

Complexity, Design, Q-analysis, Science, Life & Everything

in ~~ten~~ minutes

5

Jeffrey Johnson

Department of Design and Innovation

The Open University - UK

Complexity

Complexity – nobody knows what it is!

Complexity – nobody knows what it is!

but everyone knows about

self-organising systems

evolutionary & cooperative processes

emergence

networks & distributed control

scaling effects

Complexity – nobody knows what it is!

but everyone knows about

self-organising systems

evolutionary & cooperative processes

emergence

networks & distributed control

scaling effects



Design

Design – everybody knows what that is!

the act of working out the form of something (as by making a sketch or outline or plan);

www.cogsci.princeton.edu/cgi-bin/webwn2.1

BUSINESS

PUBLIC SECTOR

LEARNING & EDUCATION

ABOUT DESIGN

OUR EVENTS

CASE STUDIES

OUR PUBLICATIONS

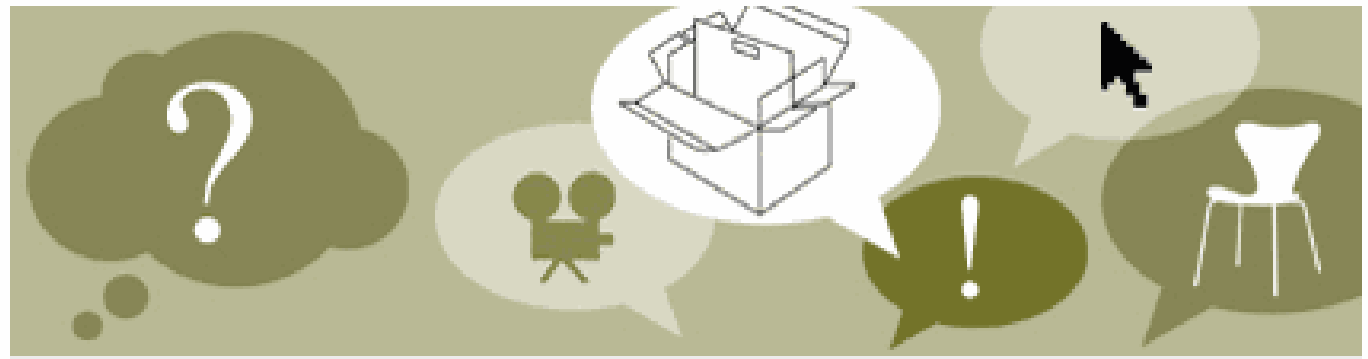
USEFUL ORGANISATIONS

NEWSROOM

ABOUT US & OUR WORK

REGISTER FOR OUR
BULLETIN

FEEDBACK



What is Design

Design is everywhere – and that's why looking for a definition may not help you to grasp what it is

Design is everywhere. It's what drew you to the last piece of furniture you bought and it's what made online banking possible. It's made London taxi cabs easier to get in and out of and it made Stella McCartney's name. It's driving whole business cultures and making sure environments from hospitals to airports are easier to navigate.

Why is CAD lousy for sketching & early stages of design?

Why is CAD lousy for sketching & early stages of design?

☞ computer representation not rich enough!

Why is CAD lousy for sketching & early stages of design?

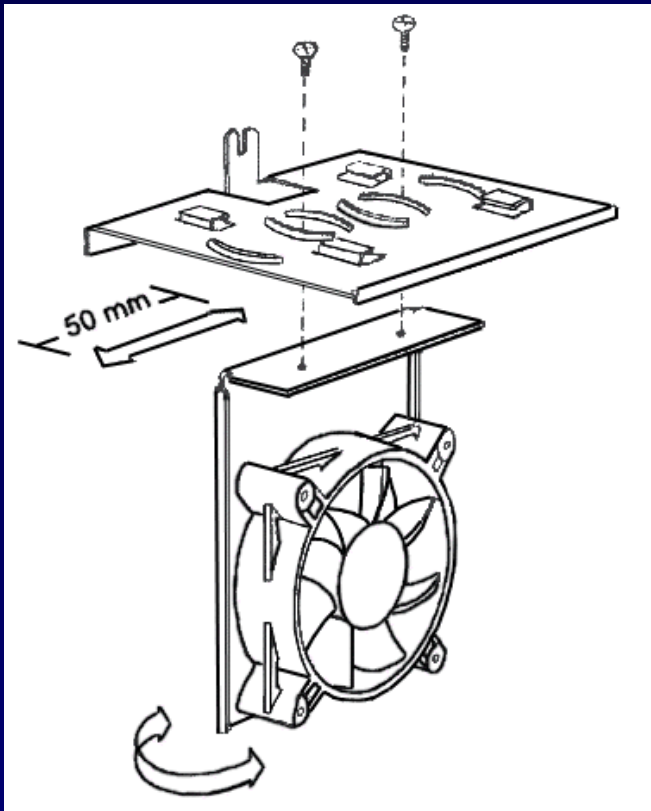
☞ computer representation not rich enough!

☞ geometry and arithmetic are great
... but design uses other constructs

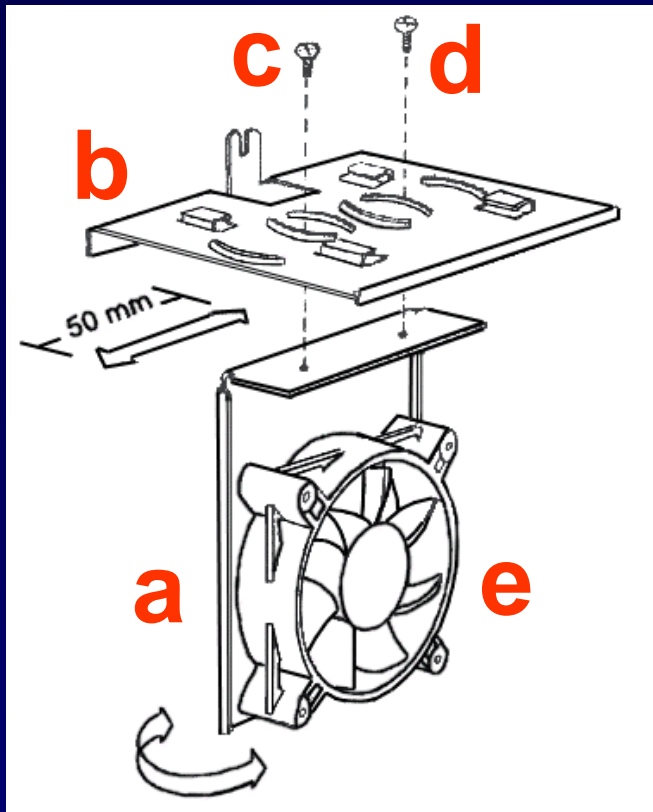
Why is CAD lousy for sketching & early stages of design?

- ☞ computer representation not rich enough!
- ☞ geometry and arithmetic are great
... but design uses other constructs
- ☞ how to get these inside computer?

Design is about relationships between things

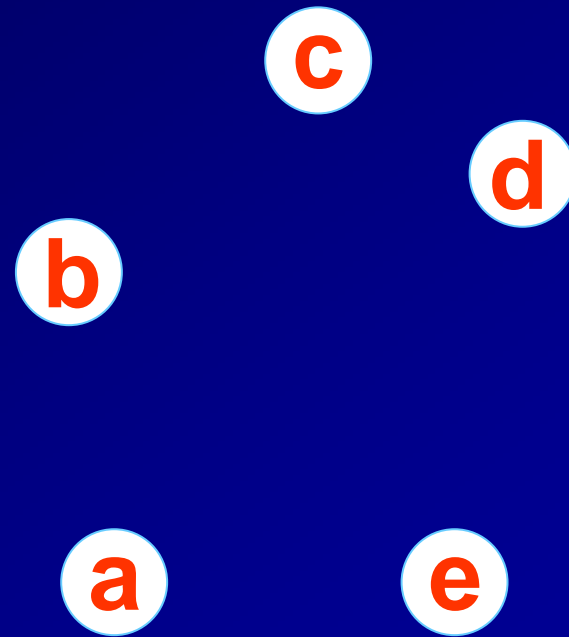
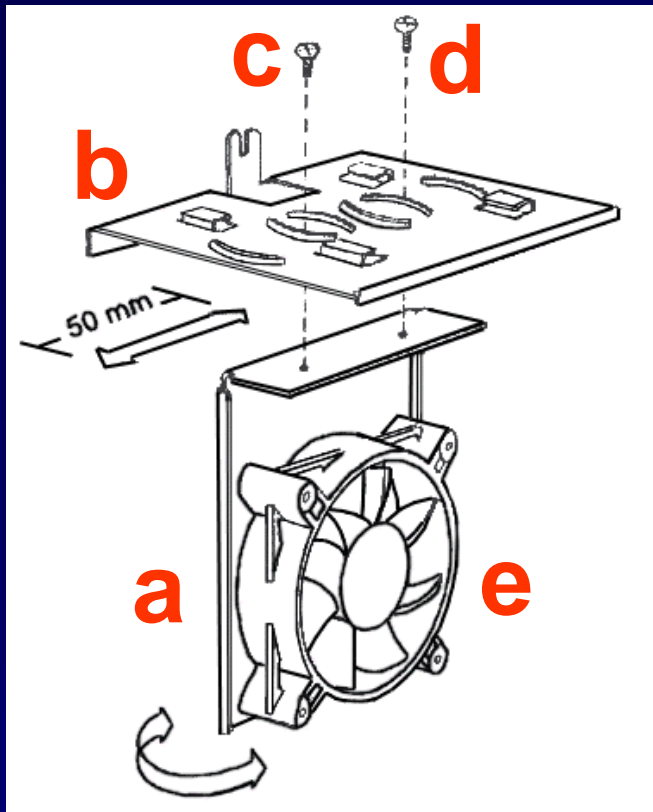


