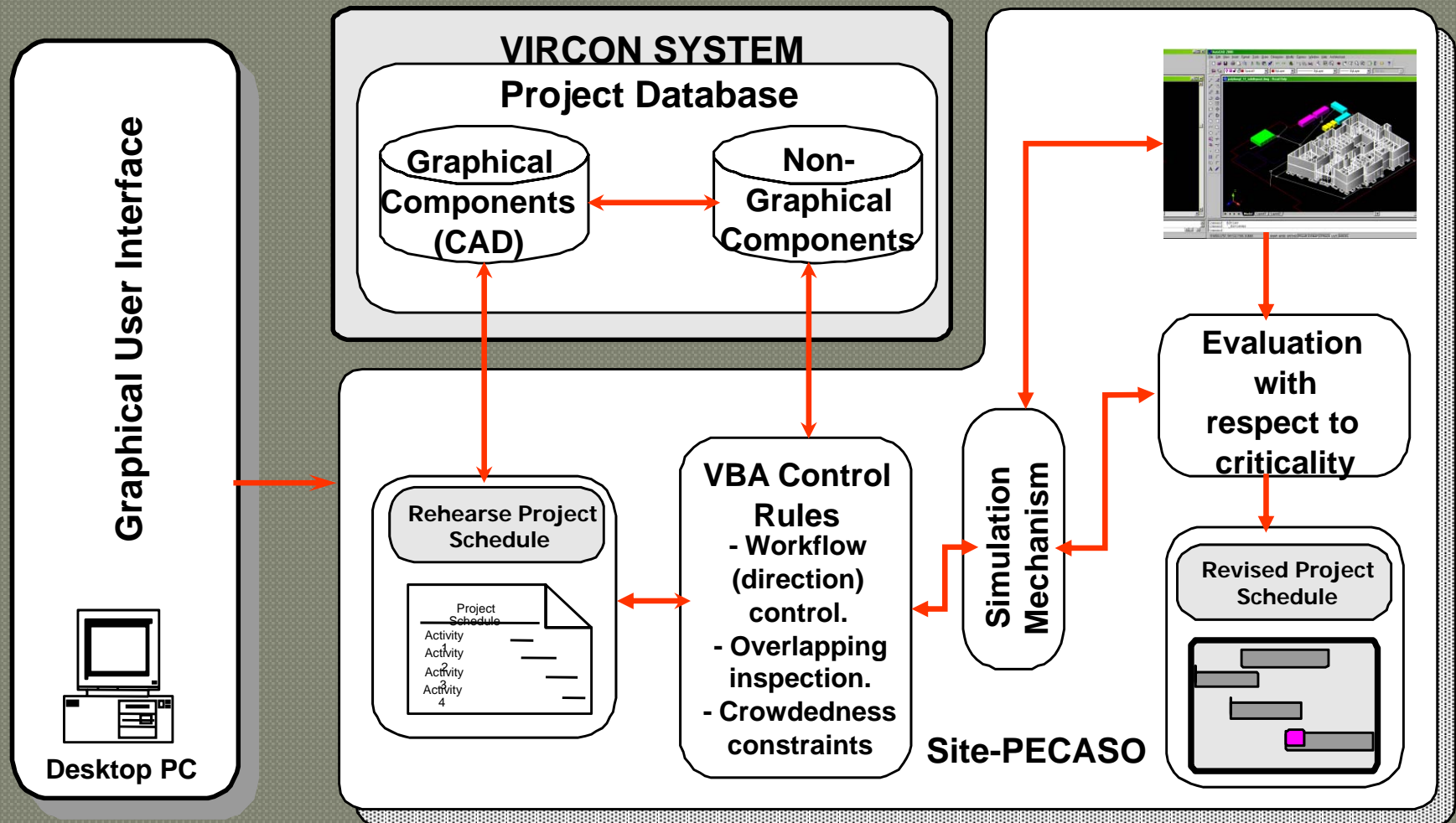
Research Problem

- Current project scheduling tools **lack analysis** of site usage when planning construction operations.
- Some 4D CAD system assess construct-ability, build-ability of design projects, and do not include **Work space**.
- Different approaches among professional on **how to include activity workspace** as in the product model.
- work activities might share the same area at the same time and that produces **insufficient free space**.
- **Space conflicts** do happen on construction sites!

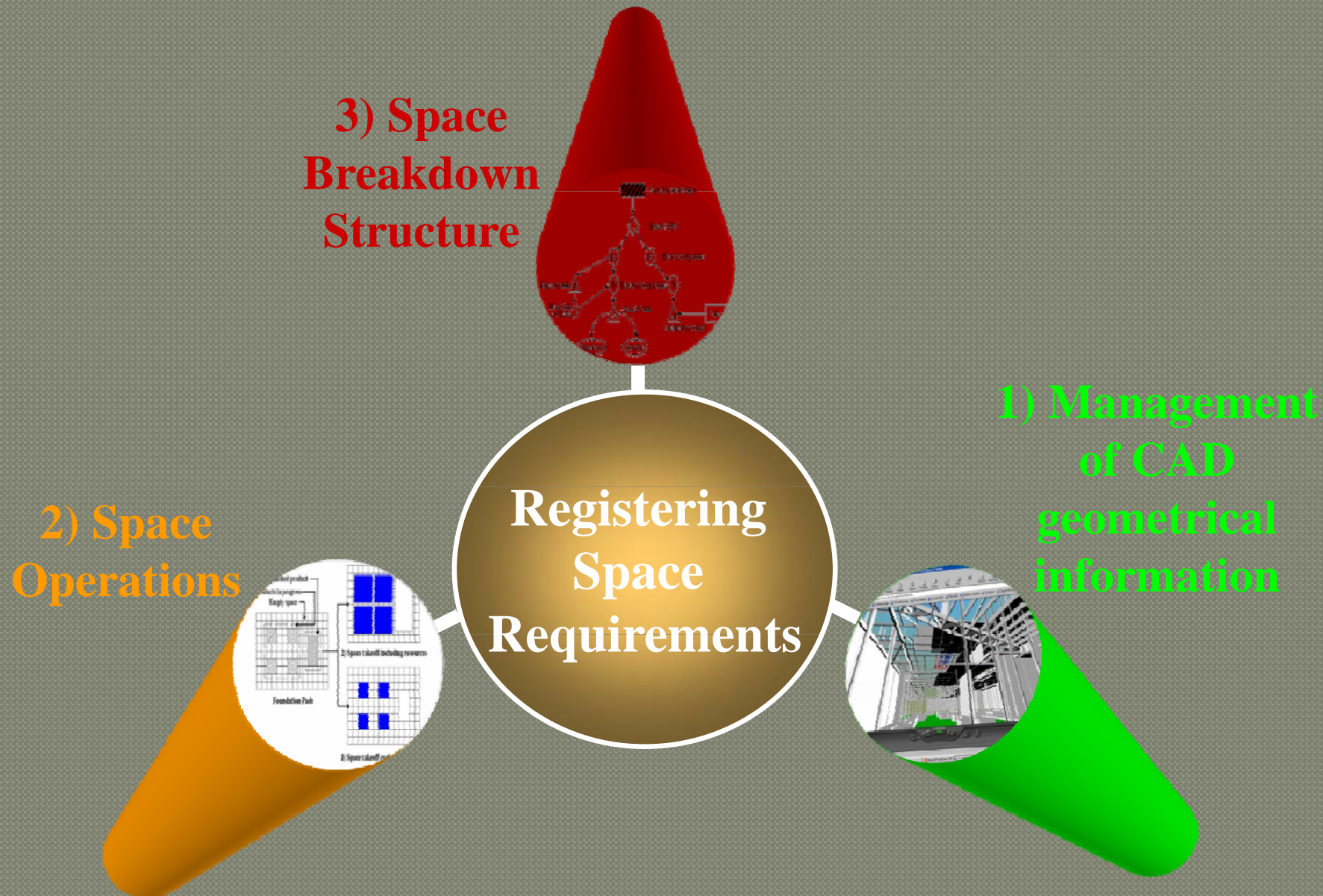
Proposed Research

- Identify and model **work space types**.
- Invest time in **modelling construction activities** to include space-related information.
- Rehearsing different **execution patterns** at a given order might highlights space-time conflicts.
- Produce a **Space Breakdown Structure** model of project activities compatible with project WBS
- **Reduce** space-time conflicts between activities.
- Advise on a **standard methodology** to modelling design projects on CAD and evaluate the system.

Site-PECASO Model Architecture



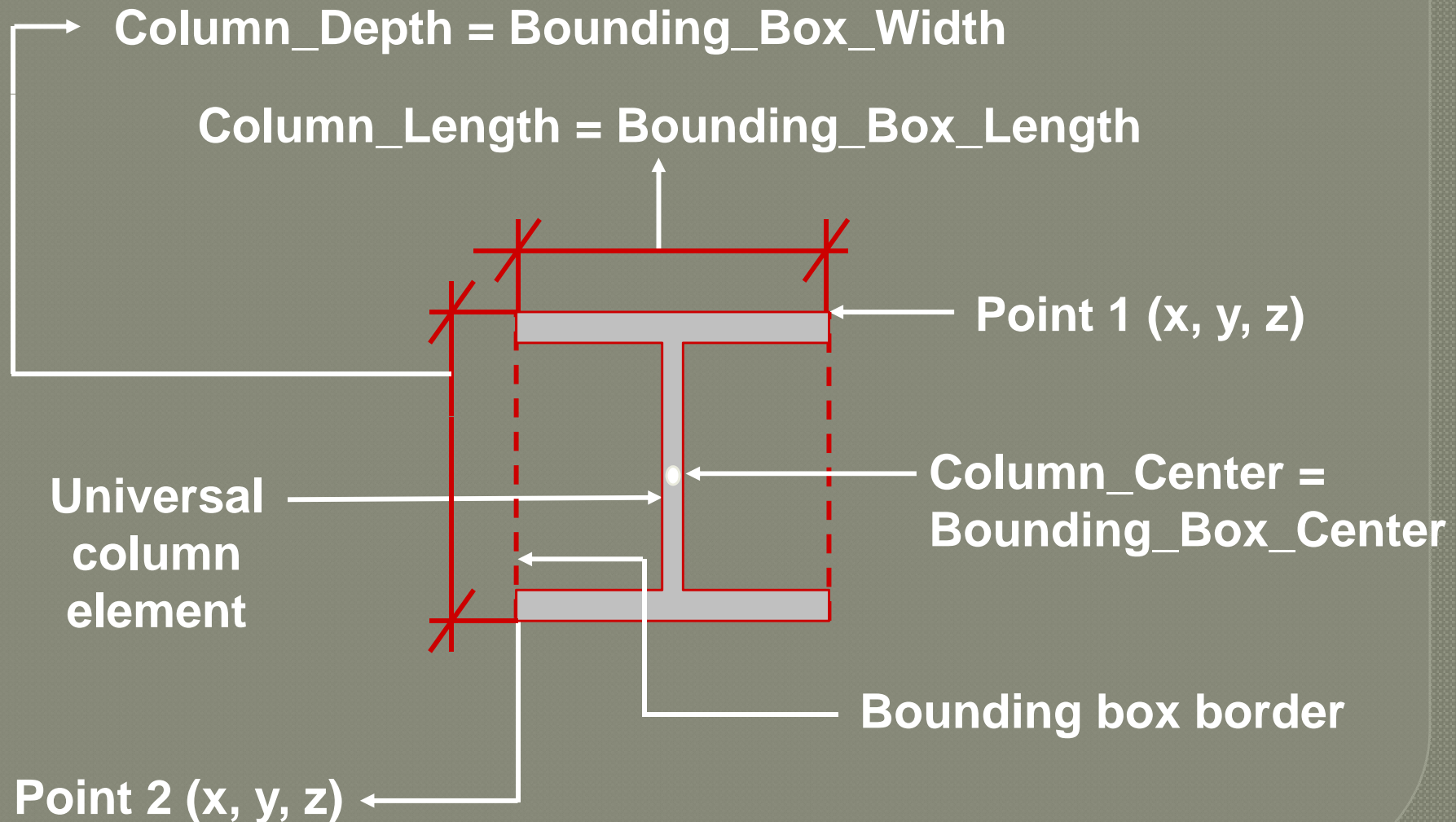
Registering Space Requirements (*development*)



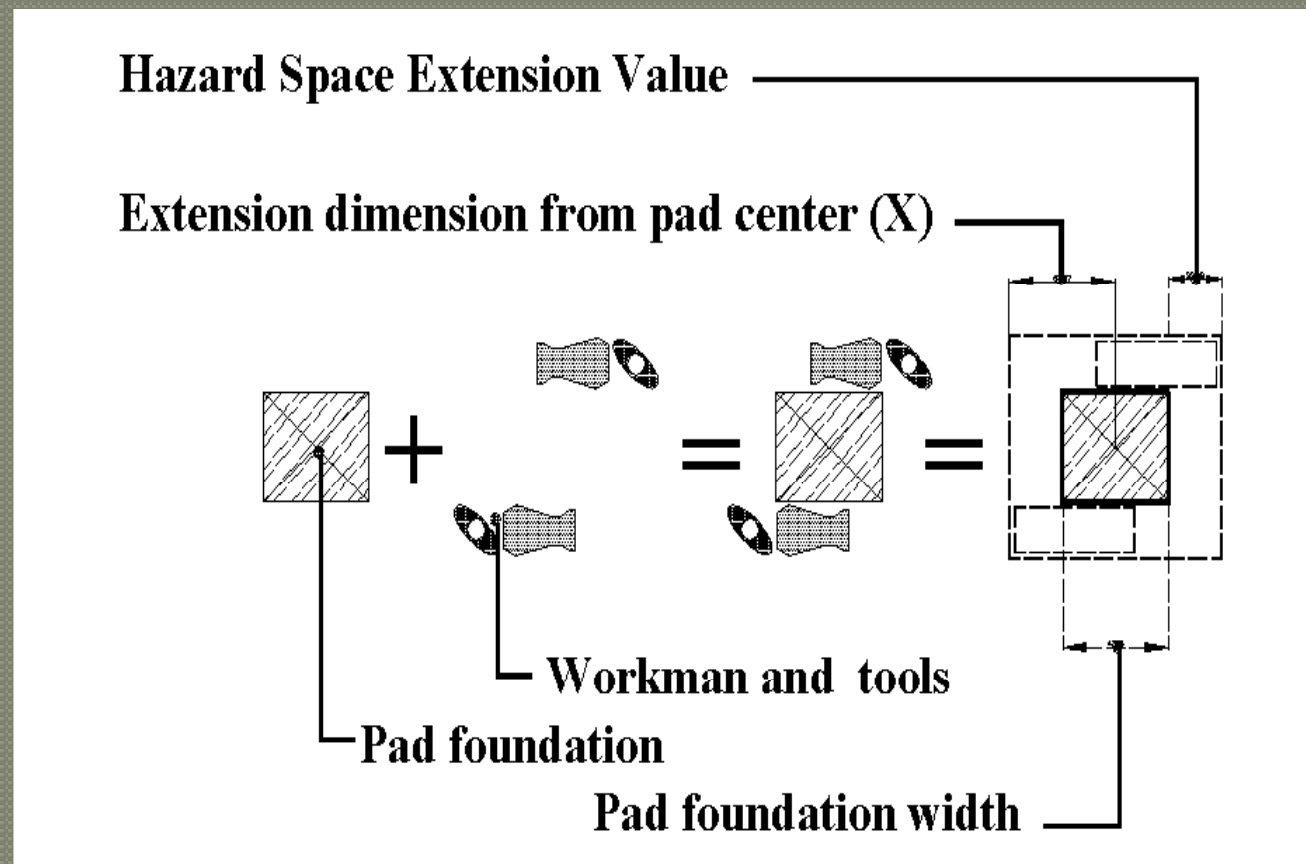
1) Management of CAD geometrical information

- Extraction of **geometrical information** from the CAD model components (location, co-ordinates, dimensions, reference of entities, volumes, areas, etc...) to the database.
- **Structuring of CAD layers** according to standard conventions of British Standards 1192-5 with implementation of Uniclass product/process code.

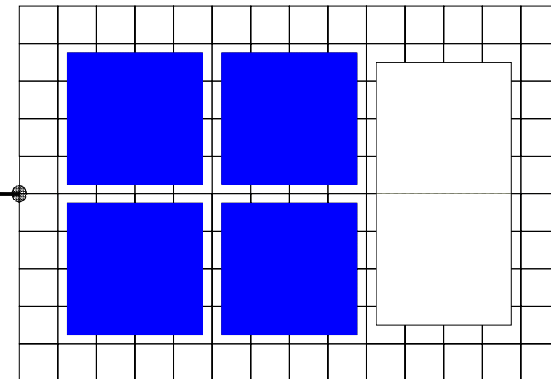
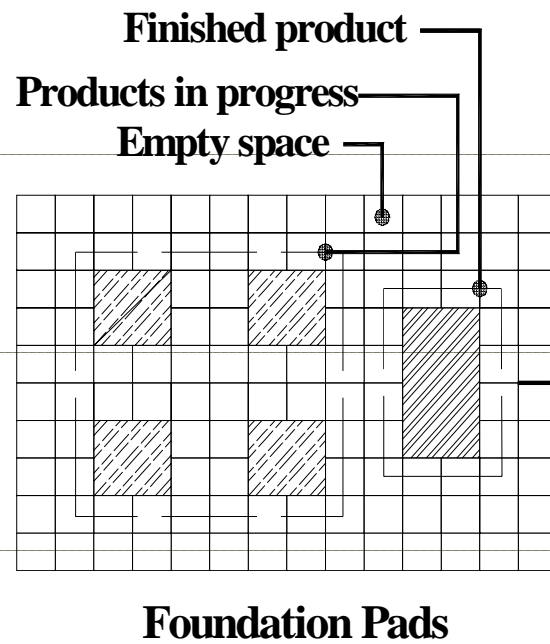
■ Deciding on the proper **3D modelling technique**.