Design is about relationships between things



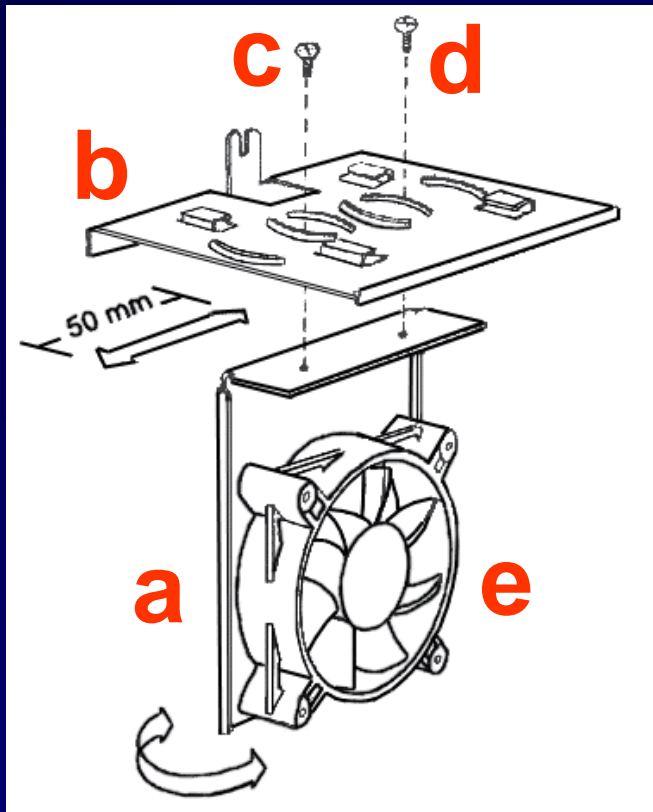
Set of parts

Design is about relationships between things

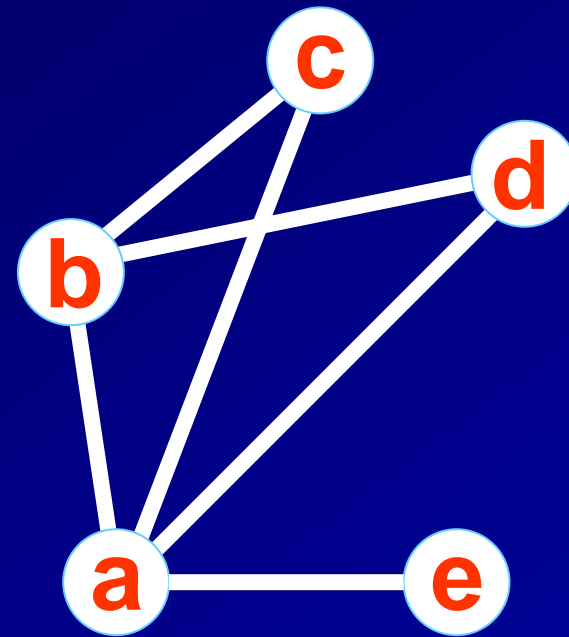


Set of parts

Design is about relationships between things

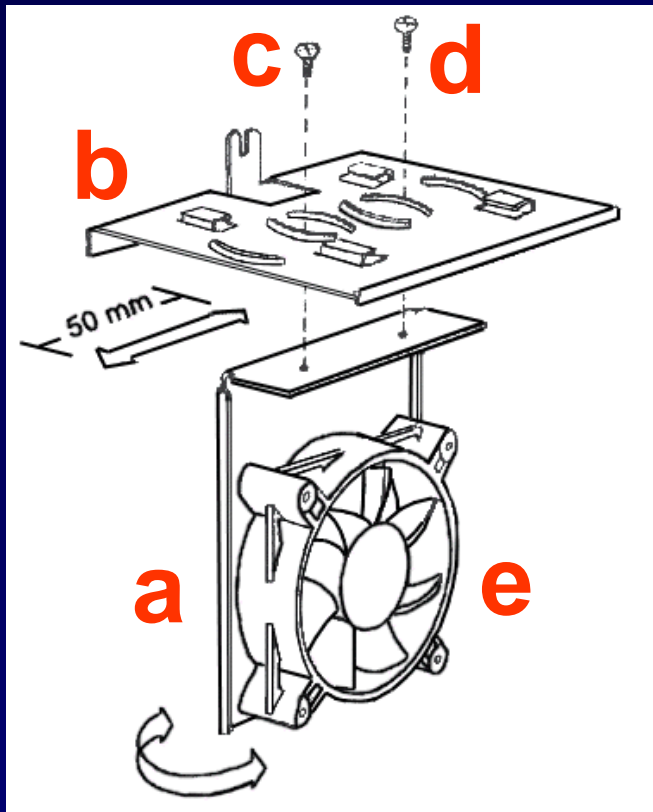


Set of parts

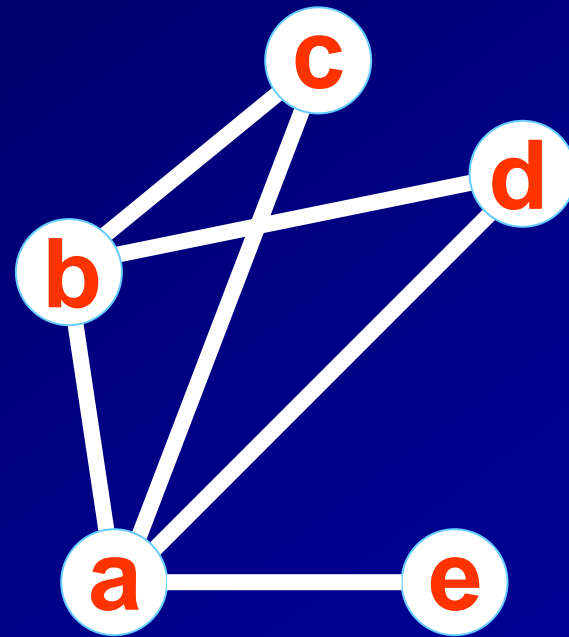


Relations between them

Design is about relationships between things

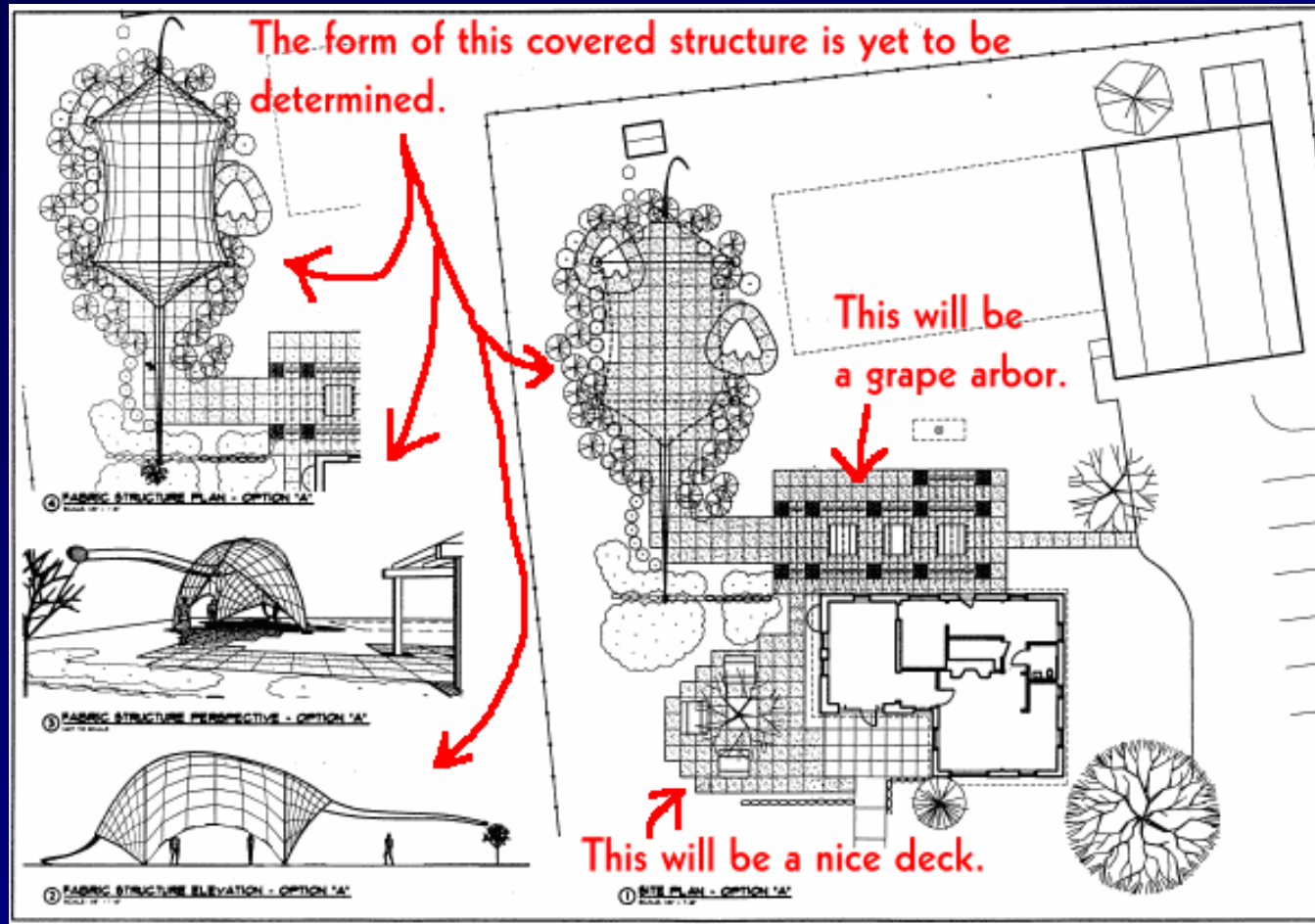


Set of parts



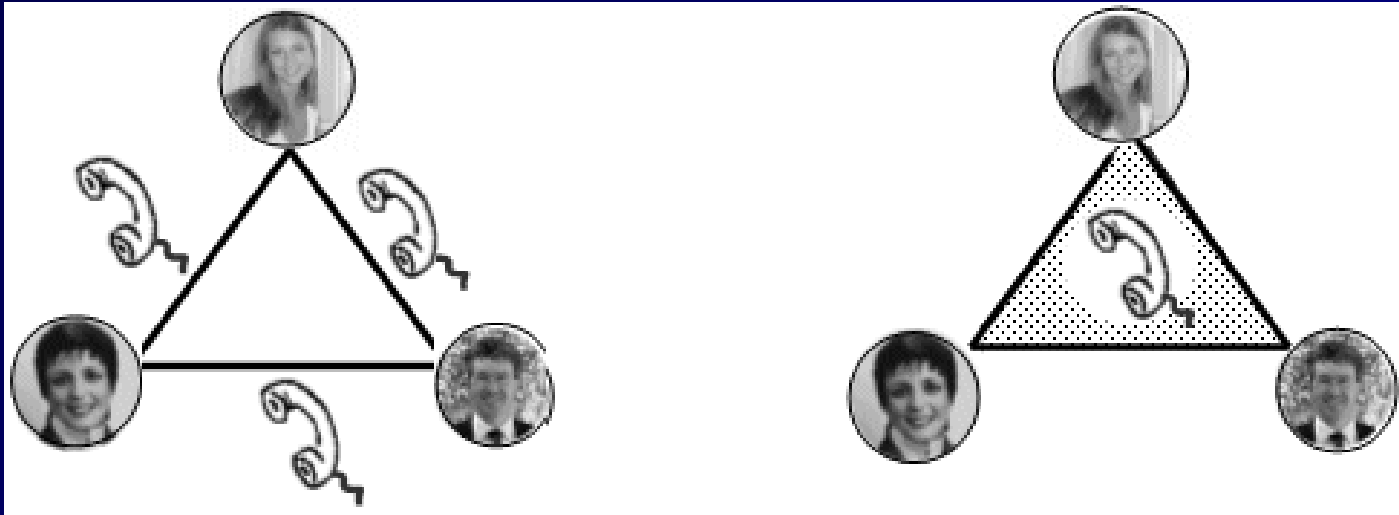
**Relations between them
as a *Graph***

Design is about relationships between things



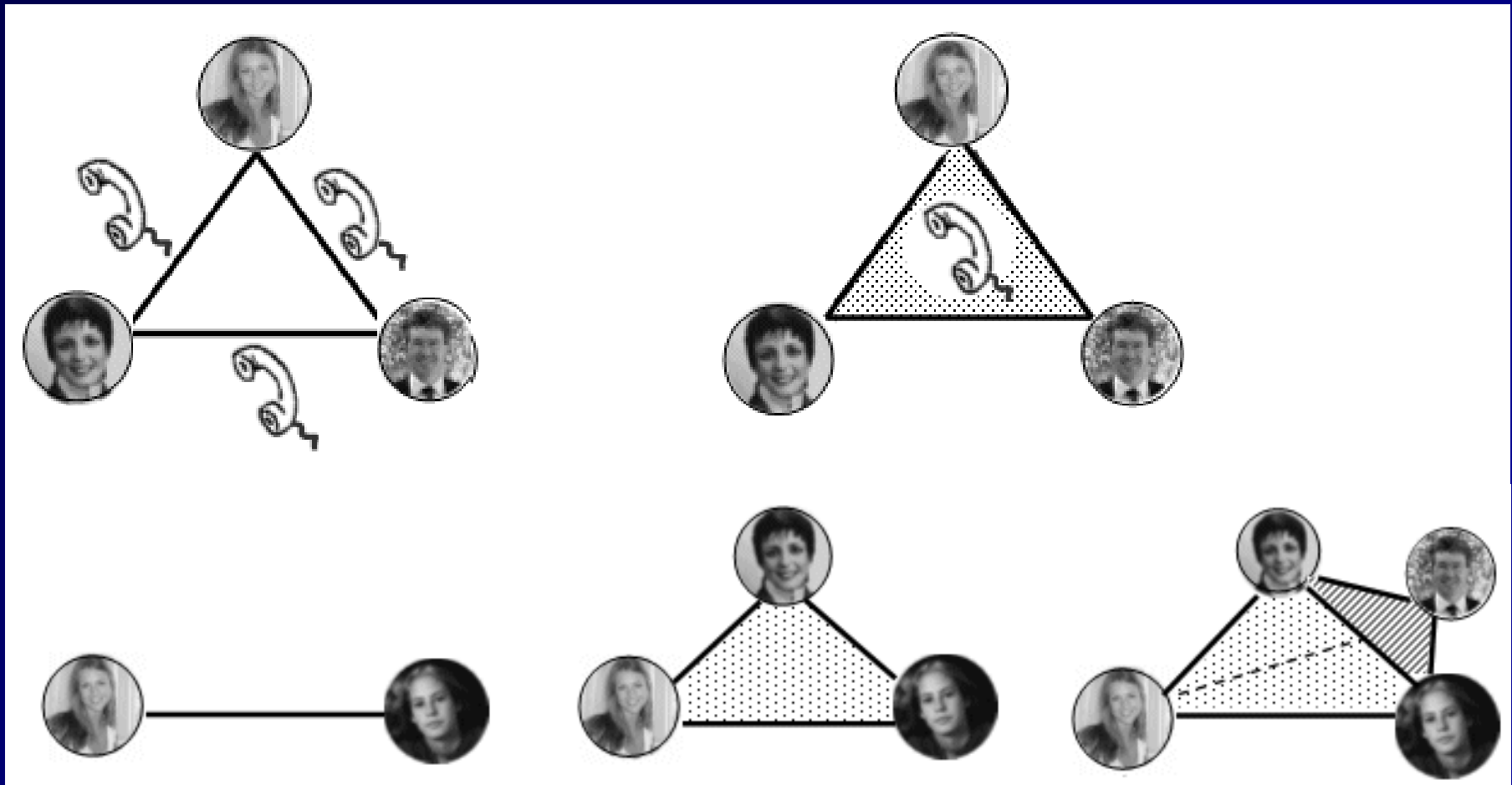
... and *emergence* from *assembling* things