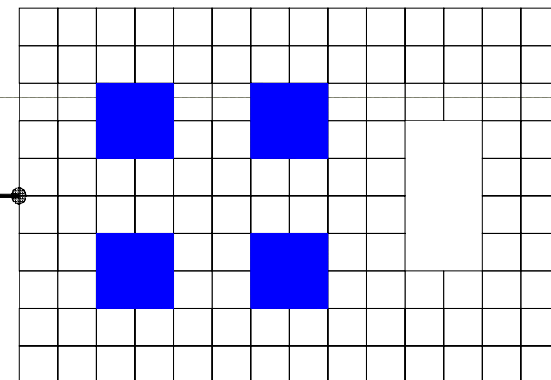
2) Space Operations (VBA routines):



Module 1) Approximation Envelope (AE)
including the hazard space



2) Space takeoff including hazard space

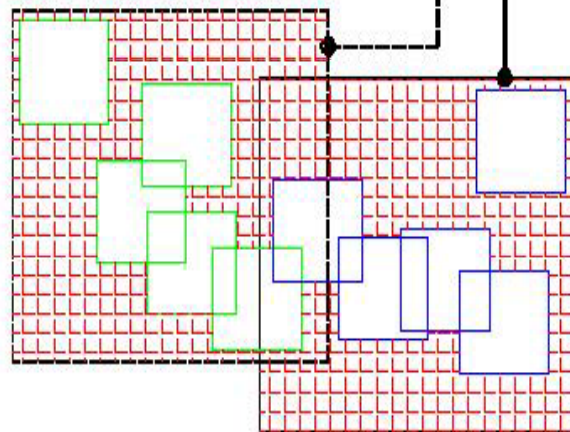


1) Space takeoff excluding hazard space

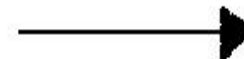
Module 2) Space take-off operation to extract occupied spaces

Activity B Space Takeoff

Activity A Space Takeoff

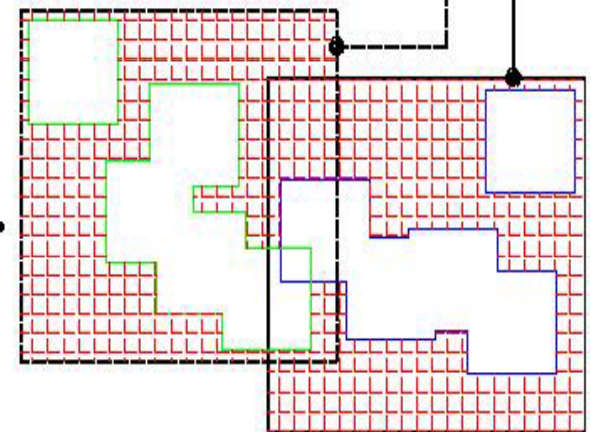


**Space Takeoff for Activities A
and B Before Boolean_Union**



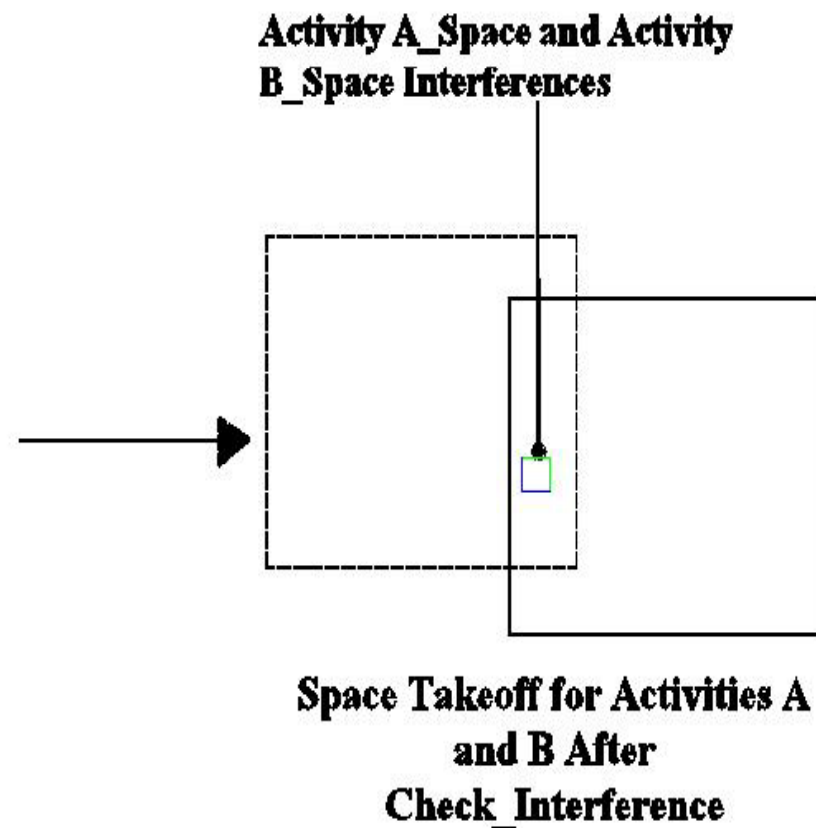
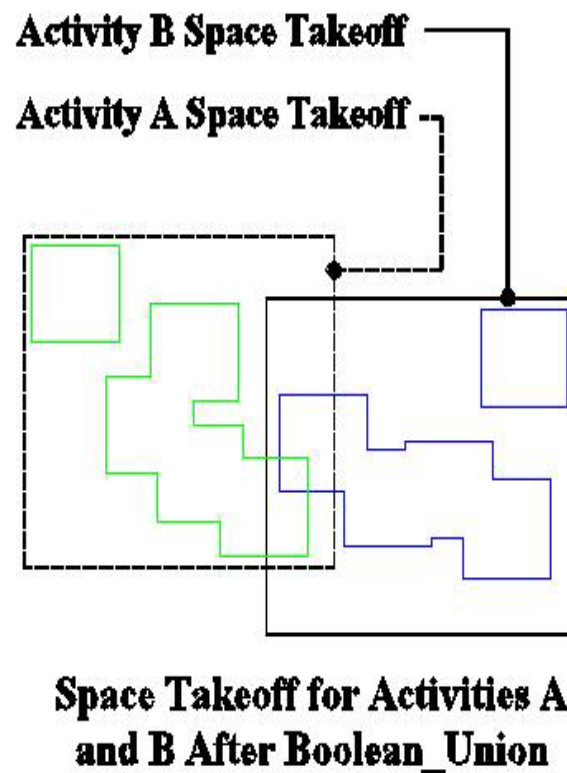
Activity B_Space

Activity A_Space



**Space Takeoff for Activities A
and B After Boolean_Union**




Module 3) Boolean_Union space operation

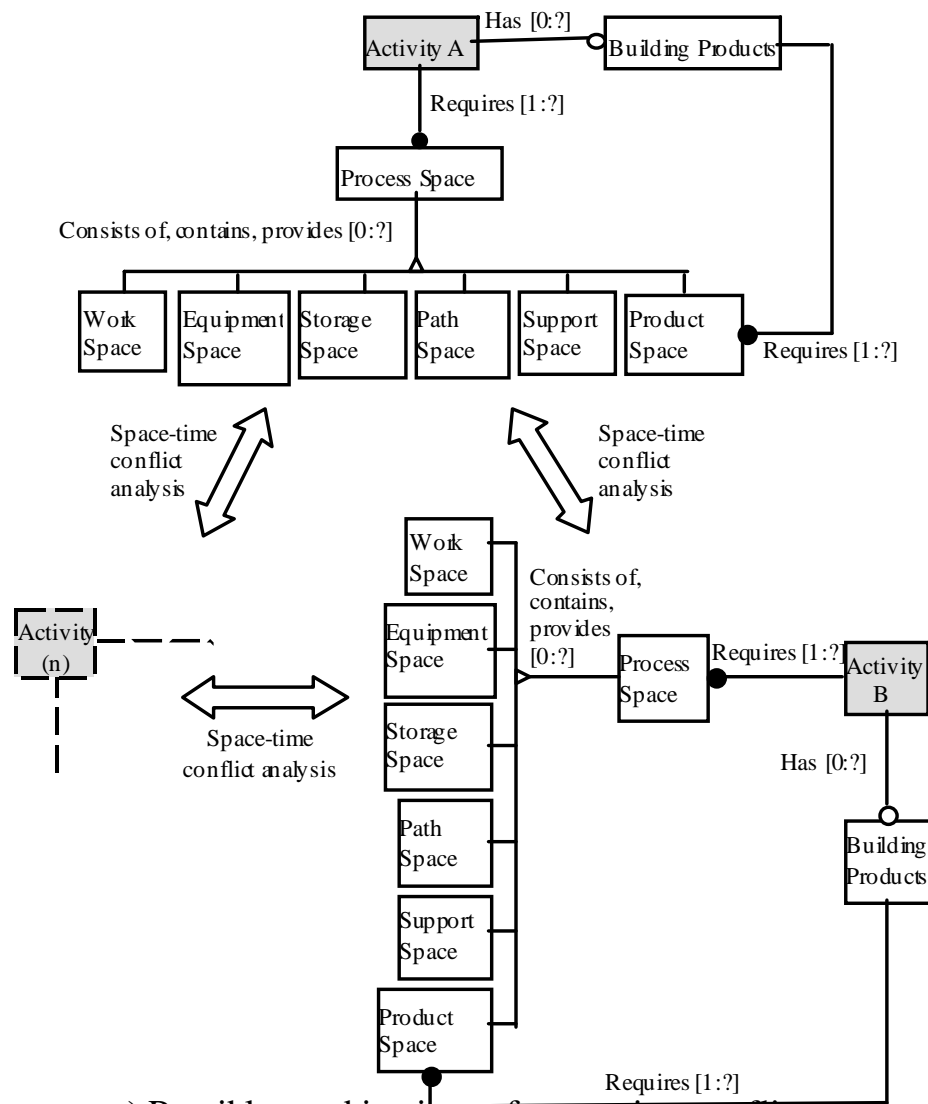


Module 4) Check_Interference space operation

3) *Space Breakdown Structure*

- Implements a hierarchical arrangements of 3D CAD components and layers in a way compatible with WBS.

	Week (X1)	Week (X)	Week (X +1)
Activity A			
Activity B			
Activity (n)			



a) Possible combinations of space-time conflicts between activities A and B in the product CAD model in week X

	Activity A	Activity B	Activity (n)
Activity A	No Conflict	Conflict	Conflict
Activity B		No Conflict	Conflict
Activity (n)			No Conflict

Activity A -B Space Conflicts							
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		0.0	0.0	0.0	0.0	0.0	0.0
			0.0	0.0	0.0	0.0	0.0
				0.0	0.0	0.0	0.0
					0.0	0.0	0.0
						0.0	0.0
							0.0

[Source: Akinici et. al., 2000]

- ⌚ = No Space Interference

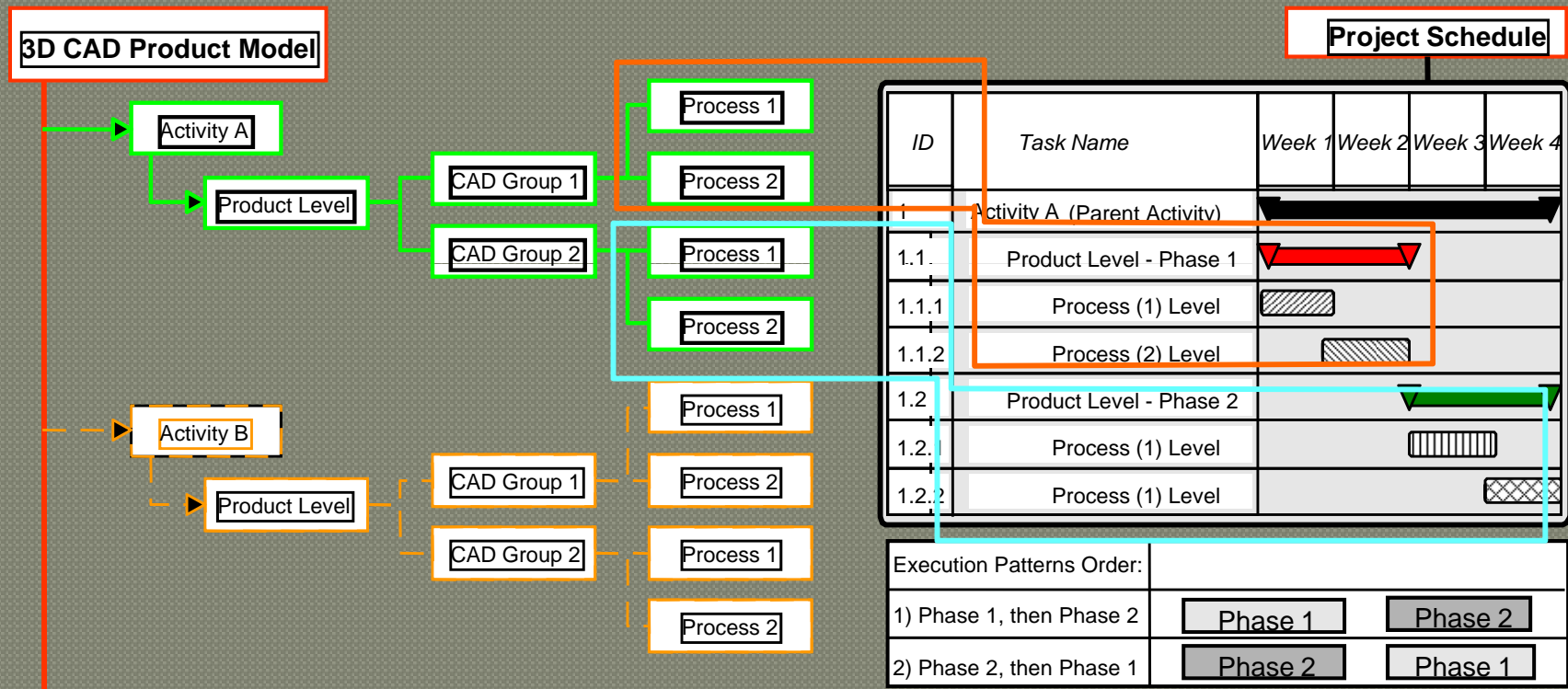
-  = Space Interference

Conflict Details:

- Severe Congestion
- Safety Hazard
- No Impact
- Space Obstruction
- Congestion
- Work Interruption
- Severe Damage

Space_Types Hierarchy and Space Conflict Taxonomy

Site-PECASO Simulation *(on going)*



Example One (Execution Pattern Run)

Site-PECASO

Simulation Input | Products Simulation | Space Visualisation | Space Report

1) Project Tasks Summary

In situ concrete pad and strip
In situ concrete pad and strip
Structural steel columns framing
In situ ground slab
Structural steel beam framing

☐ West-East ☒ East-West
☐ South-North

Add Simulation Input to Database

3) Quantity of Work

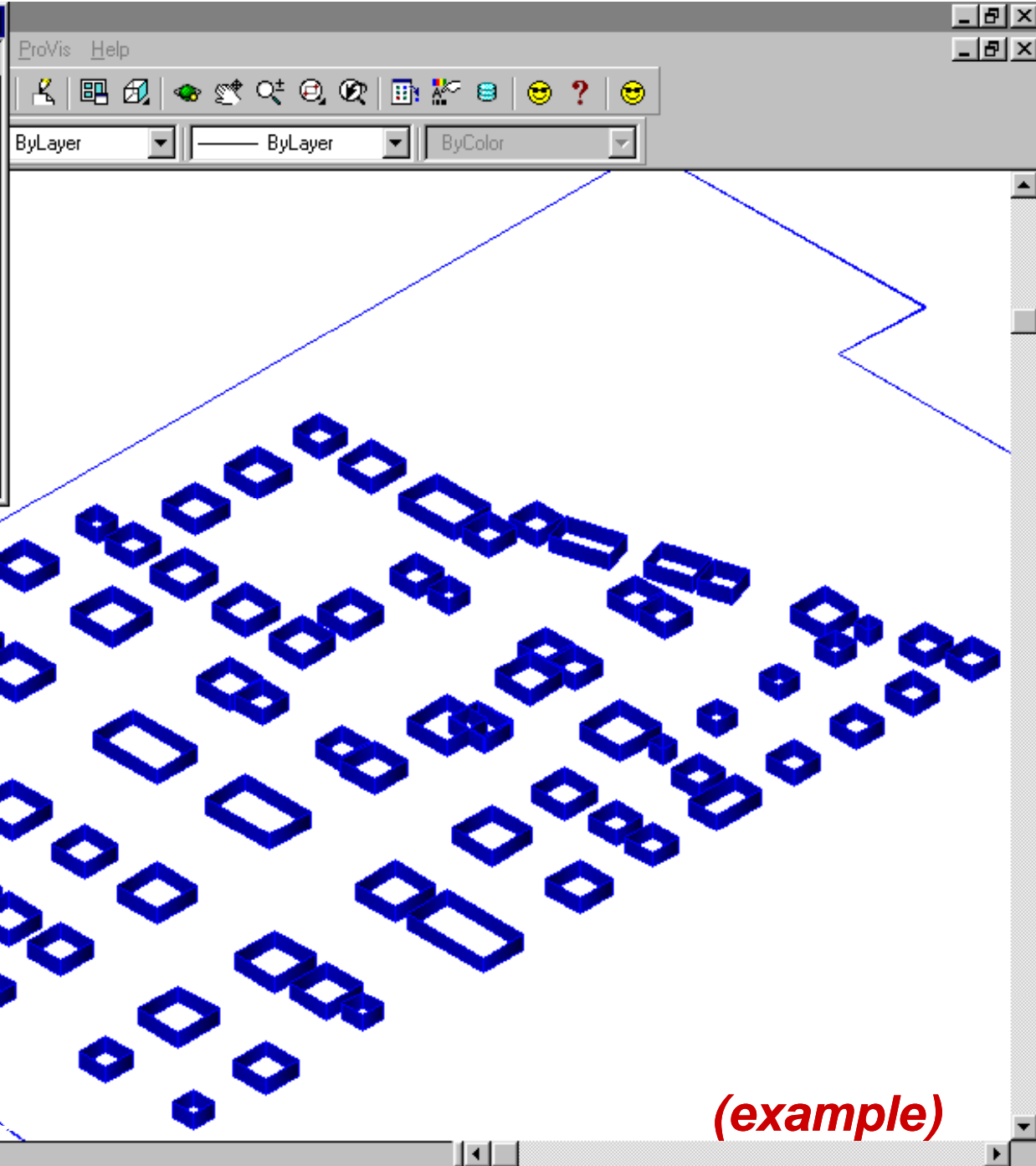
Productivity Index Value (PI)
1

Total Quantity of Work (m2/w)
471.6938

Quantity of products per week
86.89097

4) Add Space Types

Start



Command: *Cancel*

Command:

-2726.3660, 540214.3694, 0.0000

SNAP GRID ORTHO POLAR OSNAP OTRACK LWT MODEL

Start

Explorin... Window... Explorin...

pecaso...

shots.ppt

AutoC...

Microso...