Graphs are not rich enough



3 binary relations \neq one 3-ary relation

From Links to Multidimensional Polyhedra



Binary relation

3-ary relation

4-ary relation

From Links to Multidimensional Polyhedra

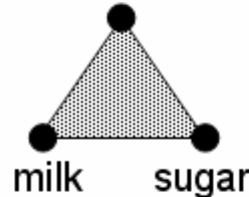
housing shops



1-simplex

2-vertices

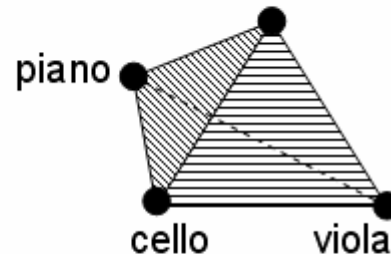
coffee



2-simplex

3-vertices

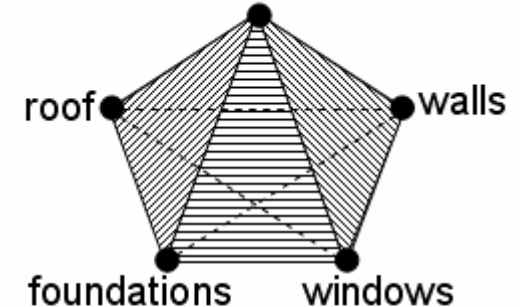
violin



3-simplex

4-vertices

doors

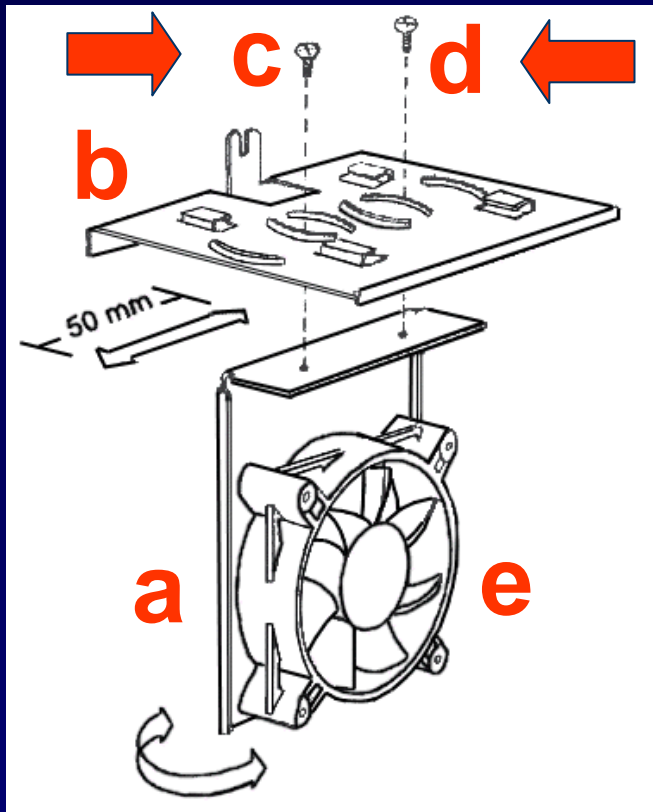


4-simplex

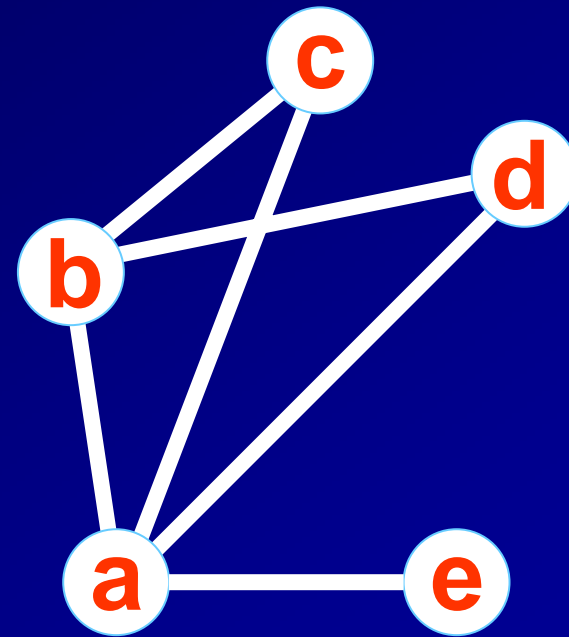
5-vertices

The generality is n -ary relations – not just links

From Links to Multidimensional Polyhedra

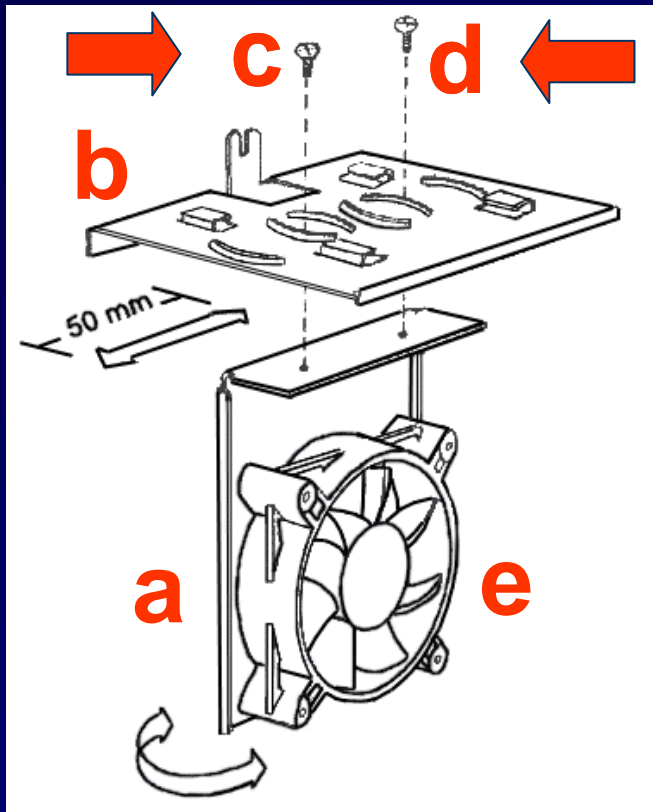


Set of parts

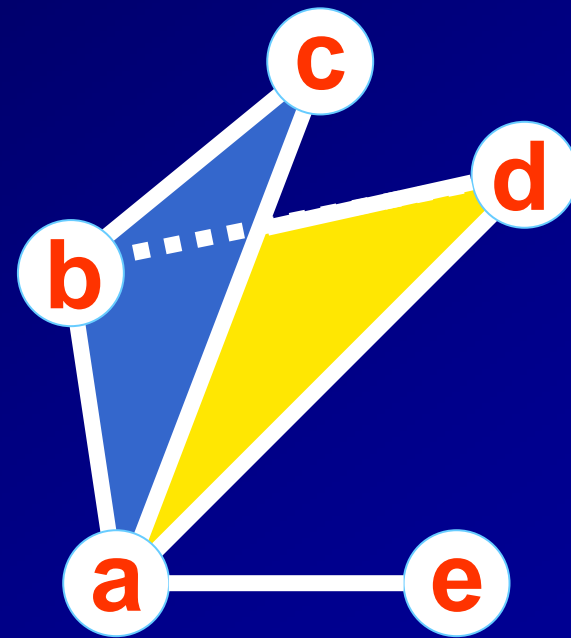


**Relations between them as
a Graph**

From Links to Multidimensional Polyhedra

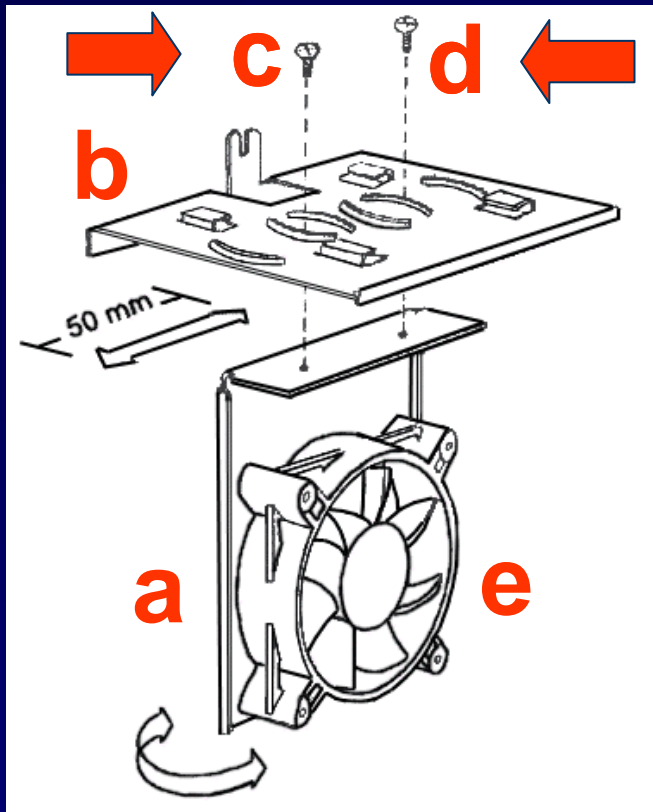


Set of parts

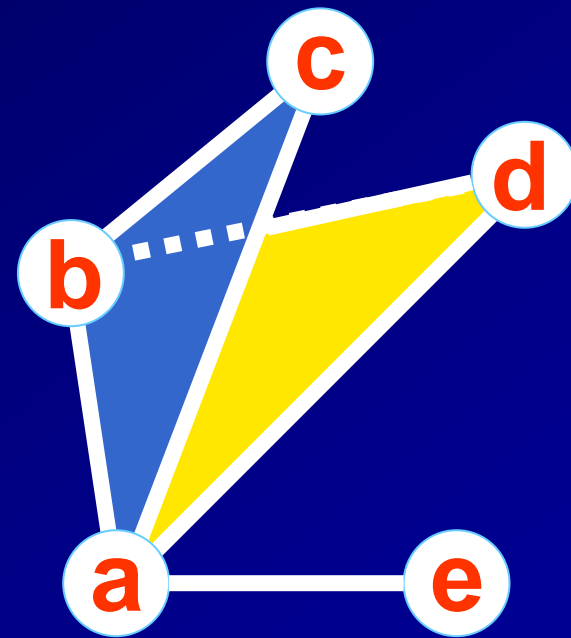


**Relations between them as
a ~~Graph~~ Simplicial Complex**

From Links to Multidimensional Polyhedra

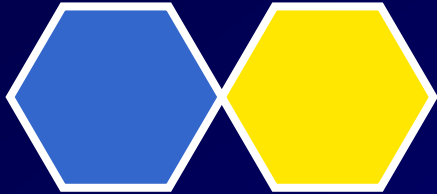


Set of parts



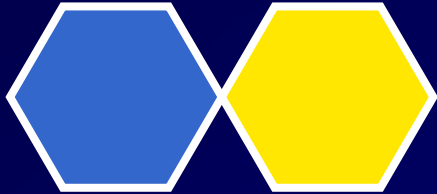
**Relations between them as
a ~~Graph~~ Simplicial Complex**

Polyhedral Connectivity

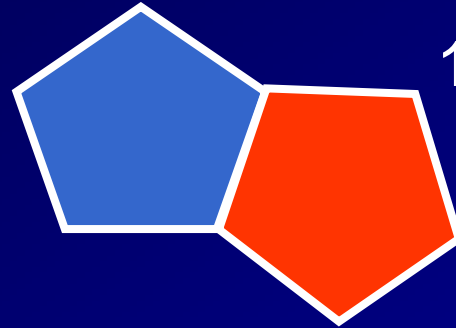


0- near polyhedra

Polyhedral Connectivity

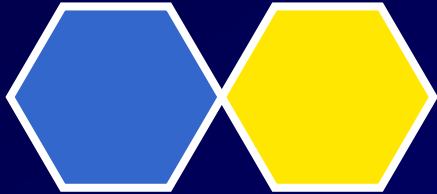


0- near polyhedra

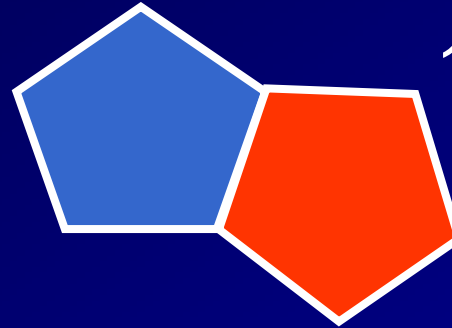


1- near polyhedra

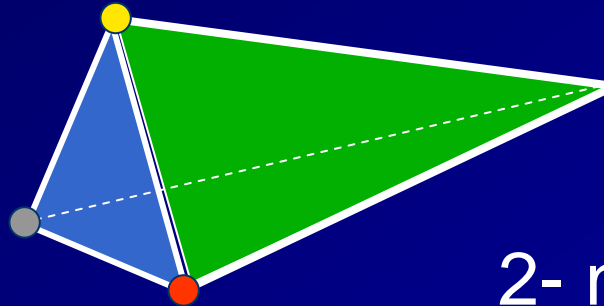
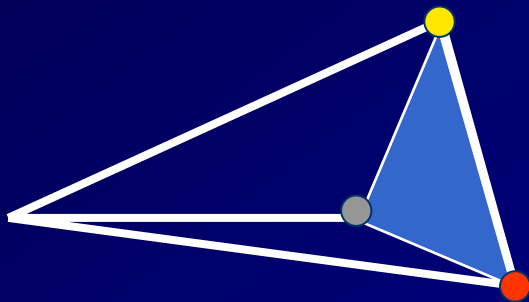
Polyhedral Connectivity



0- near polyhedra

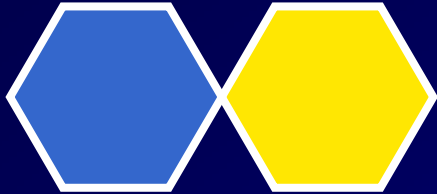


1- near polyhedra

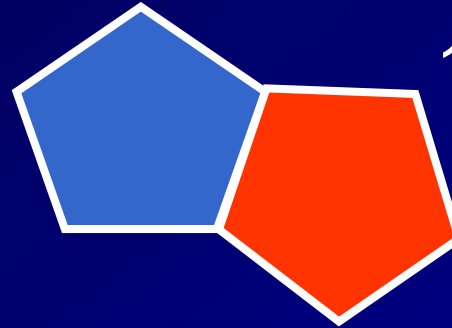


2- near polyhedra

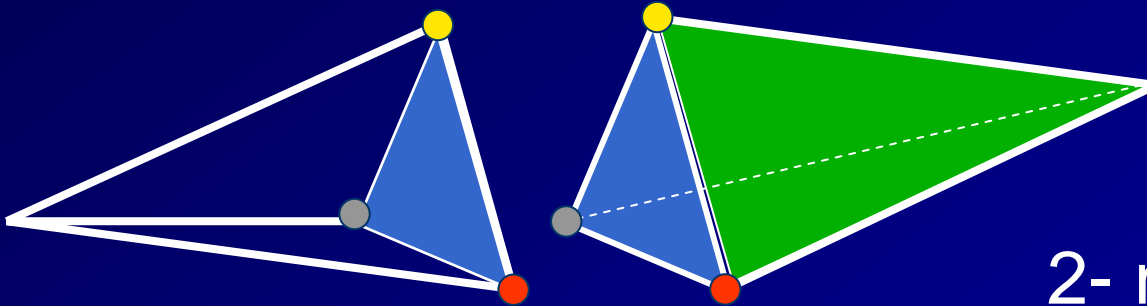
Polyhedral Connectivity



0- near polyhedra

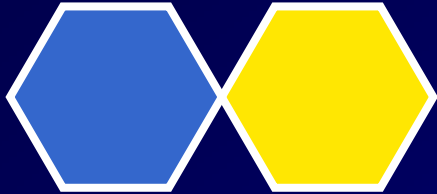


1- near polyhedra

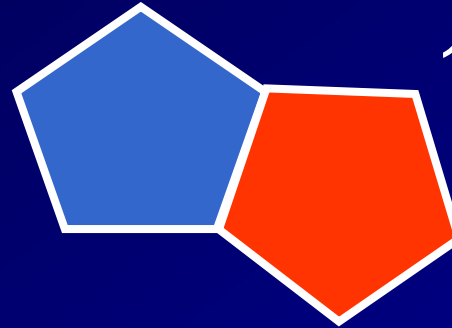


2- near polyhedra

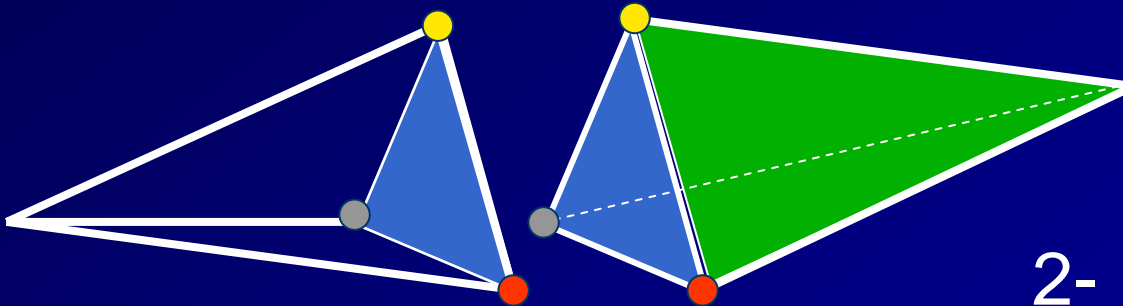
Polyhedral Connectivity



0- near polyhedra

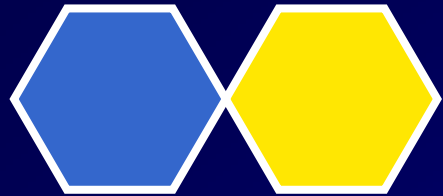


1- near polyhedra

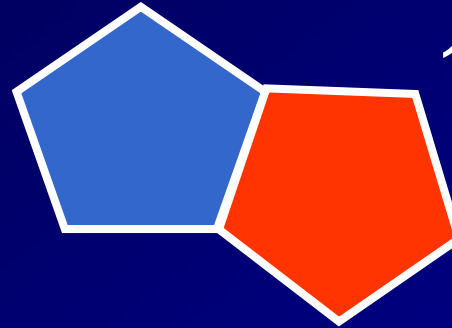


2- near polyhedra

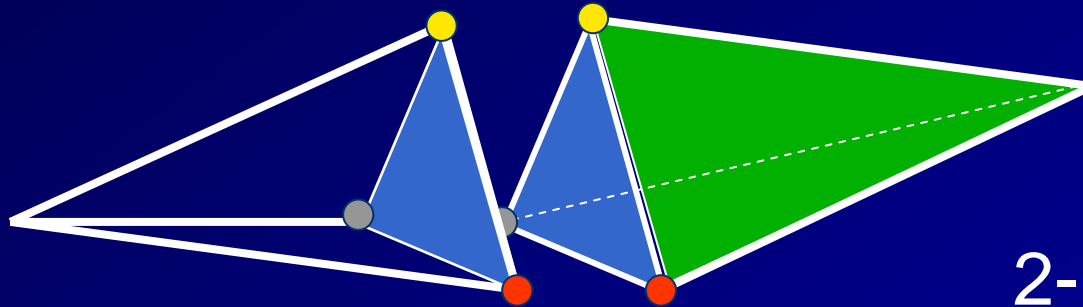
Polyhedral Connectivity



0- near polyhedra

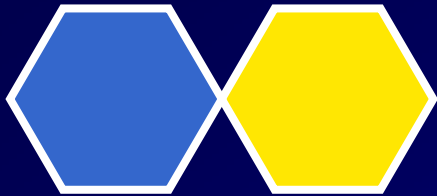


1- near polyhedra

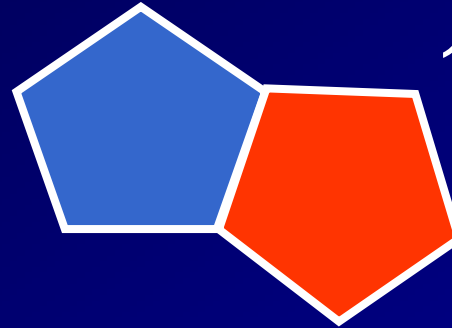


2- near polyhedra

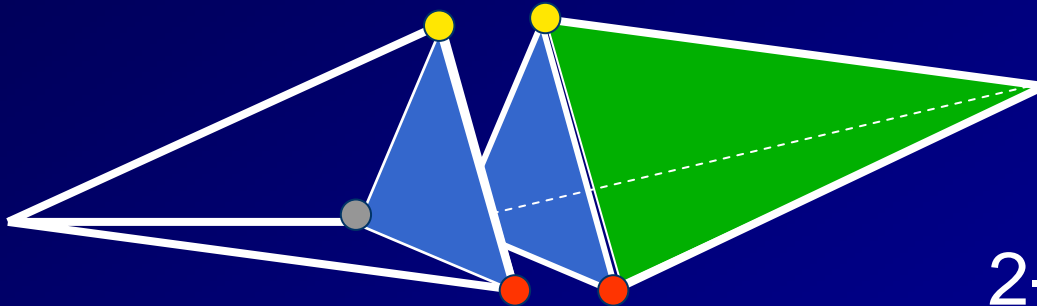
Polyhedral Connectivity



0- near polyhedra

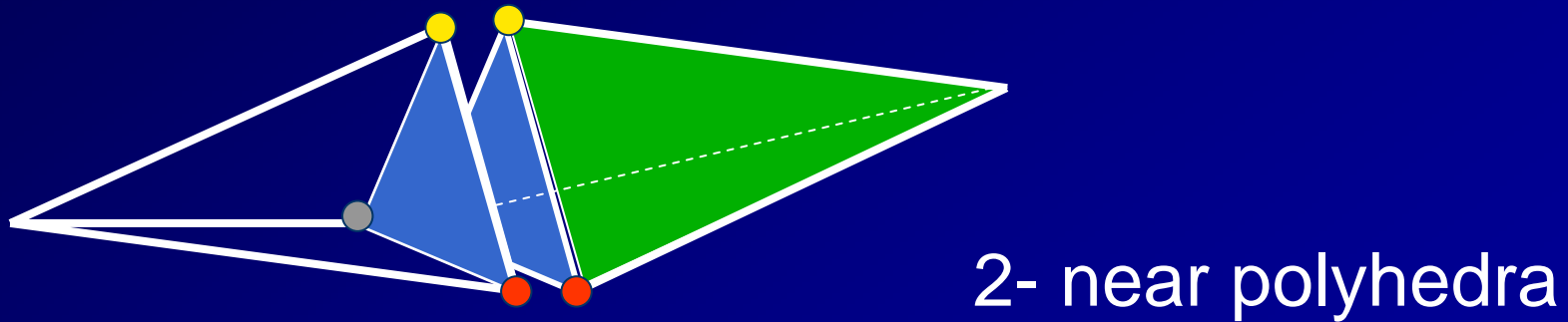
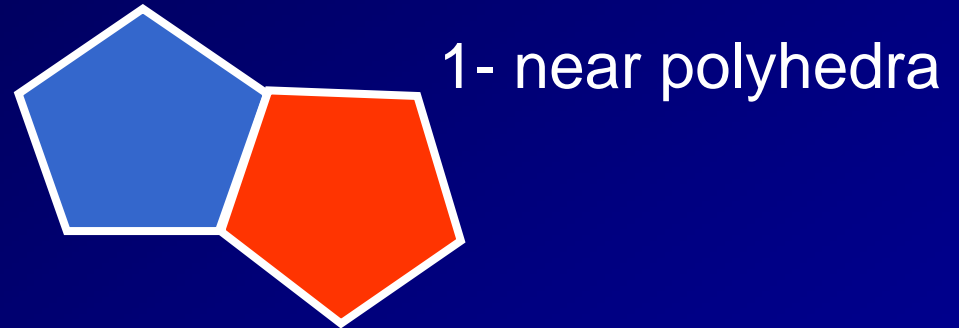