02:36

Site-PECASO

Simulation Input | Products Simulation | Space Visualisation | Space Report

1) Project Tasks Summary

In situ concrete pad and strip

2) Work Direction

☐ North-South

☐ West-East ☒ East-West ☐ South-North

Add Simulation Input to Database

3) Quantity of Work

Productivity Index Value (PI)

1

Total Quantity of Work (m2/w)

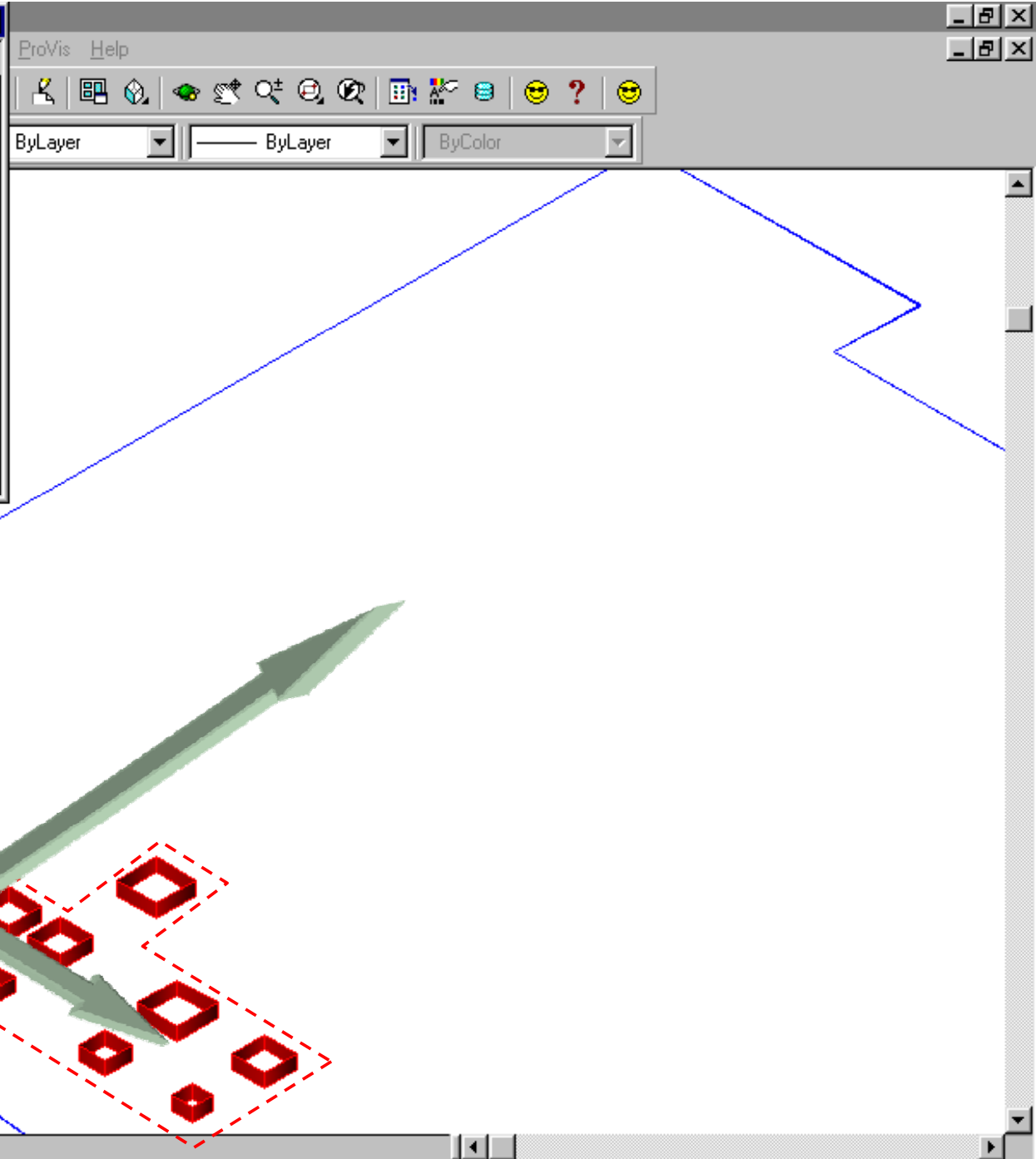
471.6938

Quantity of products per week

86.89097

4) Add Space Types

Start



Command: Regenerating model.

Command:

540775.6524, 542934.8447, 0.0000

SNAP GRID ORTHO POLAR OSNAP OTRACK LWT MODEL

Start

Explorin... Window... Explorin...

pecaso...

shots.ppt

AutoC...

Microso...

02:22

Site-PECASO

Simulation Input | Products Simulation | Space Visualisation | Space Report

1) Project Tasks Summary

In situ concrete pad and strip

2) Work Direction

☐ North-South

☐ West-East ☒ East-West ☐ South-North

Add Simulation Input to Database

3) Quantity of Work

Productivity Index Value (PI)

1

Total Quantity of Work (m2/w)

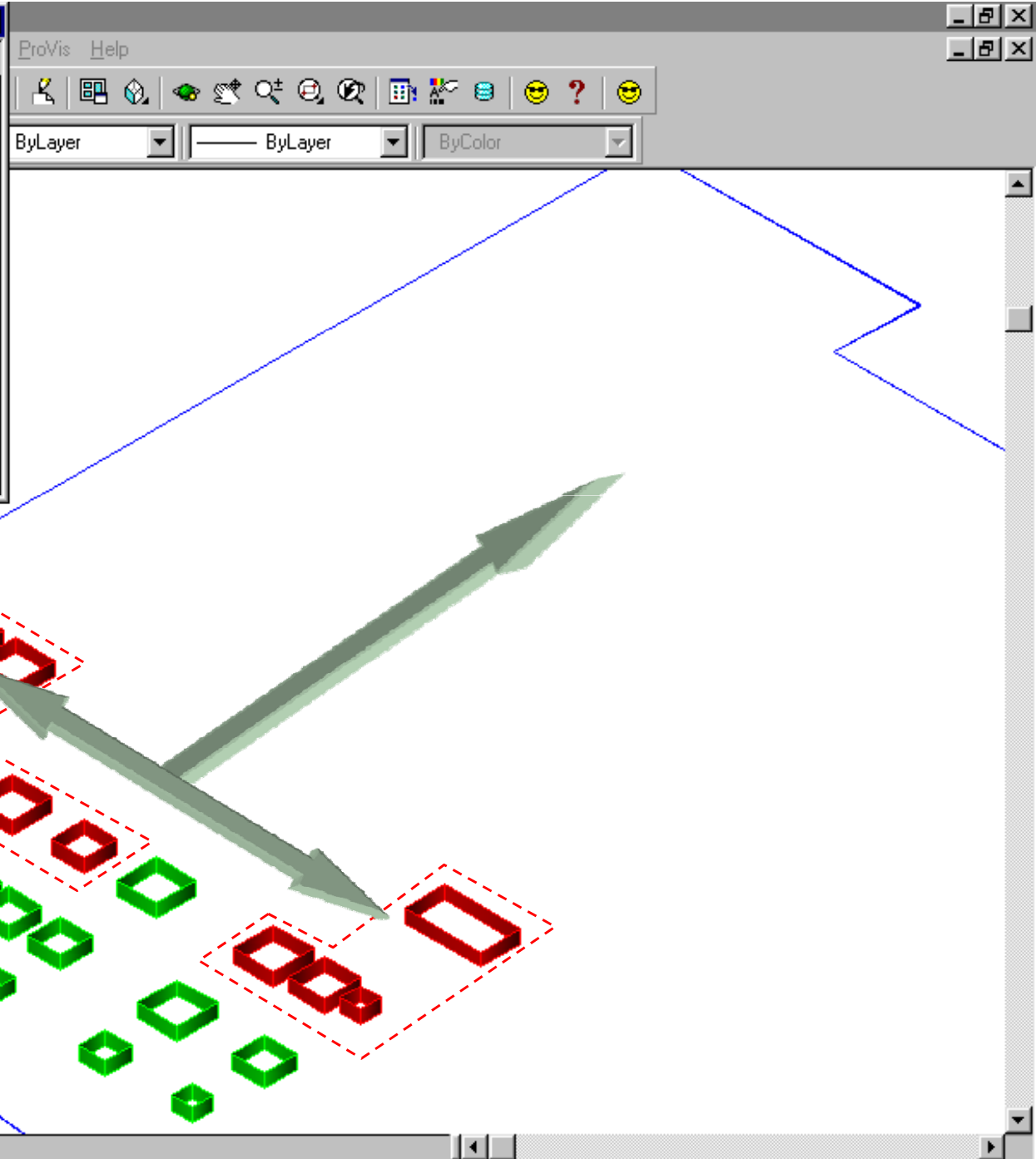
471.6938

Quantity of products per week

86.89097

4) Add Space Types

Start



Command: Regenerating model.

Command:

540775.6524, 542934.8447, 0.0000

SNAP GRID ORTHO POLAR OSNAP OTRACK LWT MODEL

Site-PECASO

Simulation Input | Products Simulation | Space Visualisation | Space Report

1) Project Tasks Summary

In situ concrete pad and strip

2) Work Direction

☒ North-South

☐ West-East

☐ East-West

☐ South-North

Add Simulation Input to Database

3) Quantity of Work

Productivity Index Value (PI)

1

Total Quantity of Work (m2/w)

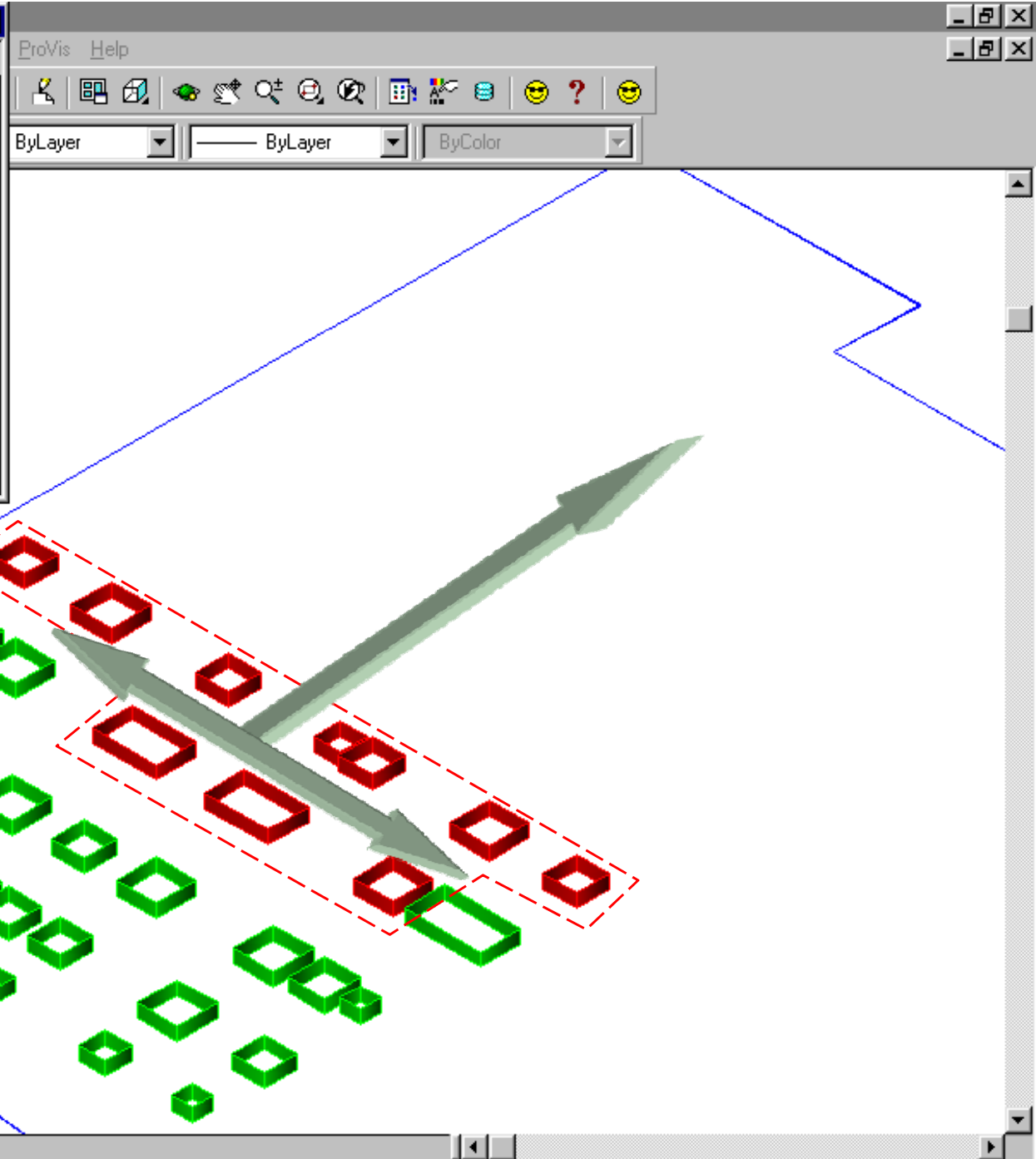
471.6938

Quantity of products per week

86.89097

4) Add Space Types

Start



Command: Regenerating model.

Command:

14115.9532, 532349.5177, 0.0000

SNAP GRID ORTHO POLAR OSNAP OTRACK LWT MODEL

Start

Explorin... Window... Explorin...

pecaso...

shots.ppt

AutoC...

Microso...

02:27

Site-PECASO

Simulation Input | Products Simulation | Space Visualisation | Space Report

1) Project Tasks Summary

In situ concrete pad and strip

2) Work Direction

☐ North-South

☐ West-East ☒ East-West ☐ South-North

Add Simulation Input to Database

3) Quantity of Work

Productivity Index Value (PI)

1

Total Quantity of Work (m2/w)

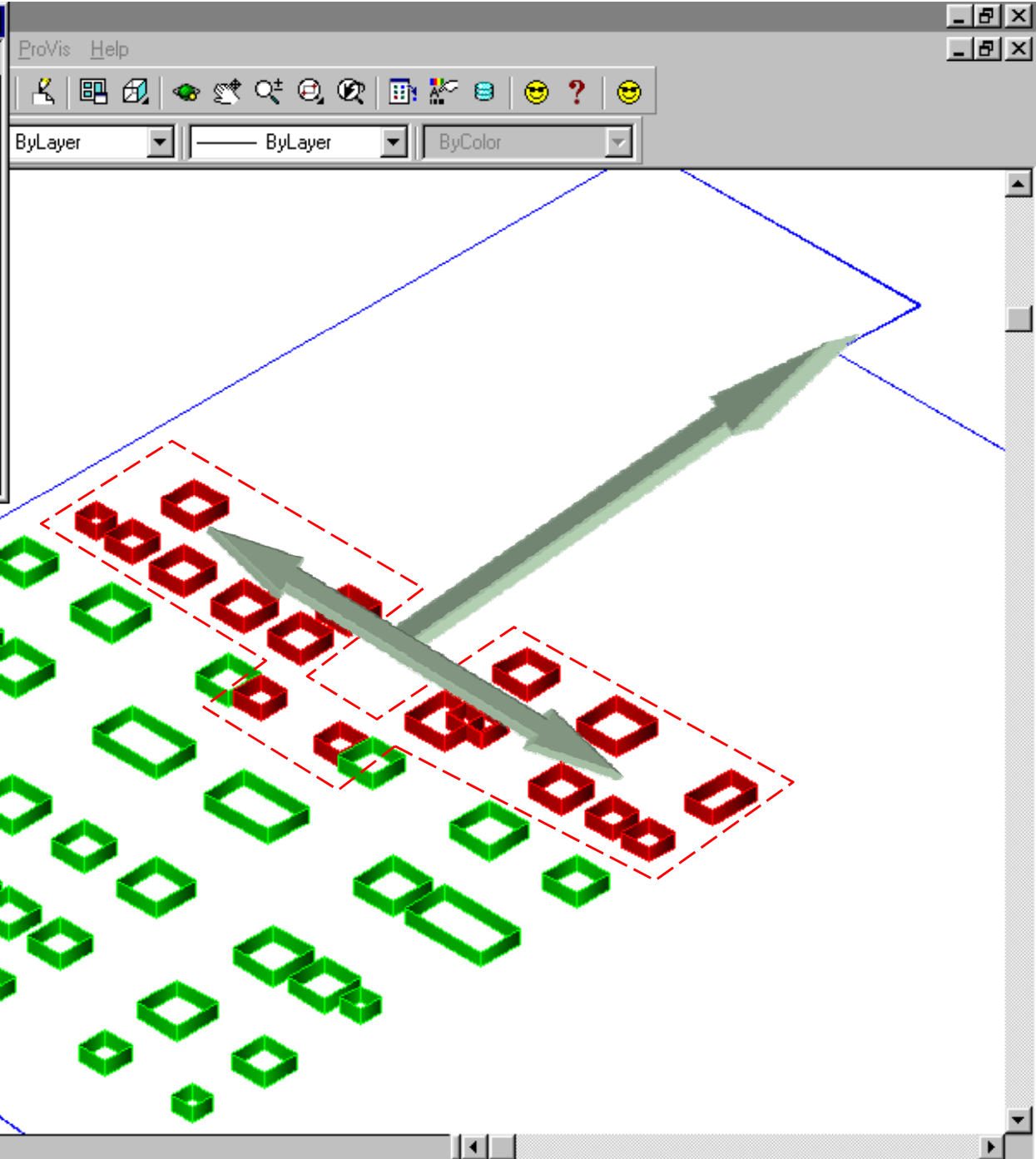
471.6938

Quantity of products per week

86.89097

4) Add Space Types

Start



Command: Regenerating model.

Command:

14115.9532, 532349.5177, 0.0000

SNAP GRID ORTHO POLAR OSNAP OTRACK LWT MODEL

Start

Explorin... Window... Explorin...

pecaso...

shots.ppt

AutoC...

Microso...

02:29

Site-PECASO

Simulation Input | Products Simulation | Space Visualisation | Space Report

1) Project Tasks Summary

In situ concrete pad and strip

2) Work Direction

☒ North-South

☐ West-East ☐ East-West

☐ South-North

Add Simulation Input to Database

3) Quantity of Work

Productivity Index Value (PI)

1

Total Quantity of Work (m2/w)