1- near polyhedra

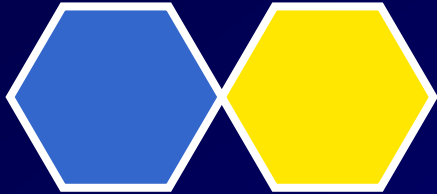


2- near polyhedra

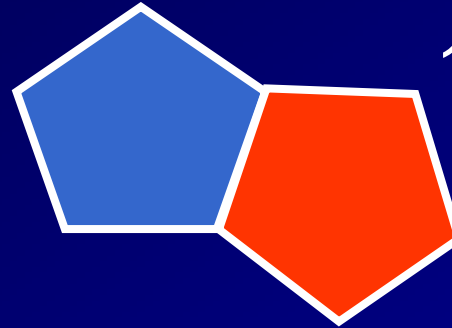
Polyhedral Connectivity



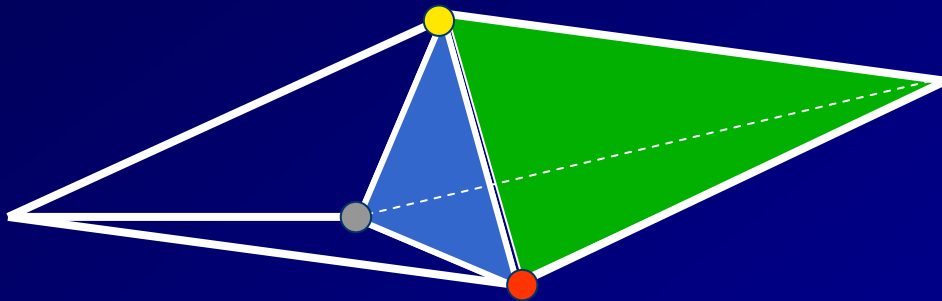
Polyhedral Connectivity



0- near polyhedra

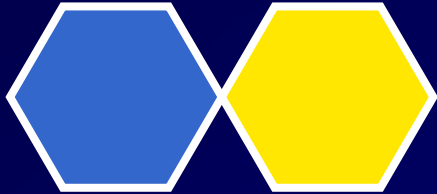


1- near polyhedra

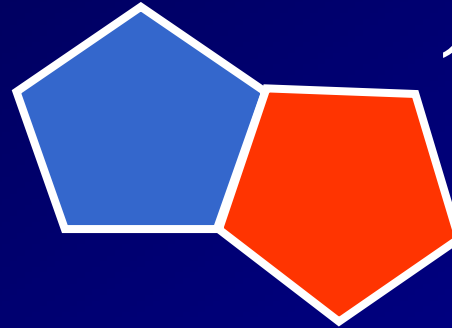


2- near polyhedra

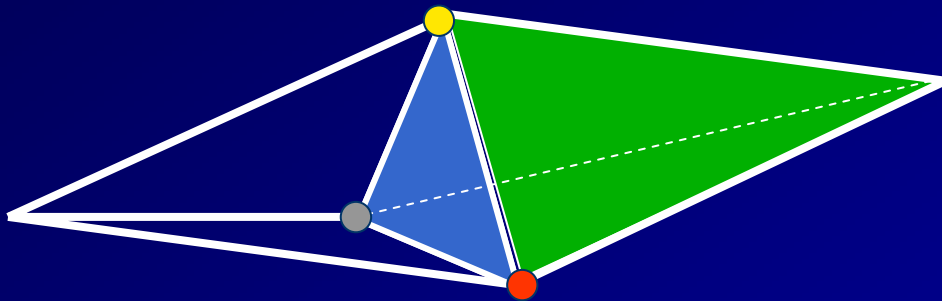
Polyhedral Connectivity



0- near polyhedra

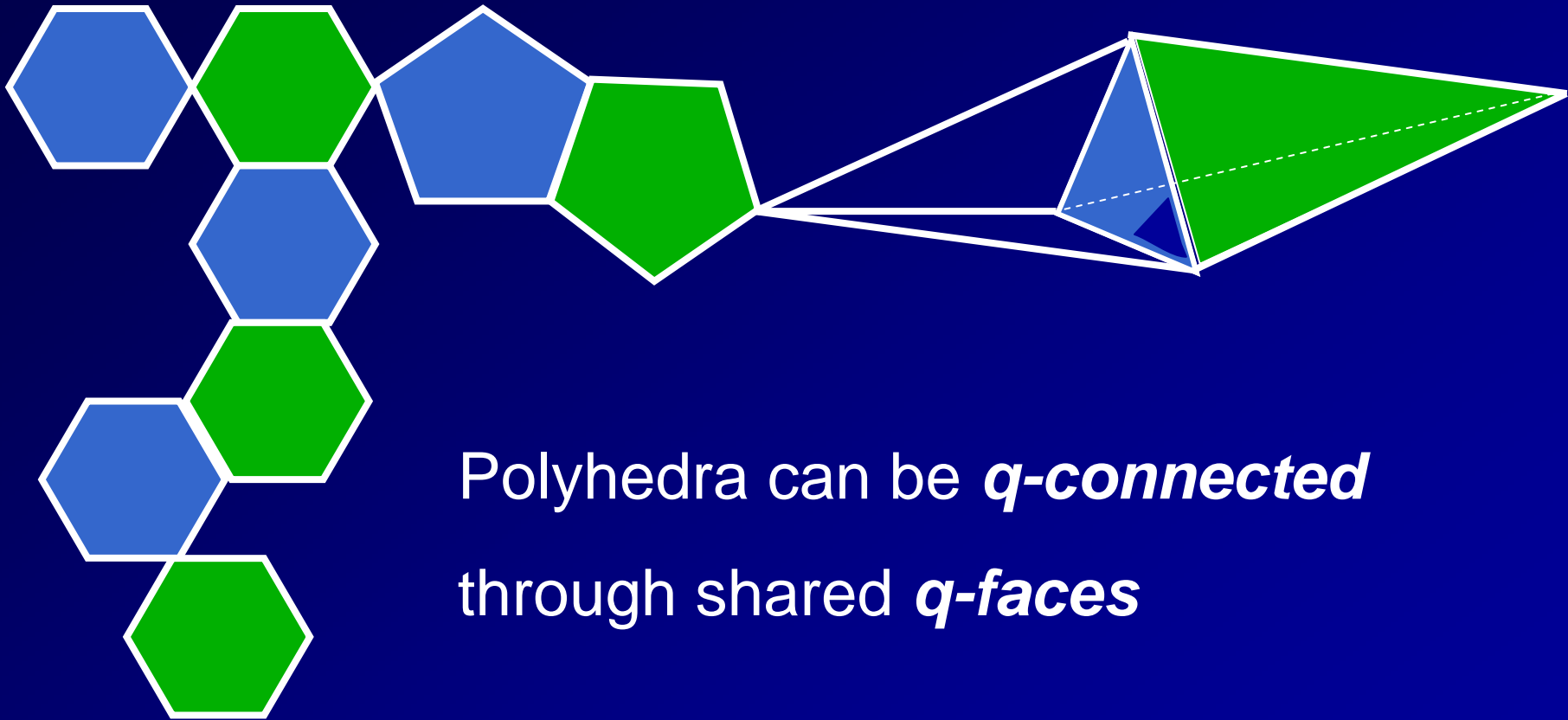


1- near polyhedra

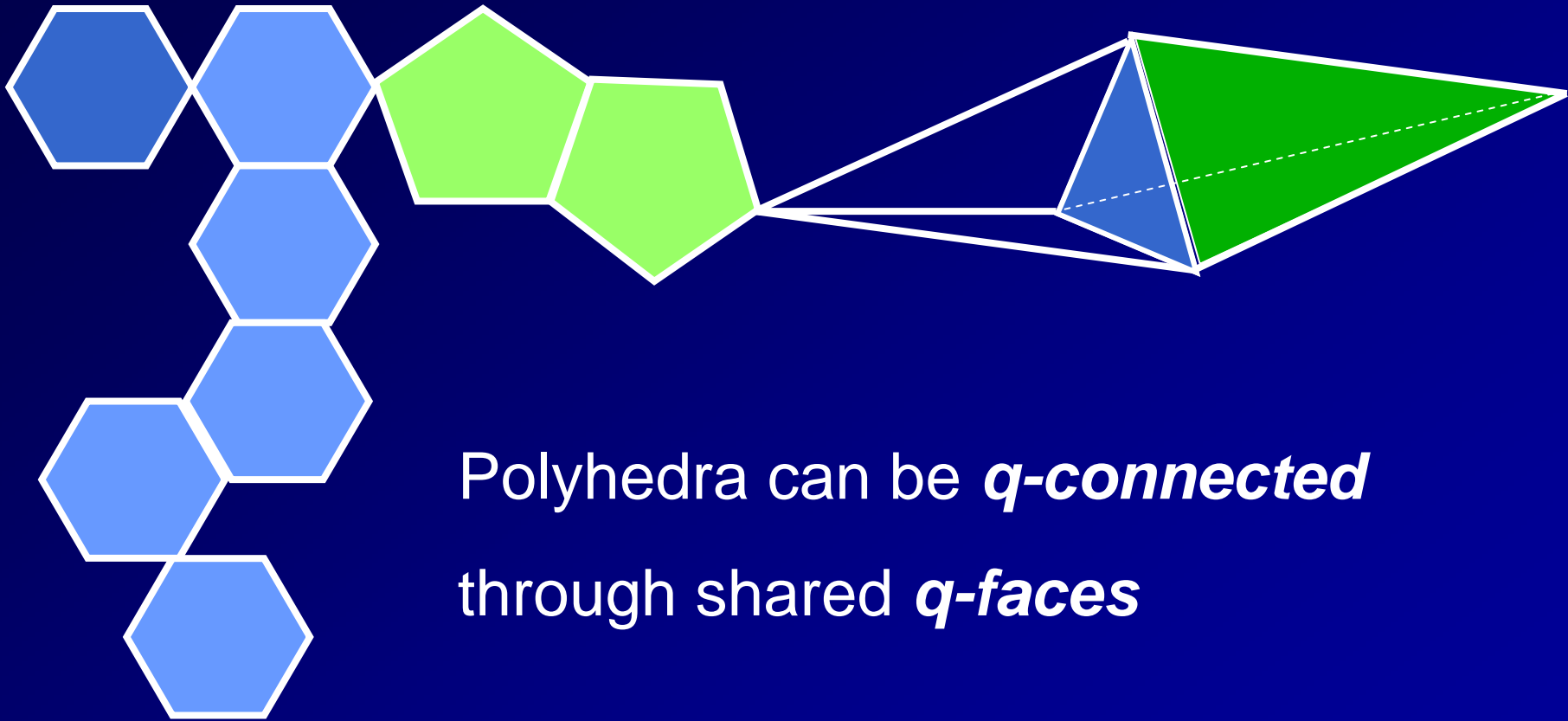


2- near polyhedra

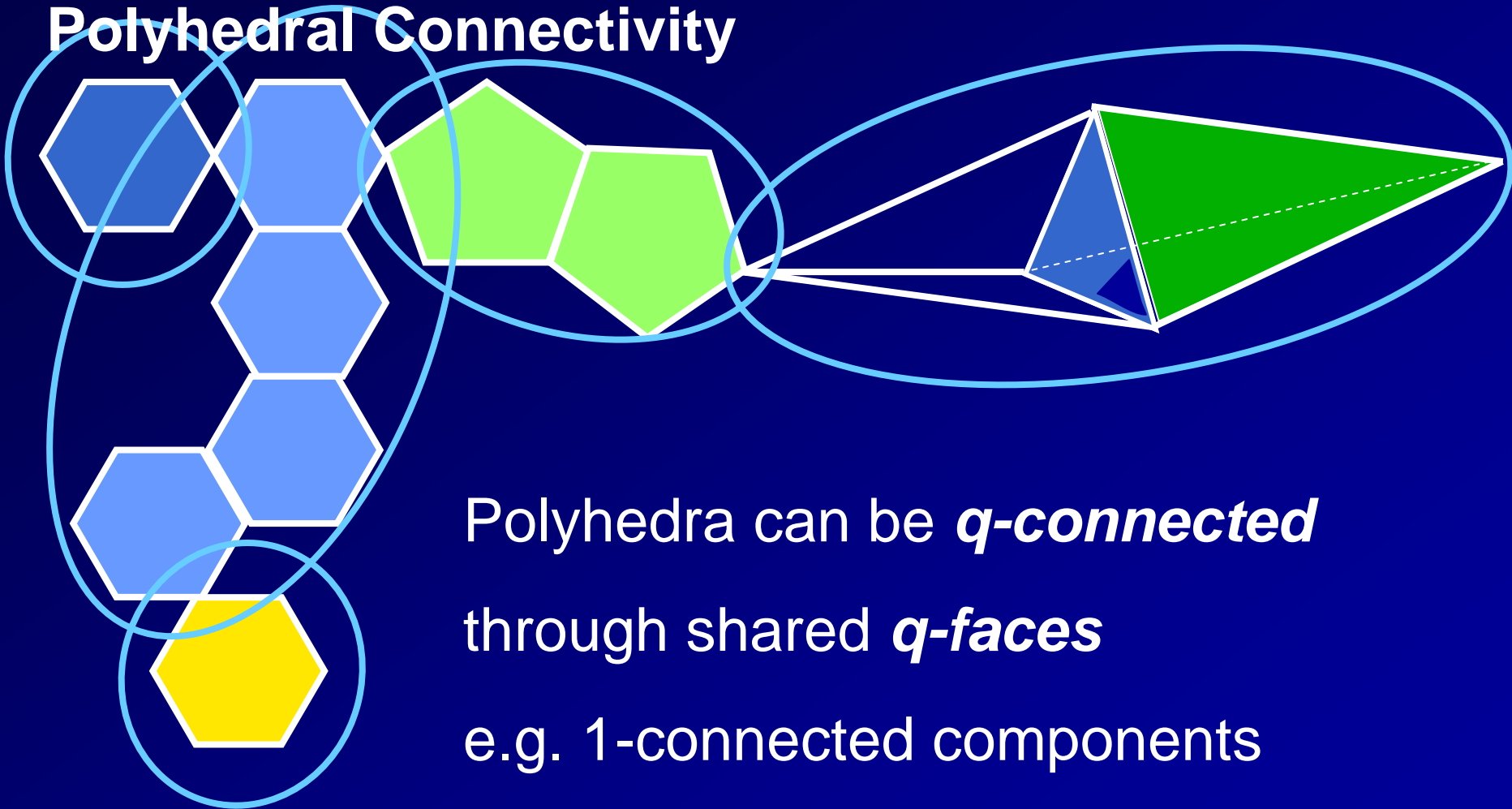
Polyhedral Connectivity



Polyhedral Connectivity

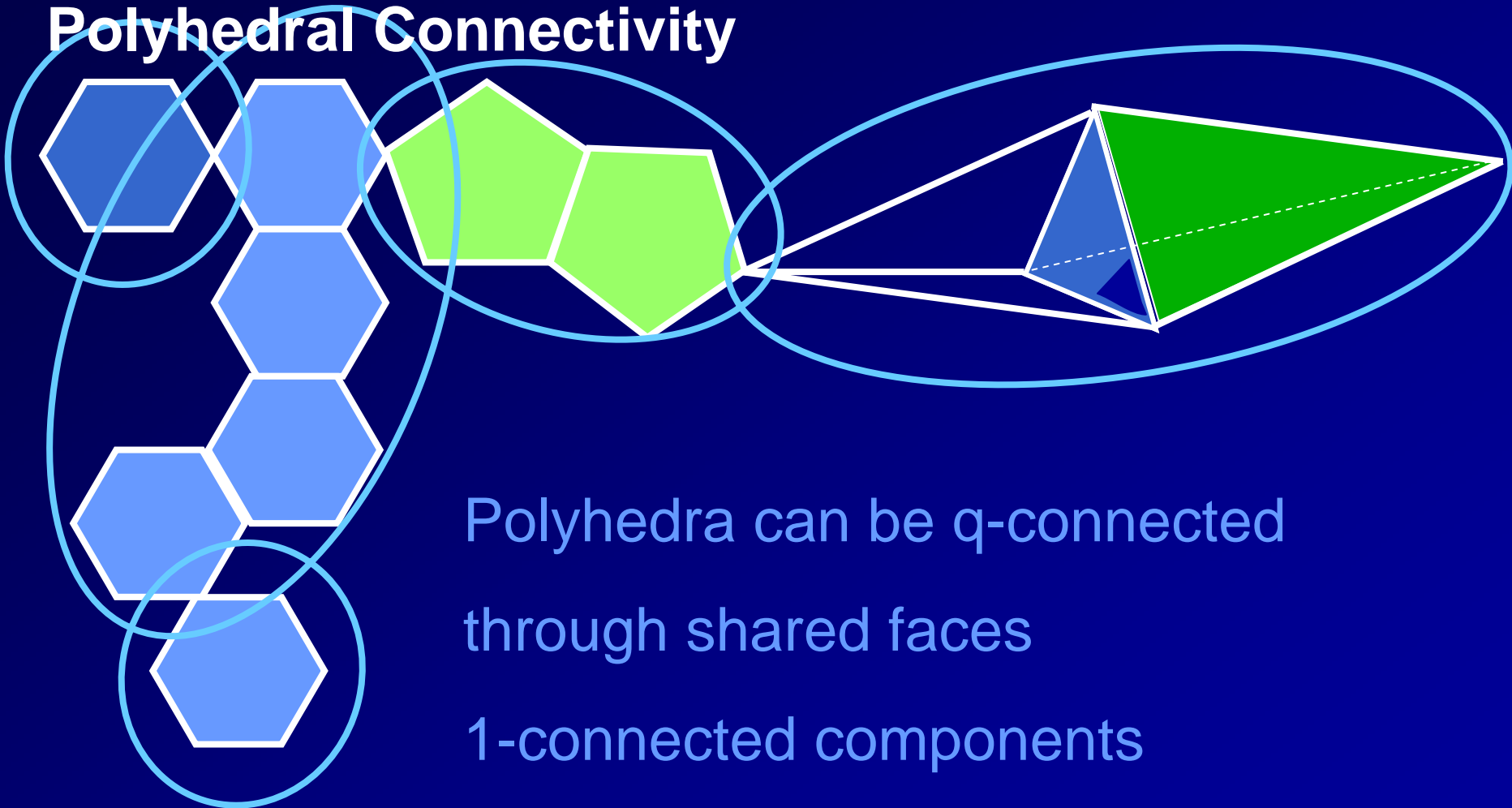


Polyhedral Connectivity



Polyhedra can be ***q-connected***
through shared ***q-faces***
e.g. 1-connected components

Polyhedral Connectivity

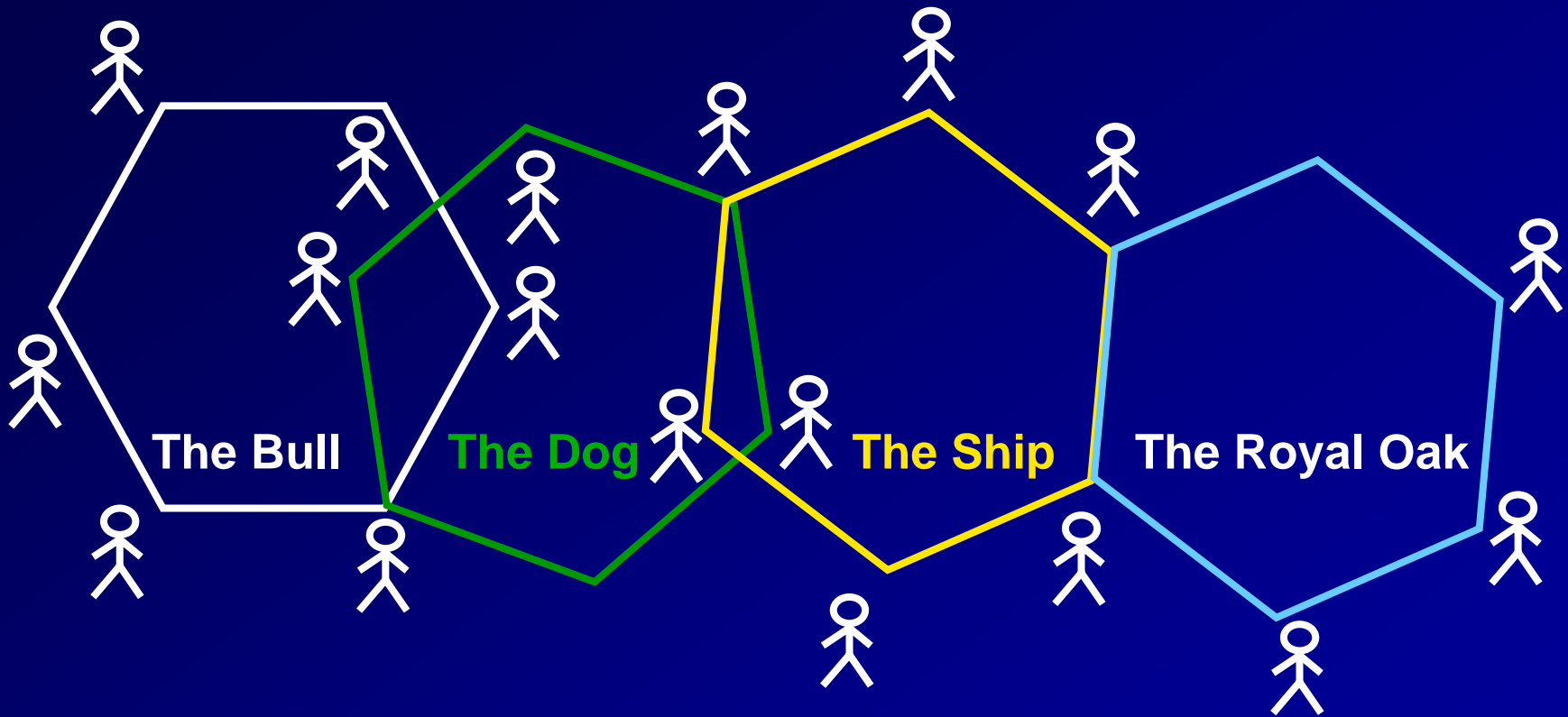


Polyhedra can be q-connected
through shared faces

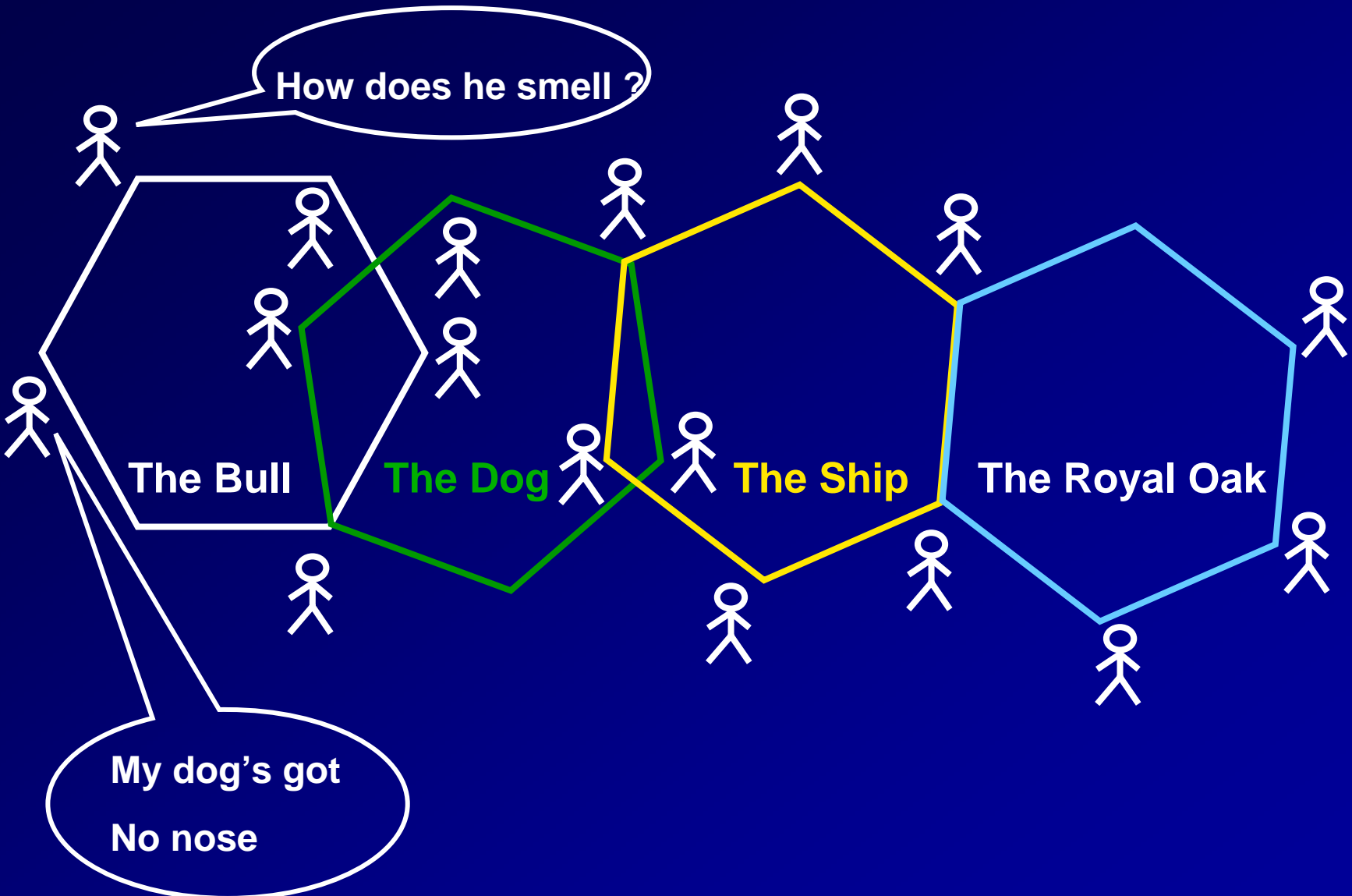
1-connected components

Q-analysis: listing q-components

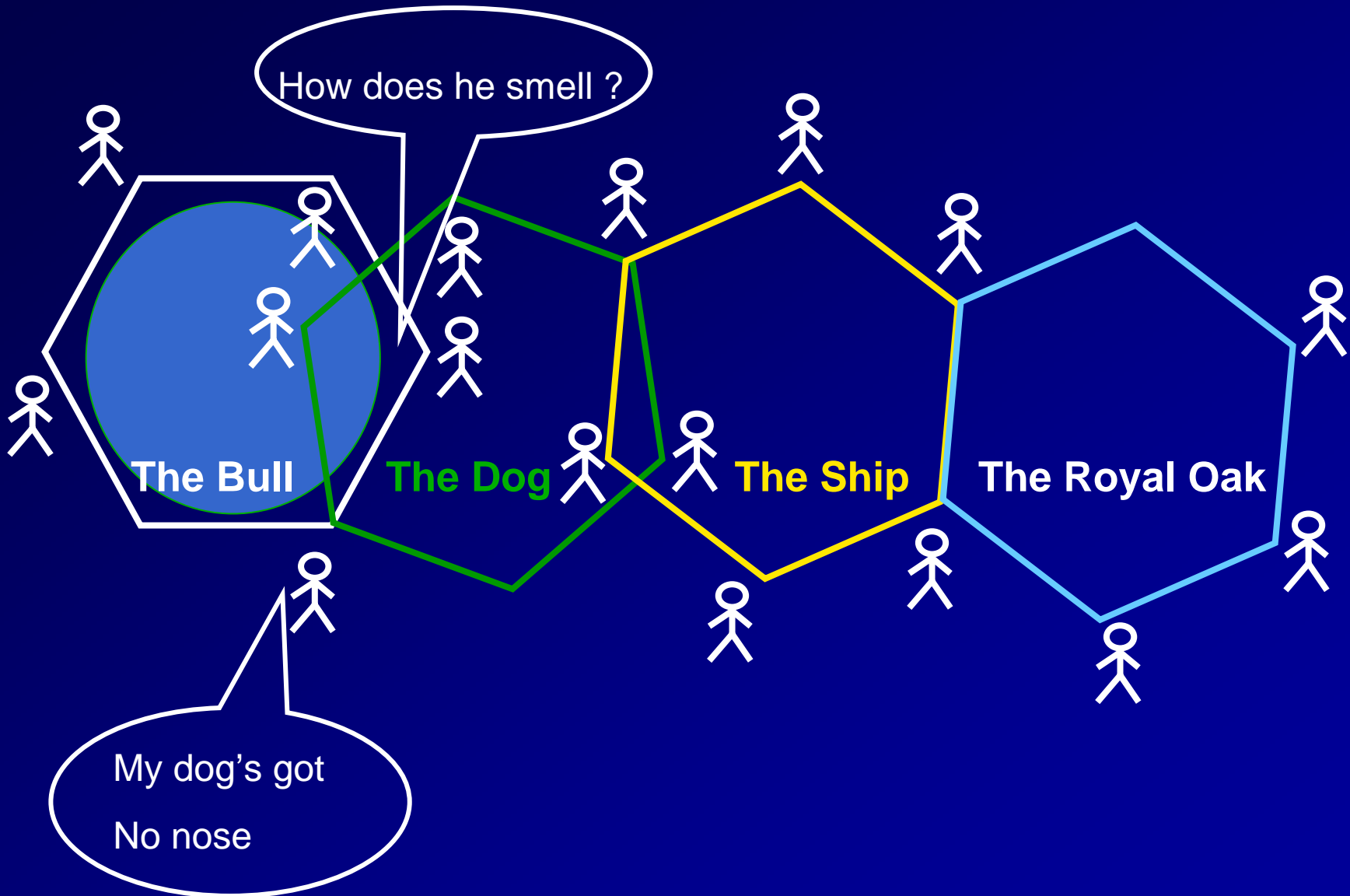
Polyhedral Connectivity



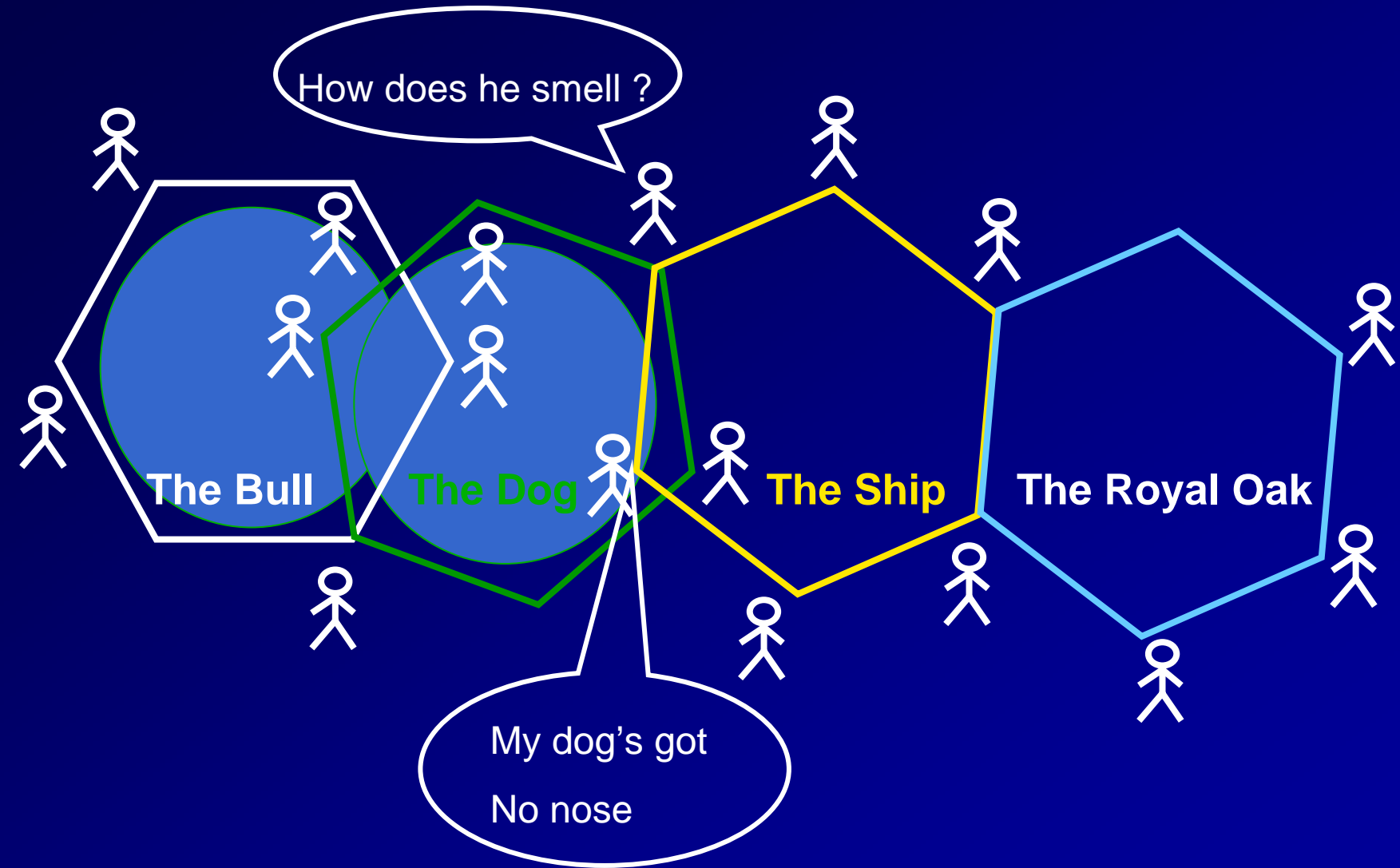
Polyhedral Connectivity & q-transmission