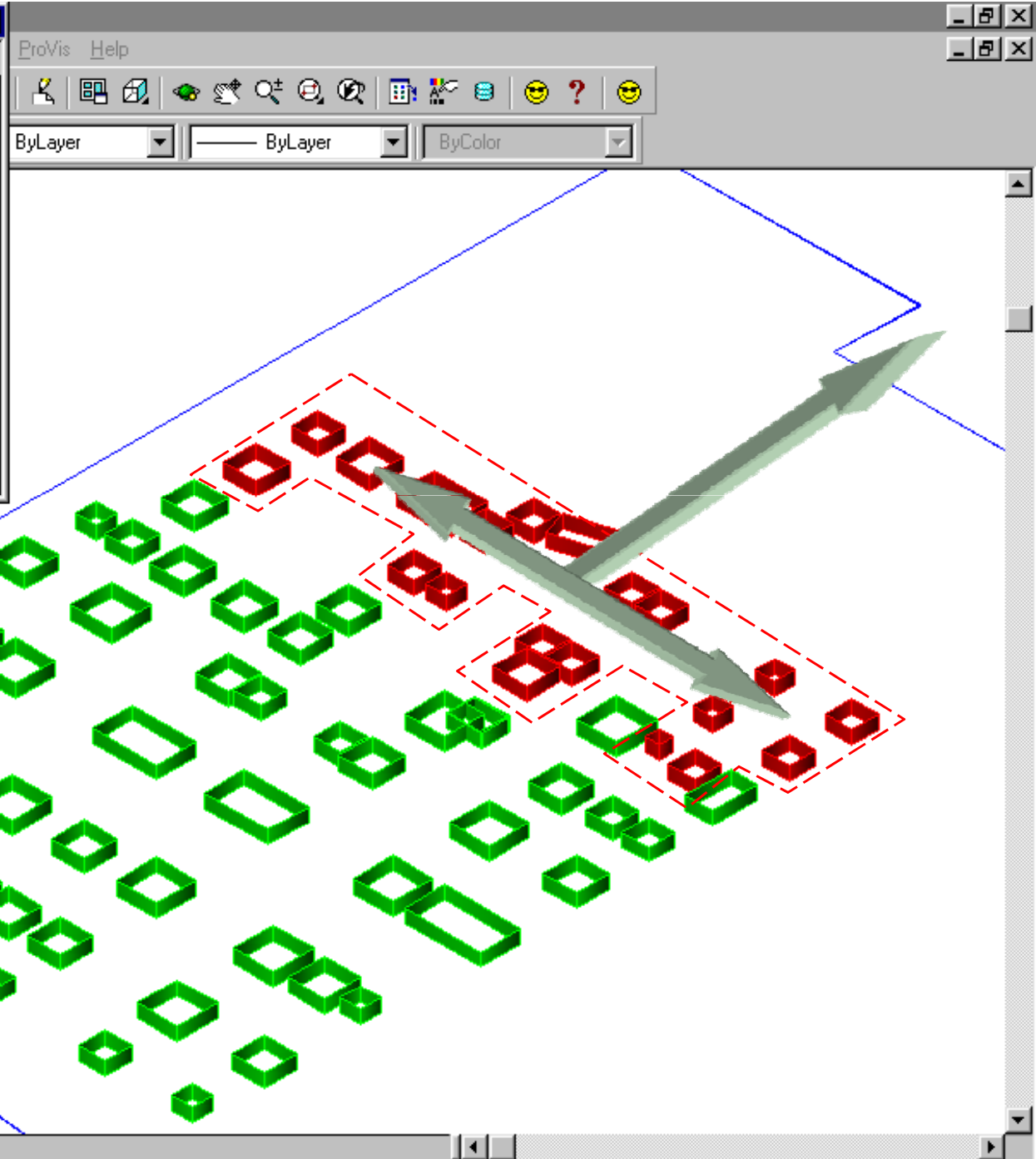
471.6938

Quantity of products per week

86.89097

4) Add Space Types

Start



Command: Regenerating model.

Command:

14115.9532, 532349.5177, 0.0000

SNAP GRID ORTHO POLAR OSNAP OTRACK LWT MODEL

Site-PECASO

Simulation Input | Products Simulation | Space Visualisation | Space Report

1) Project Tasks Summary

In situ concrete pad and strip

2) Work Direction

☒ North-South

☐ West-East ☐ East-West

☐ South-North

Add Simulation Input to Database

3) Quantity of Work

Productivity Index Value (PI)

1

Total Quantity of Work (m2/w)

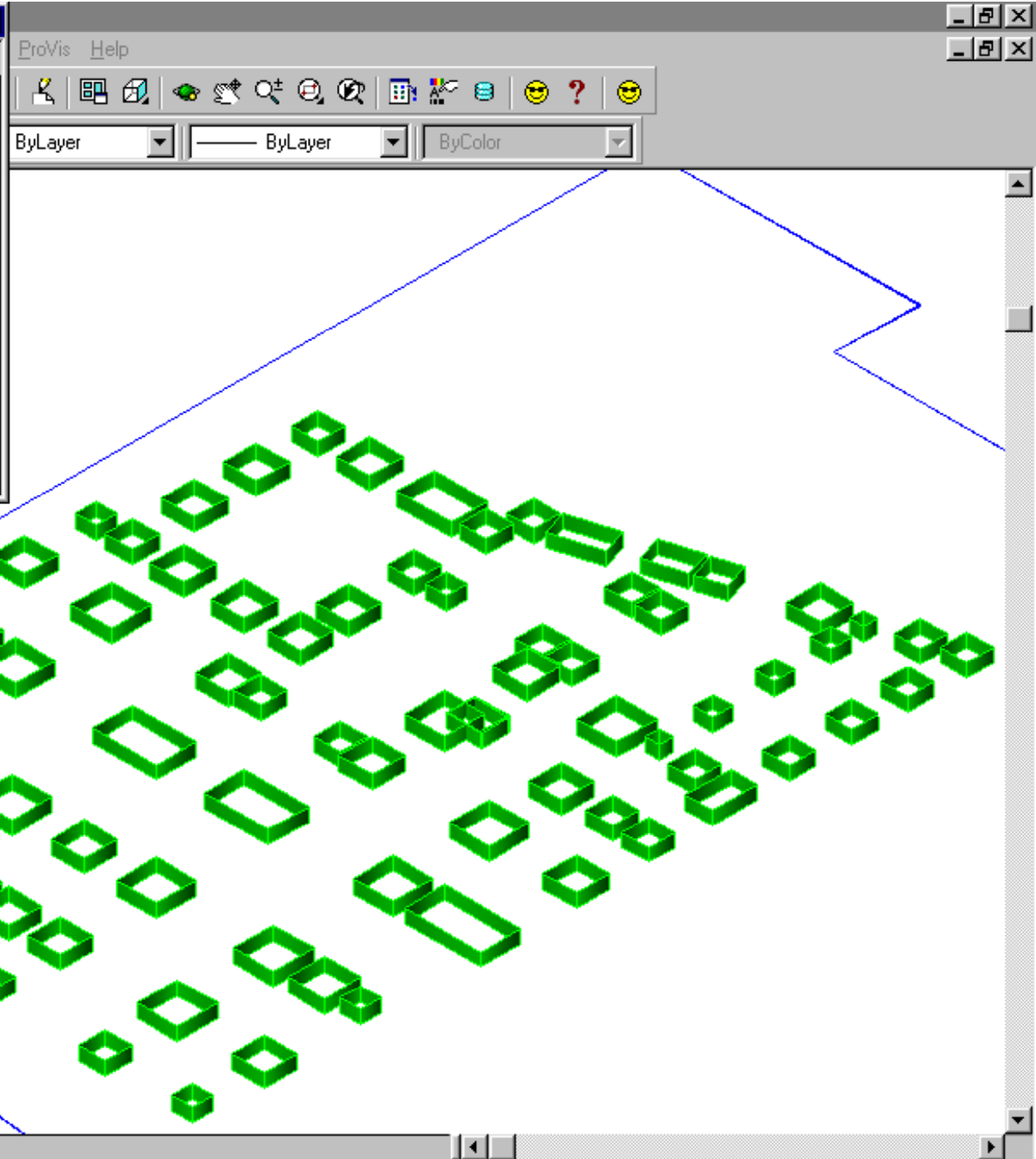
471.6938

Quantity of products per week

86.89097

4) Add Space Types

Start



Command: Regenerating model.

Command:

14115.9532, 532349.5177, 0.0000

SNAP GRID ORTHO POLAR OSNAP OTRACK LWT MODEL

Start

Explorin... Window... Explorin...

pecaso...