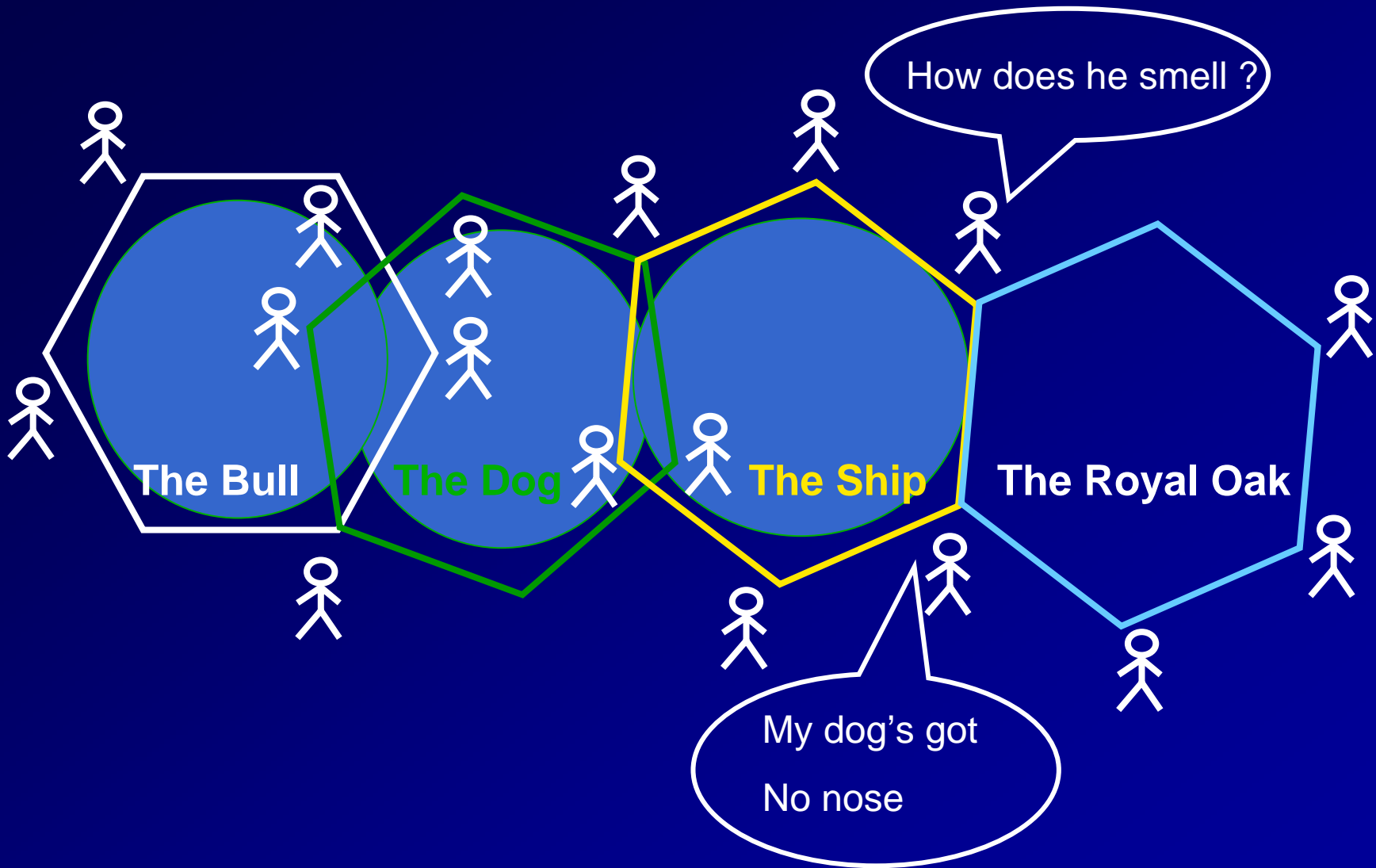
Polyhedral Connectivity & q-transmission



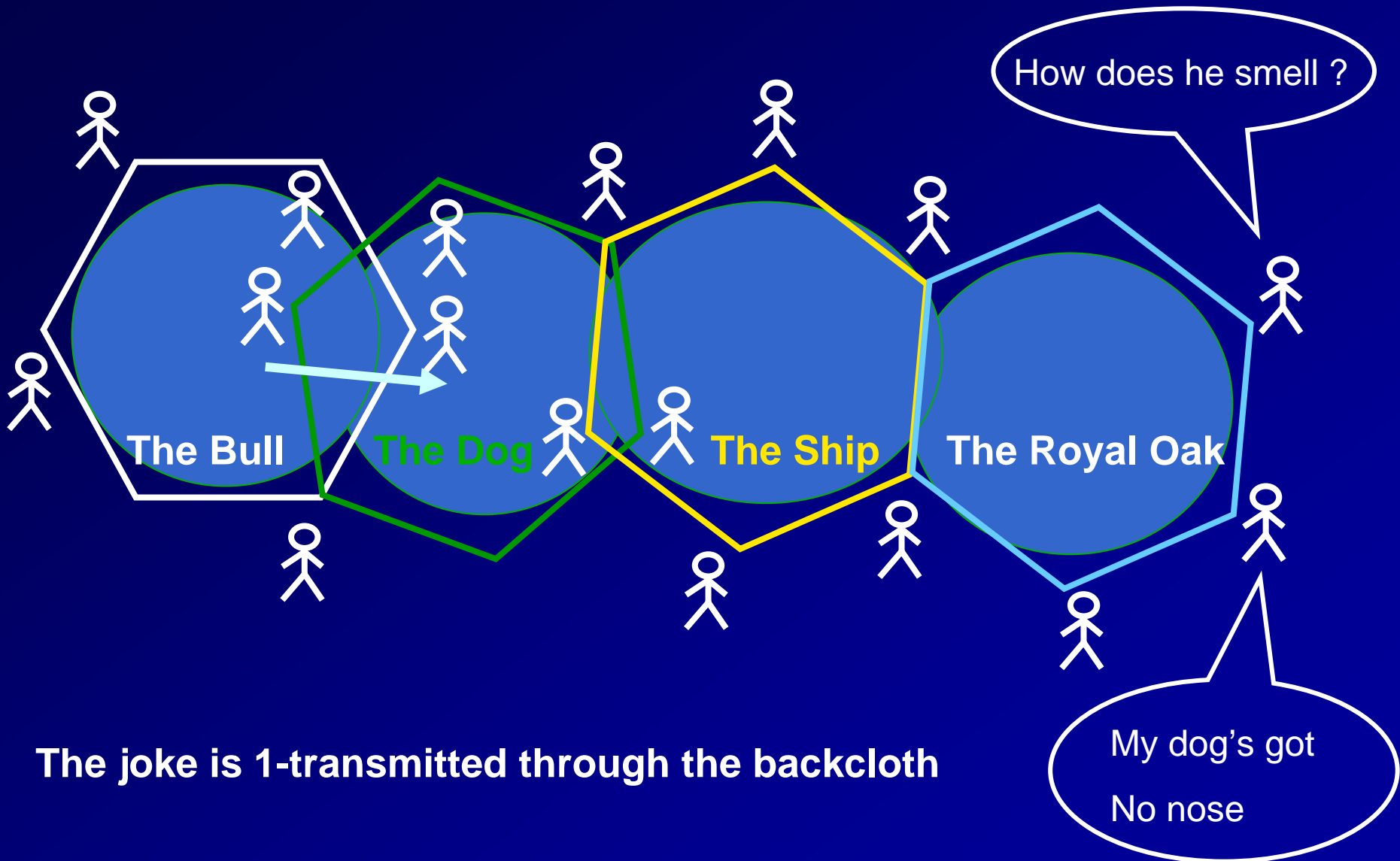
Polyhedral Connectivity & q-transmission



Polyhedral Connectivity & q-transmission

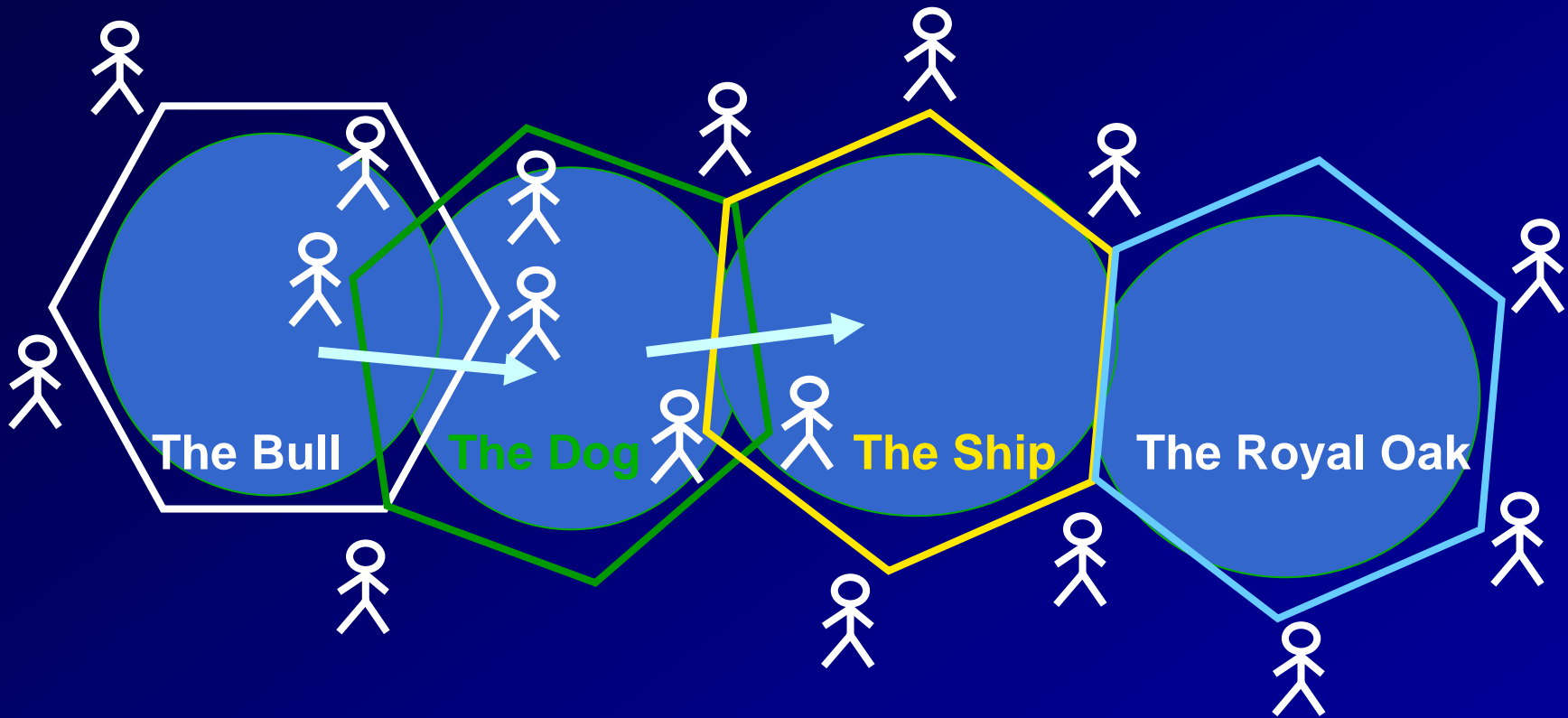


Polyhedral Connectivity & q-transmission



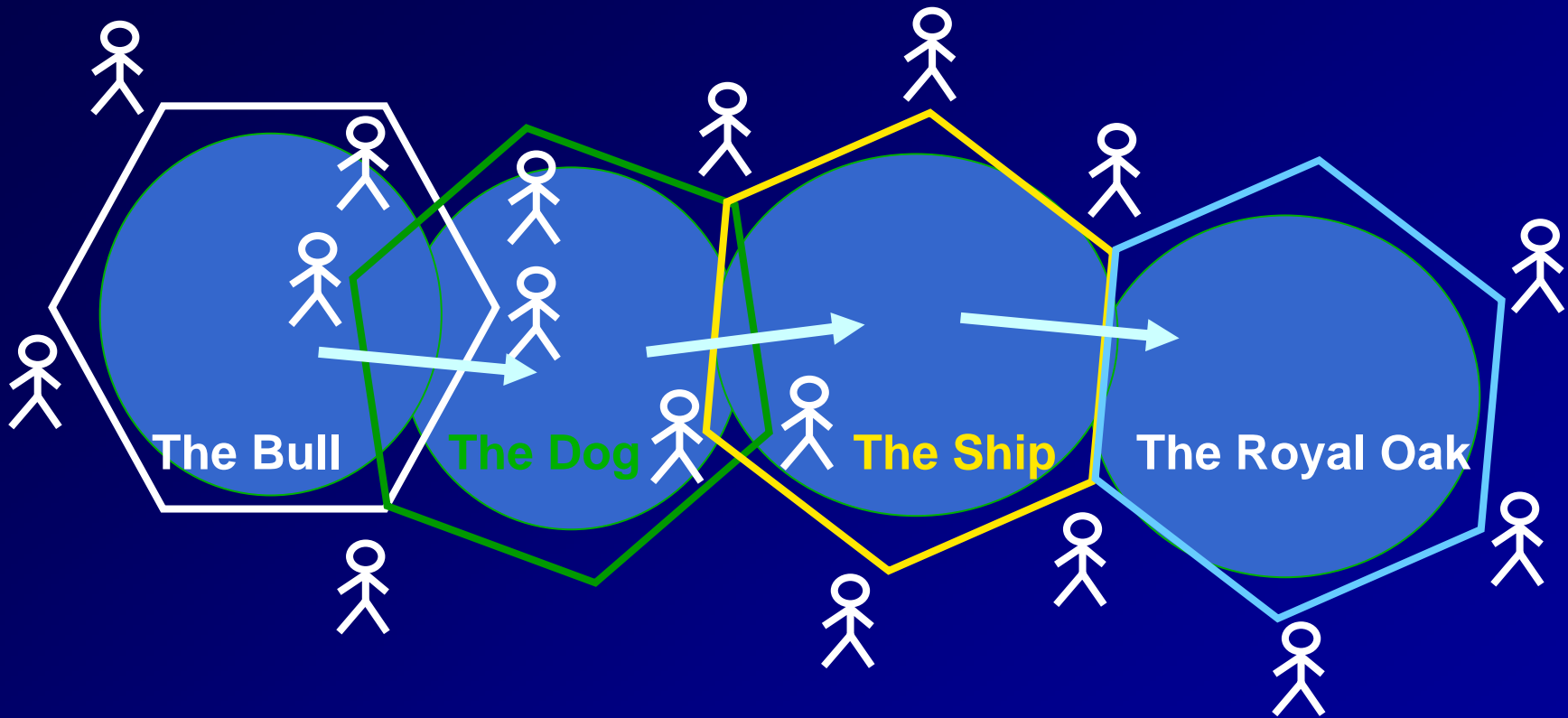
The joke is 1-transmitted through the backcloth

Polyhedral Connectivity & q-transmission



The joke is 1-transmitted through the backcloth

Polyhedral Connectivity & q-transmission



Can *design* connected structures for transmission

Relations and Incidence Matrices

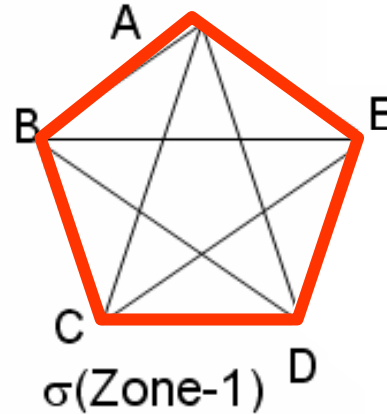
	A	B	C	D	E	F	G	H	I	J	K
Zone-1	1	1	1	1	1	0	0	0	0	0	0
Zone-2	0	0	0	1	1	1	1	1	0	0	0
Zone-3	0	0	0	0	0	1	1	0	1	1	1

(a) incidence matrix

Relations and Incidence Matrices

	A	B	C	D	E	F	G	H	I	J	K
Zone-1	1	1	1	1	1	0	0	0	0	0	0
Zone-2	0	0	0	1	1	1	1	1	0	0	0
Zone-3	0	0	0	0	0	1	1	0	1	1	1

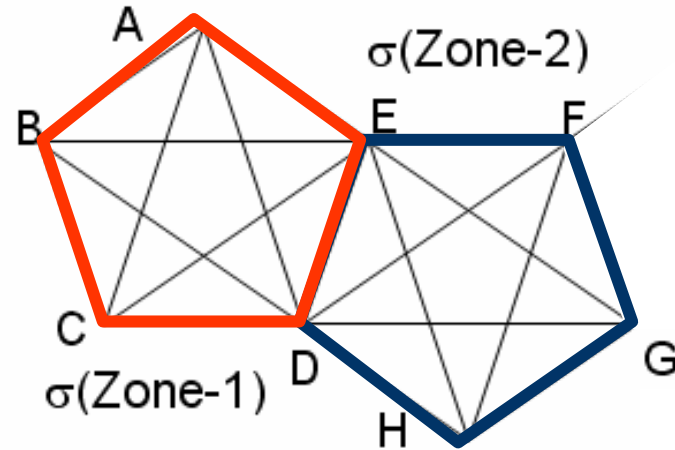
(a) incidence matrix



Relations and Incidence Matrices

	A	B	C	D	E	F	G	H	I	J	K
Zone-1	1	1	1	1	1	0	0	0	0	0	0
Zone-2	0	0	0	1	1	1	1	1	0	0	0
Zone-3	0	0	0	0	0	1	1	0	1	1	1

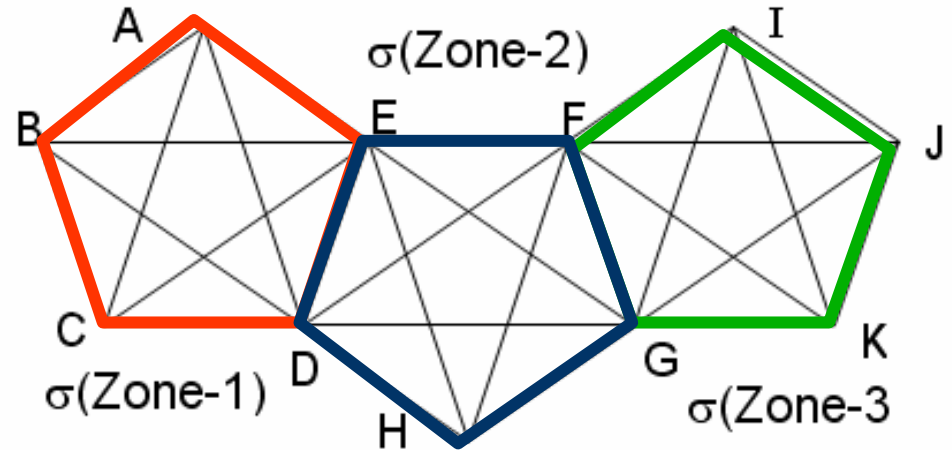
(a) incidence matrix



Relations and Incidence Matrices

	A	B	C	D	E	F	G	H	I	J	K
Zone-1	1	1	1	1	1	0	0	0	0	0	0
Zone-2	0	0	0	1	1	1	1	1	0	0	0
Zone-3	0	0	0	0	0	1	1	0	1	1	1

(a) incidence matrix



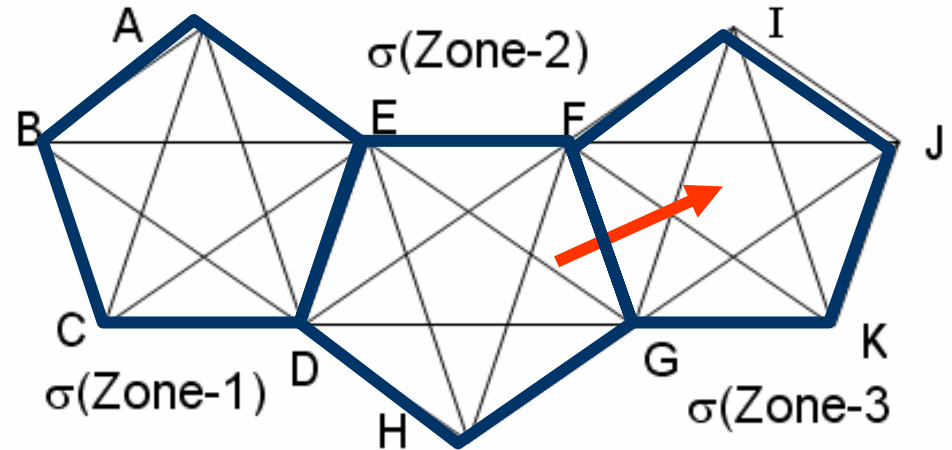
(b) the 1-connected simplicial complex

Figure 6. A simplicial complex as the backcloth for employment traffic

Relations and Incidence Matrices

	A	B	C	D	E	F	G	H	I	J	K
Zone-1	1	1	1	1	1	0	0	0	0	0	0
Zone-2	0	0	0	1	1	1	1	1	0	0	0
Zone-3	0	0	0	0	0	1	1	0	1	1	1

(a) incidence matrix



(b) the 1-connected simplicial complex

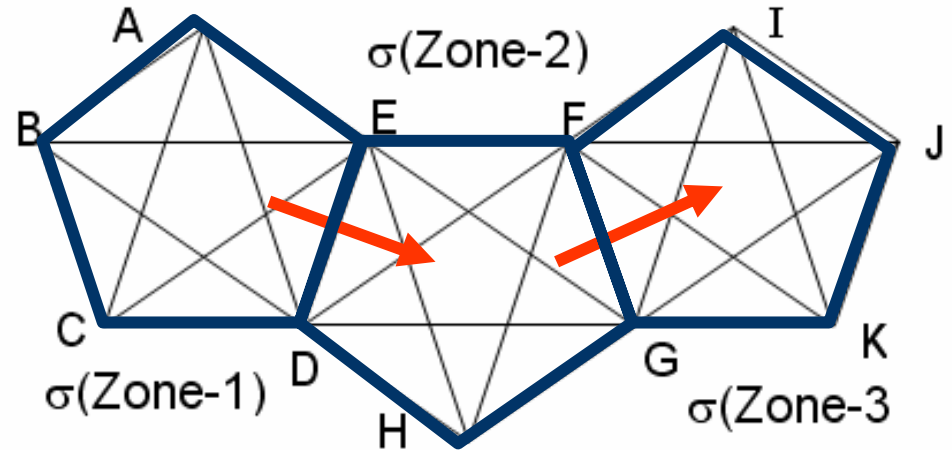
Figure 6. A simplicial complex as the backcloth for employment traffic

Transmission of jobs between zones

Relations and Incidence Matrices

	A	B	C	D	E	F	G	H	I	J	K
Zone-1	1	1	1	1	1	0	0	0	0	0	0
Zone-2	0	0	0	1	1	1	1	1	0	0	0
Zone-3	0	0	0	0	0	1	1	0	1	1	1

(a) incidence matrix

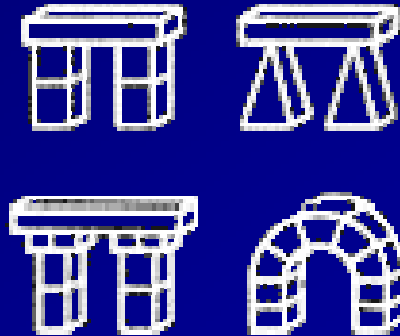
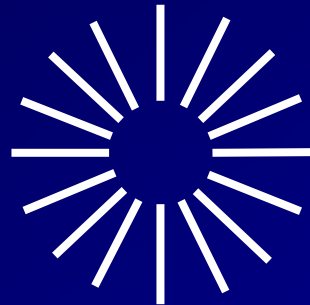


(b) the 1-connected simplicial complex

Figure 6. A simplicial complex as the backcloth for employment traffic

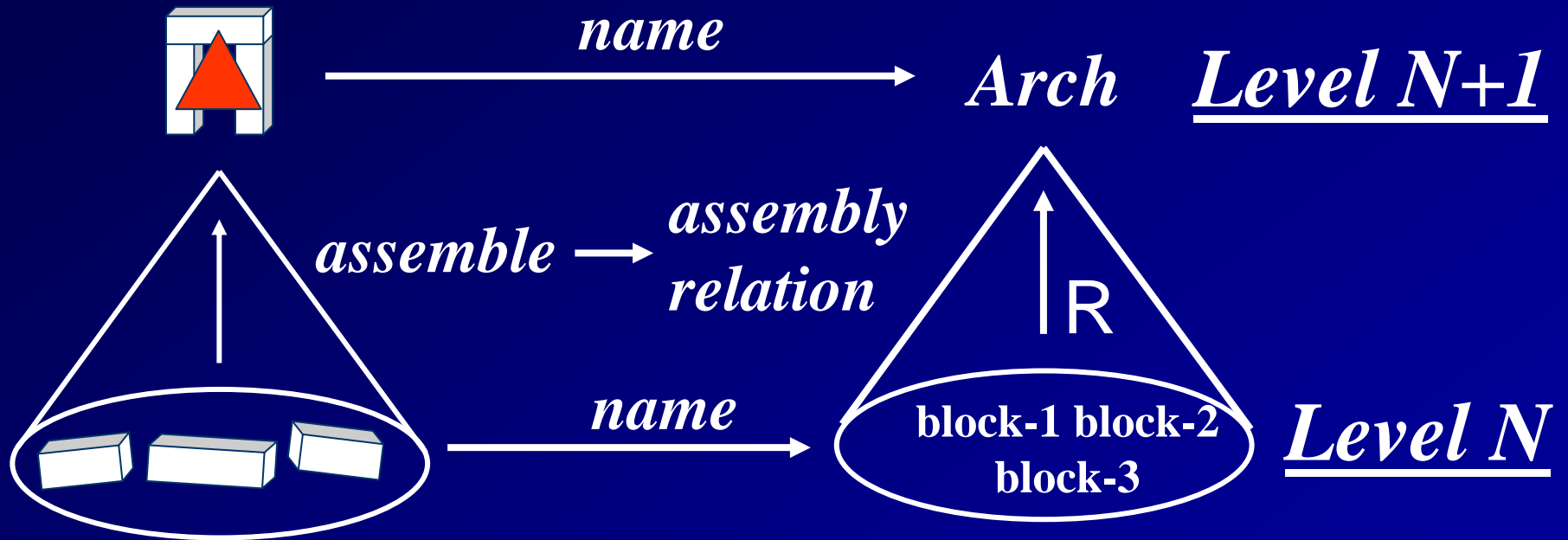
Transmission of jobs between zones

N-ary relations and emergence



Blocks assembled to make an arch

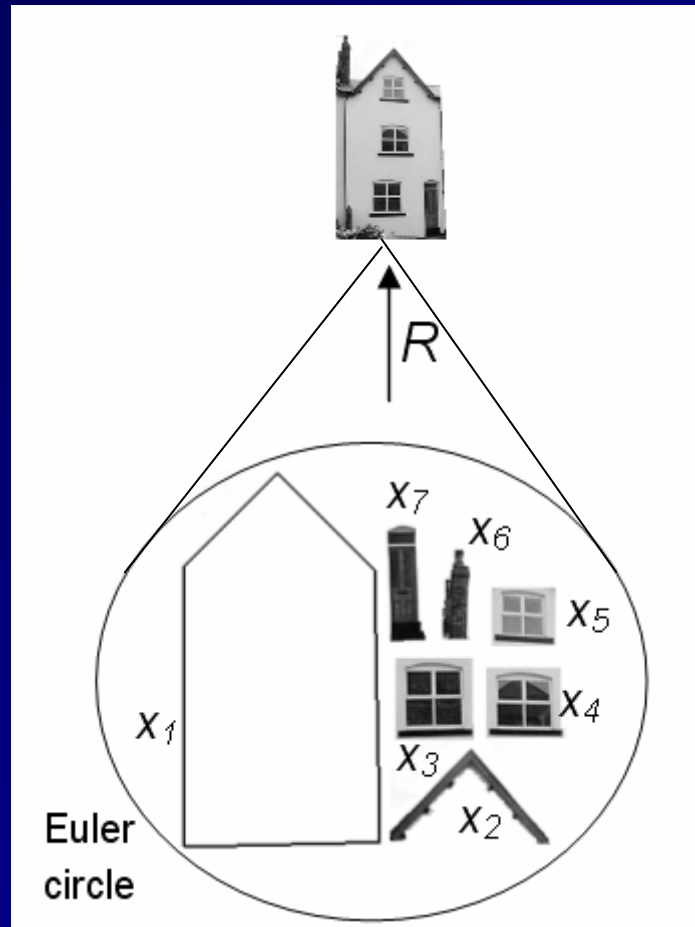
Design assembles wholes from parts



creating a multi-level hierarchy

Design assembles wholes from parts

Hierarchical Cones



Level N+1

Level N

The intermediate word problem

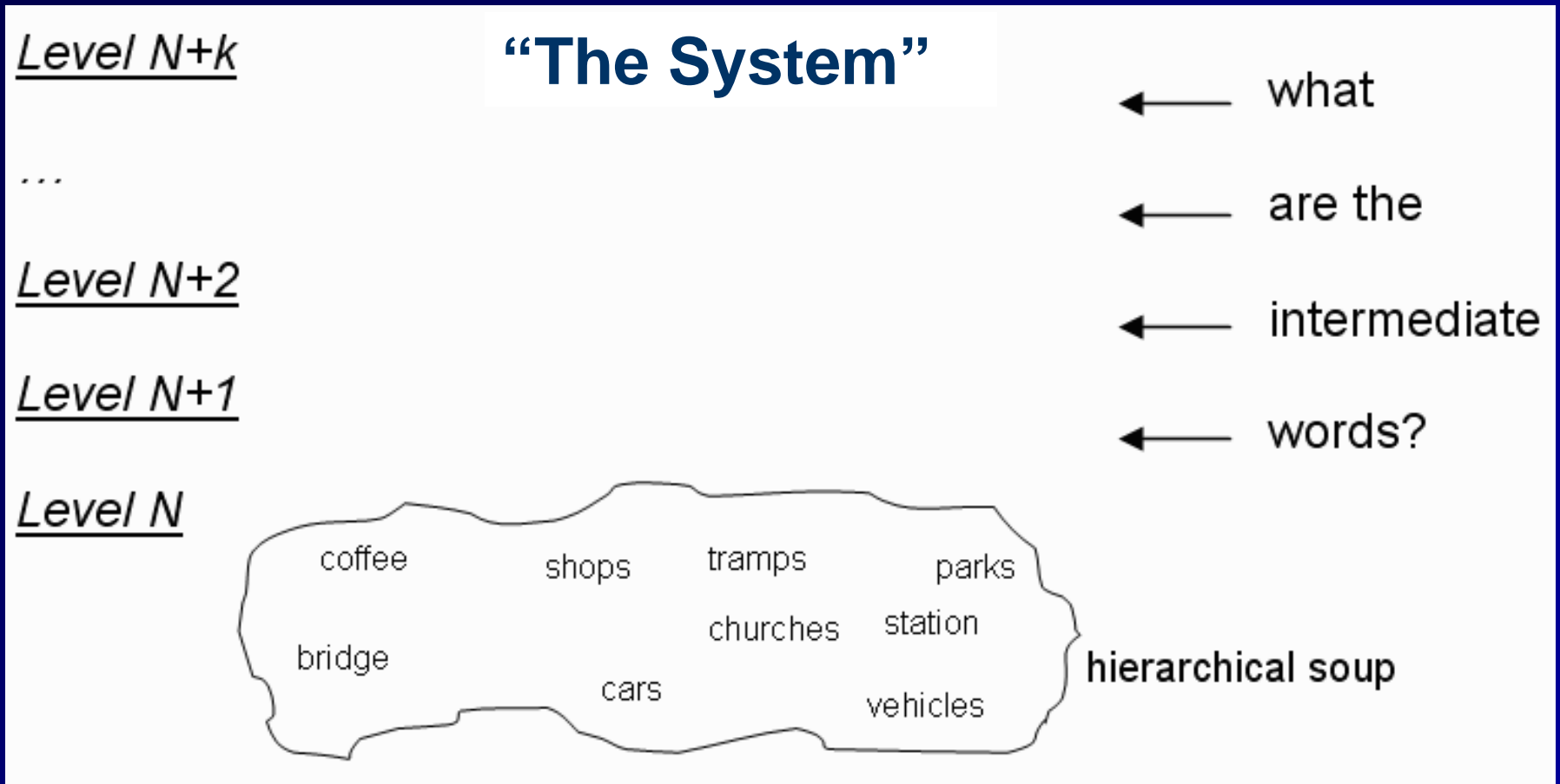
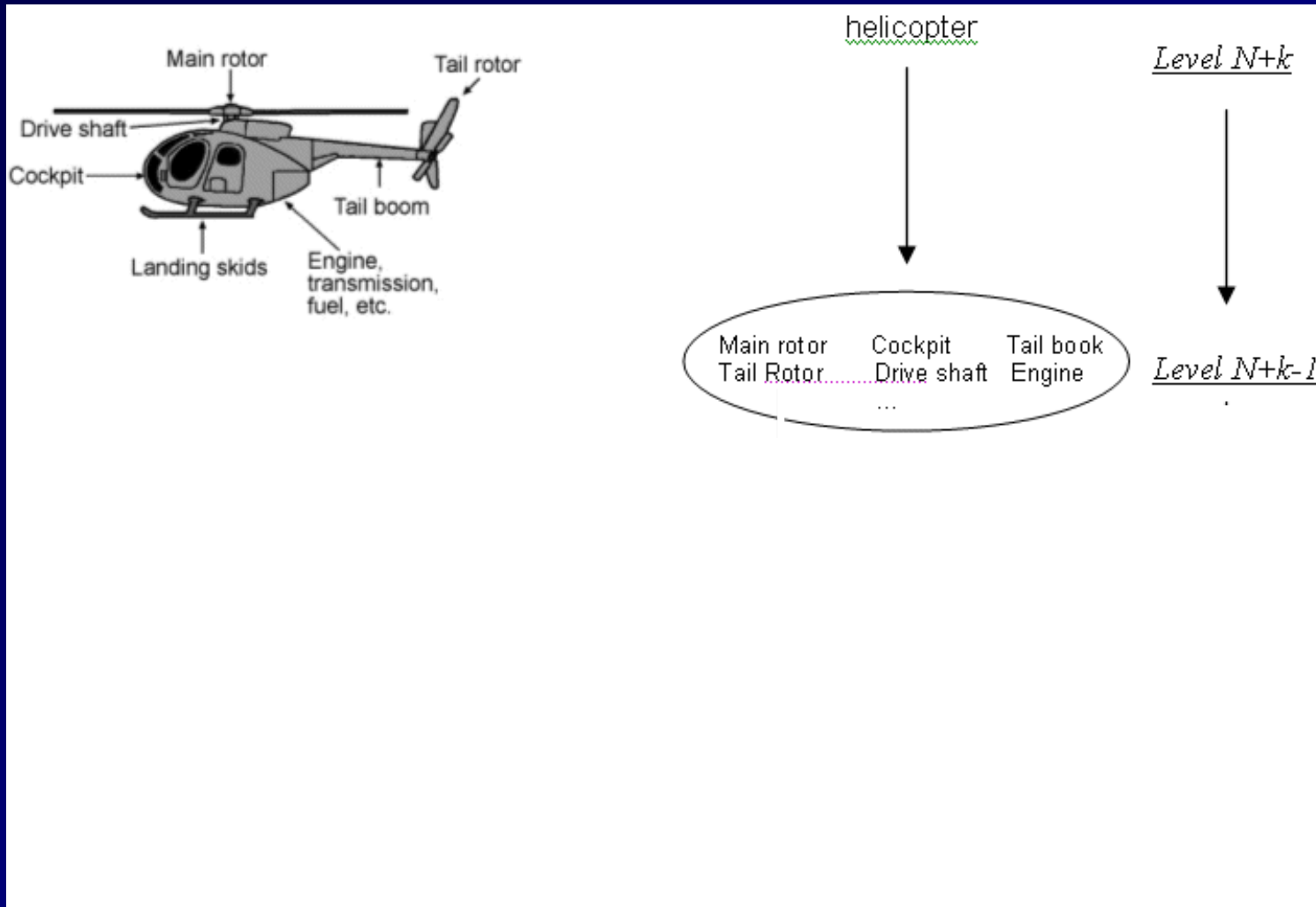
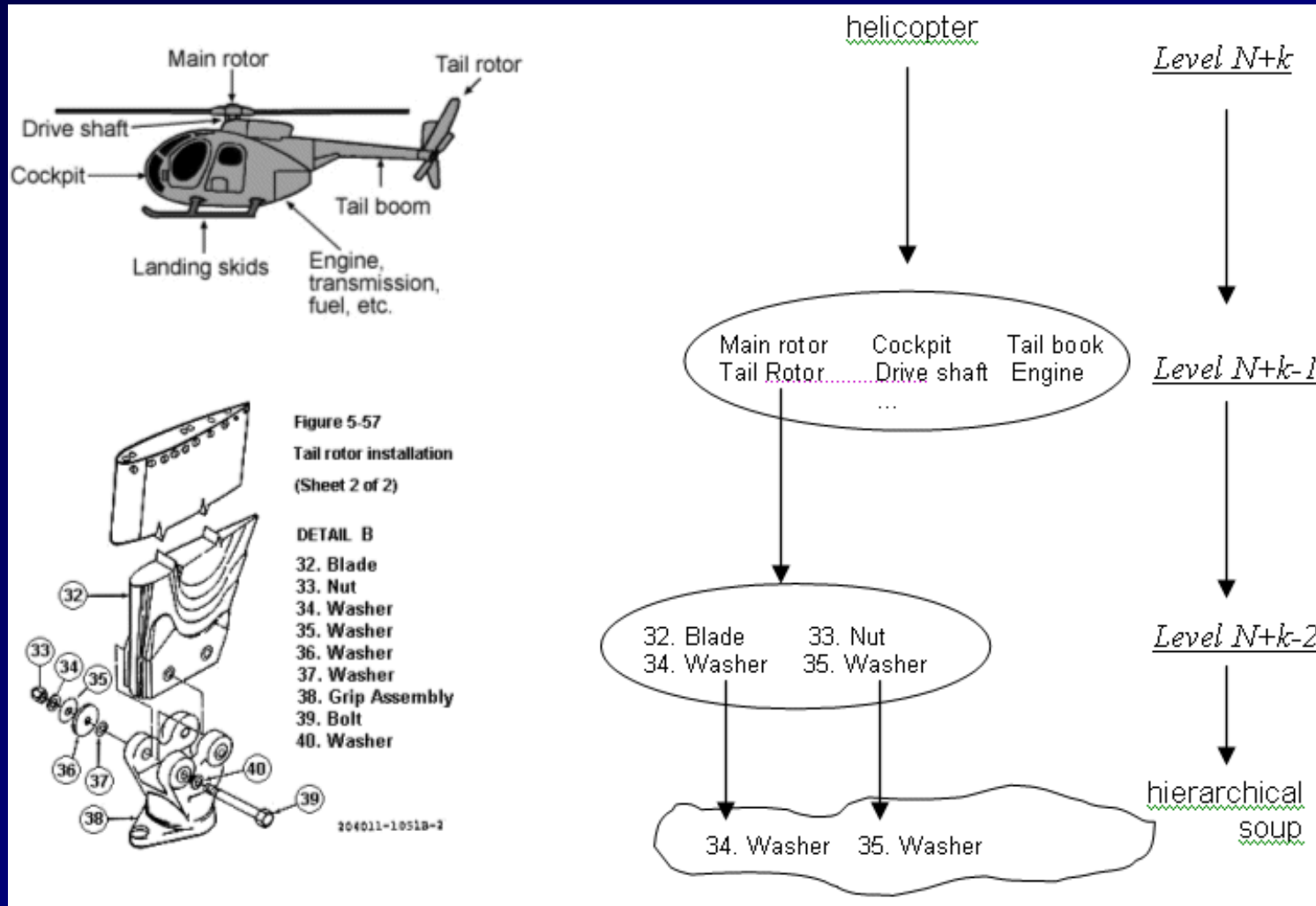