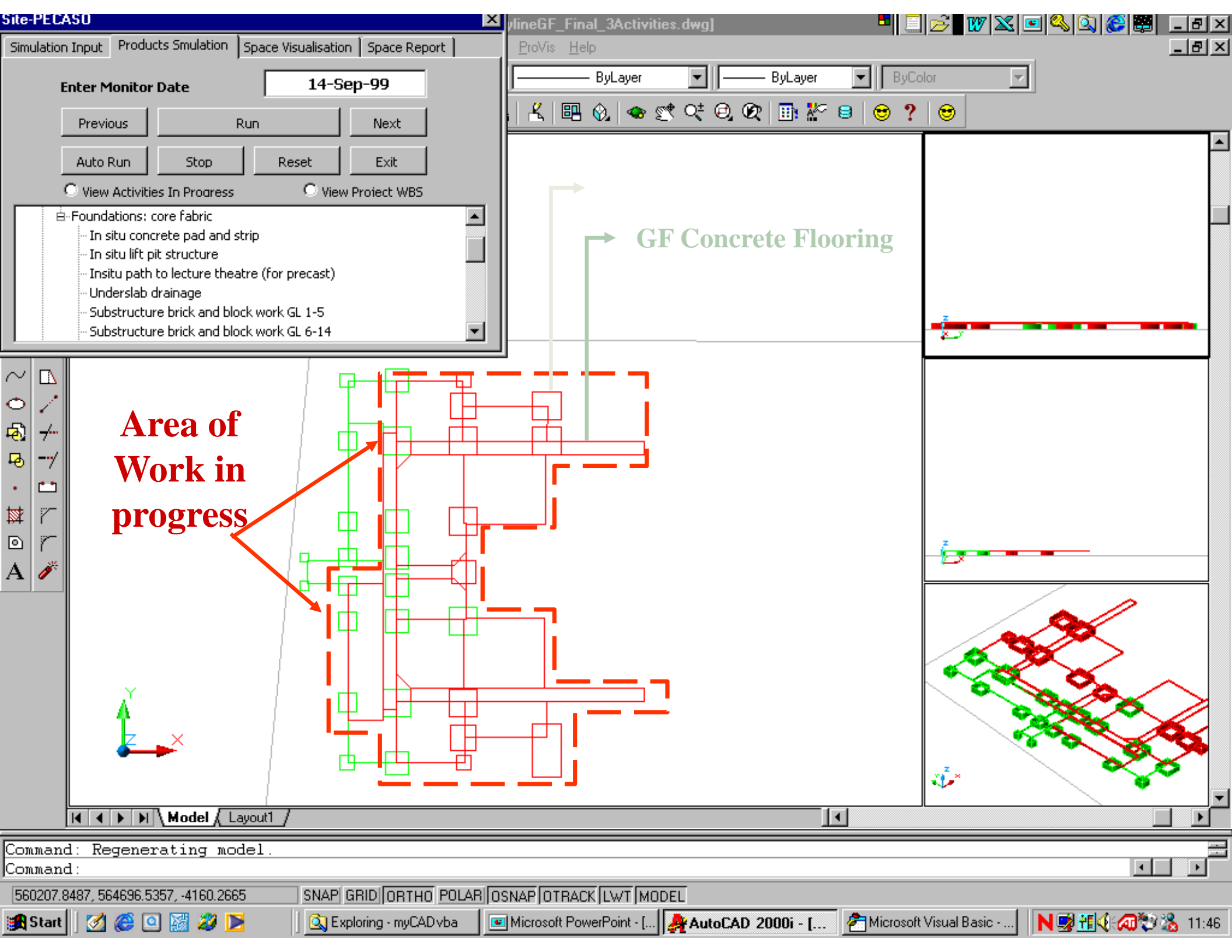
shots.ppt

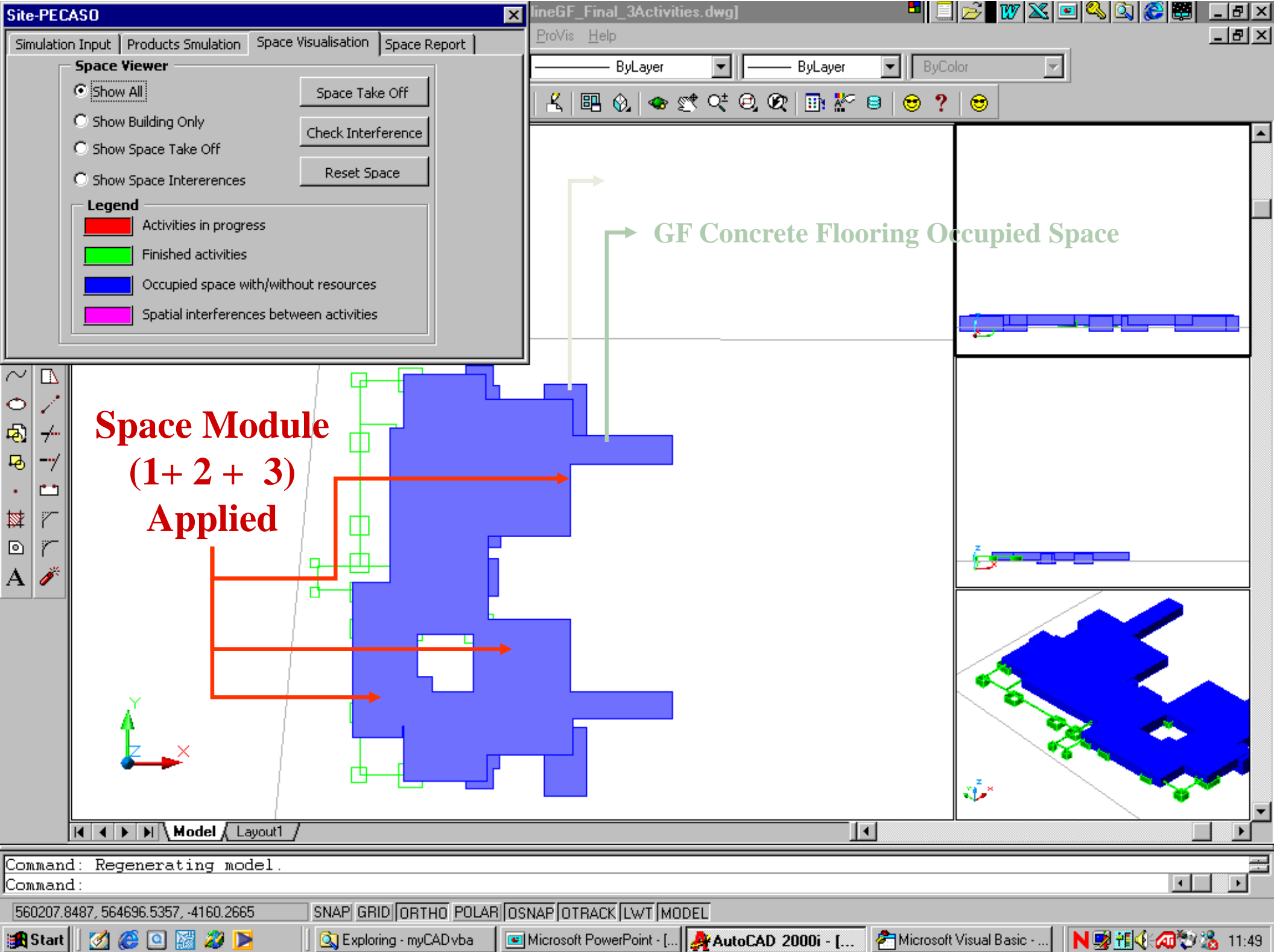
AutoC...

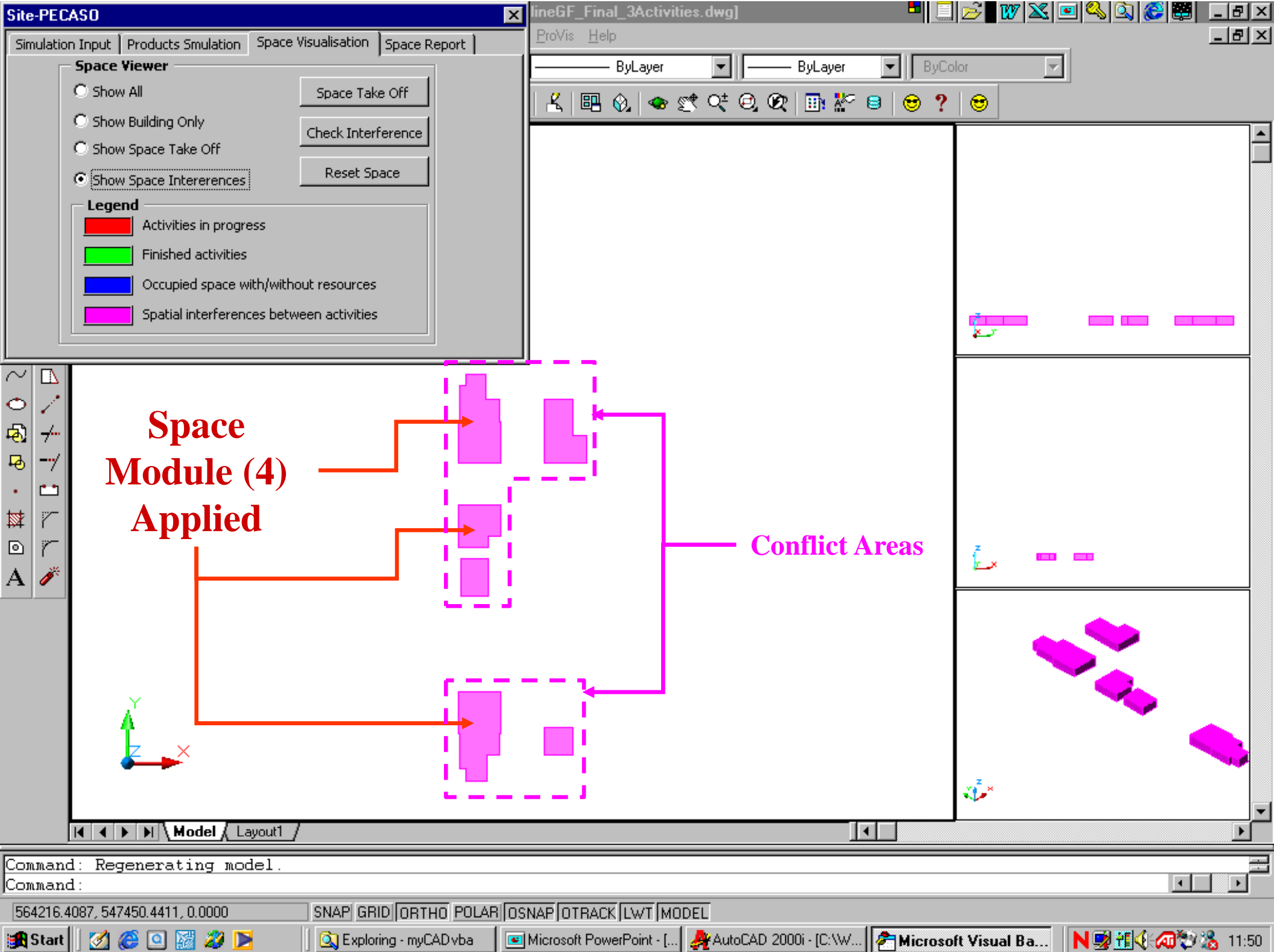
Microso...

02:34

Example Two (Space Conflicts Run)







Conclusion and Future Development

- Simplifying 4D CAD modelling techniques due to some complexity of the spatial properties in construction operations.
- Space-time conflicts can be highlighted in early stages before construction commences on site.
- CAD product-based models can be utilised in Site-PECASO to simulate construction execution patterns.
- *Promising future for using 4D CAD project scheduling tools and visualisations.*

THANK YOU