Figure 10. The intermediate word problem

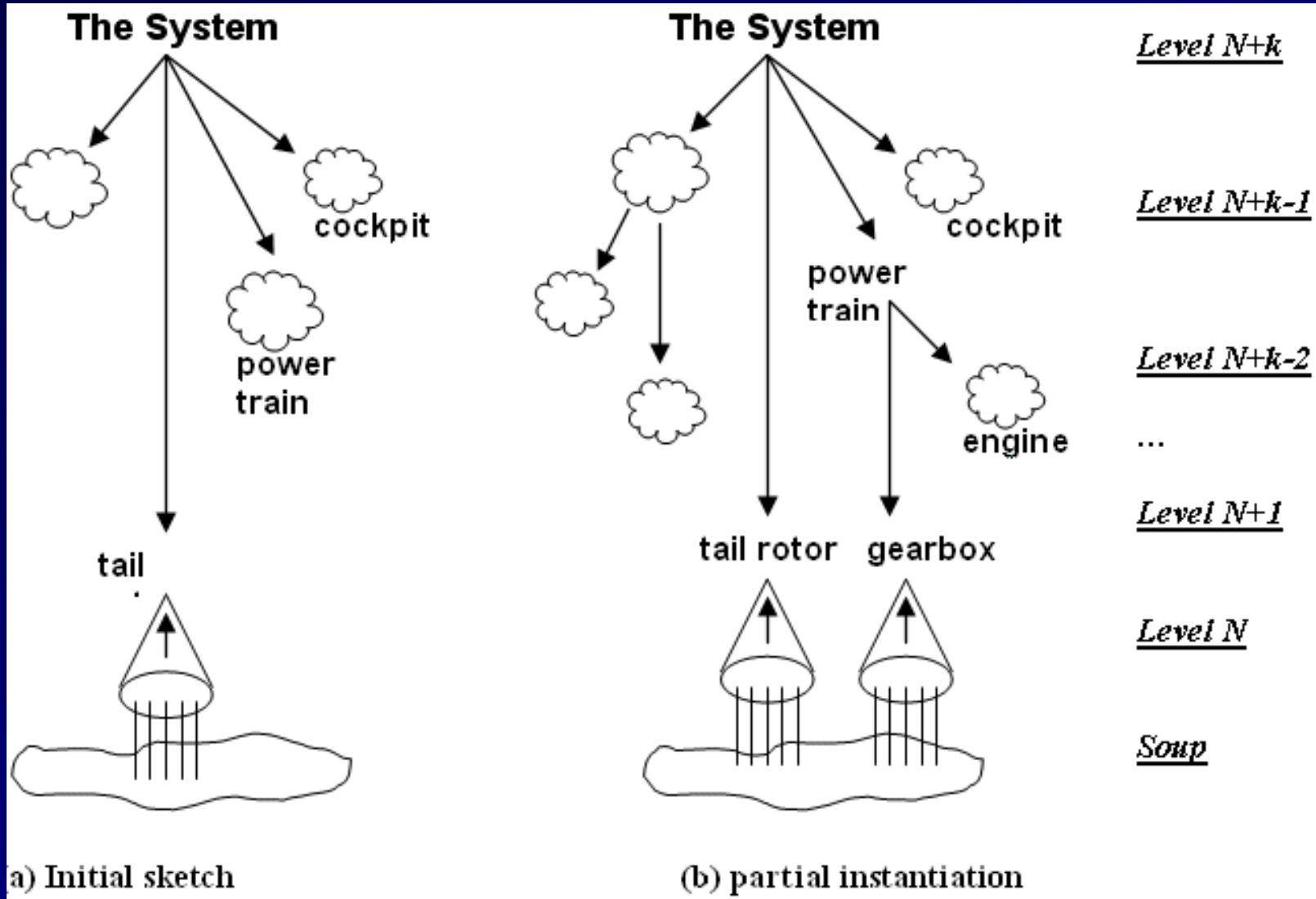
The intermediate word problem



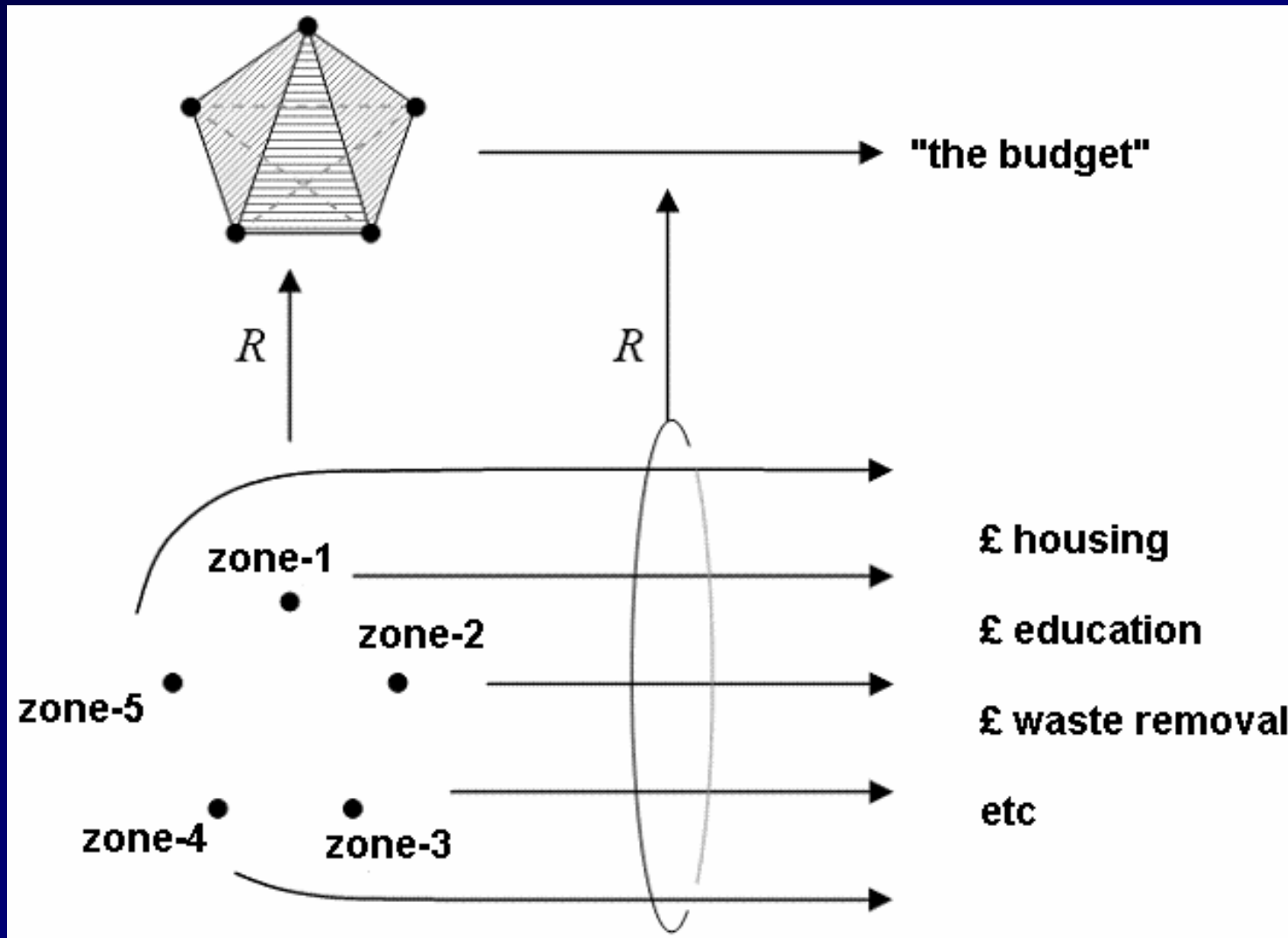
The intermediate word problem



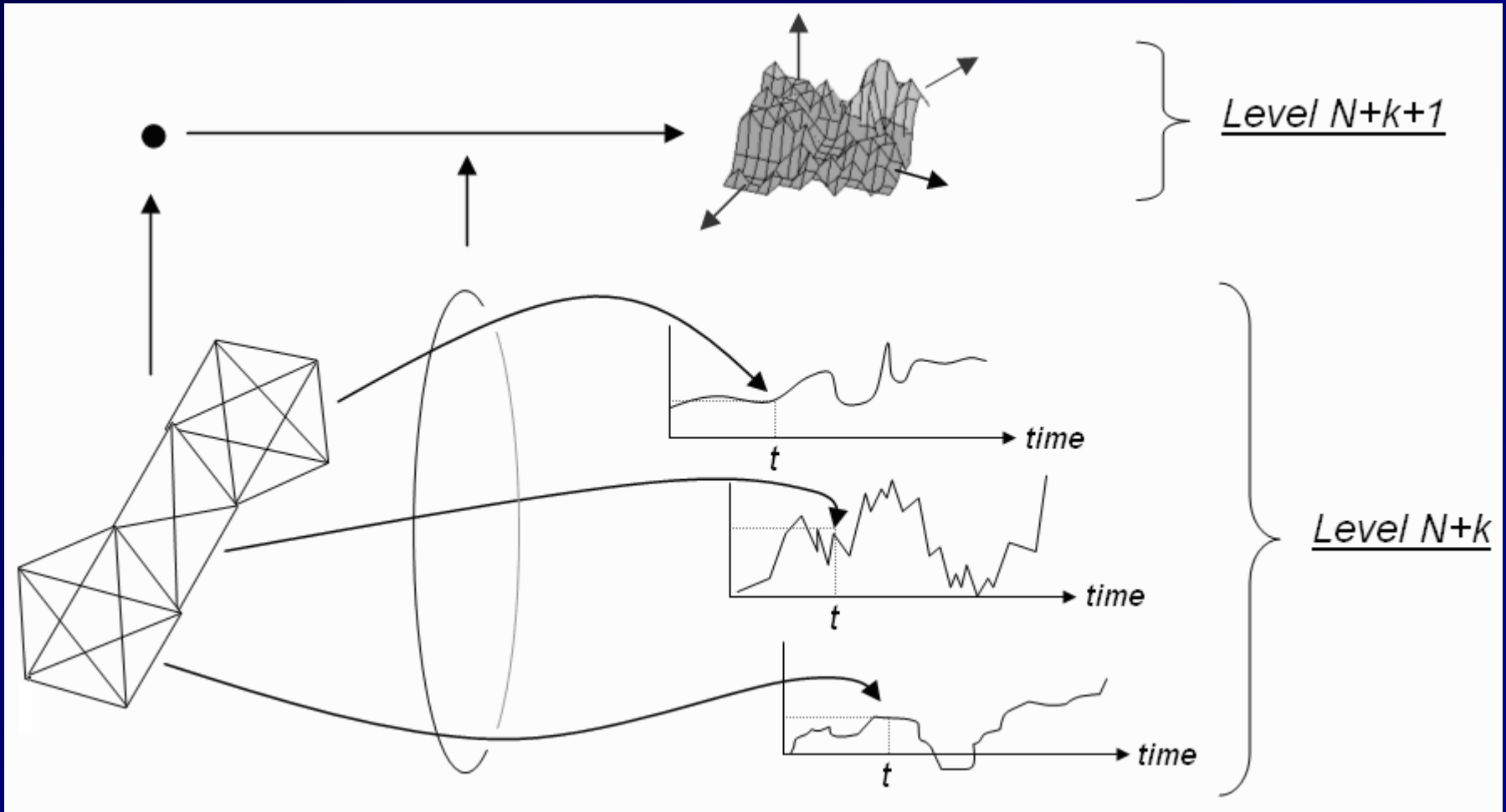
Design as the process of building an ontology



Traffic on the hierarchical backcloth



Unpacking functions to structure



System dynamics as traffic on a fixed multilevel backcloth

System time and System Events

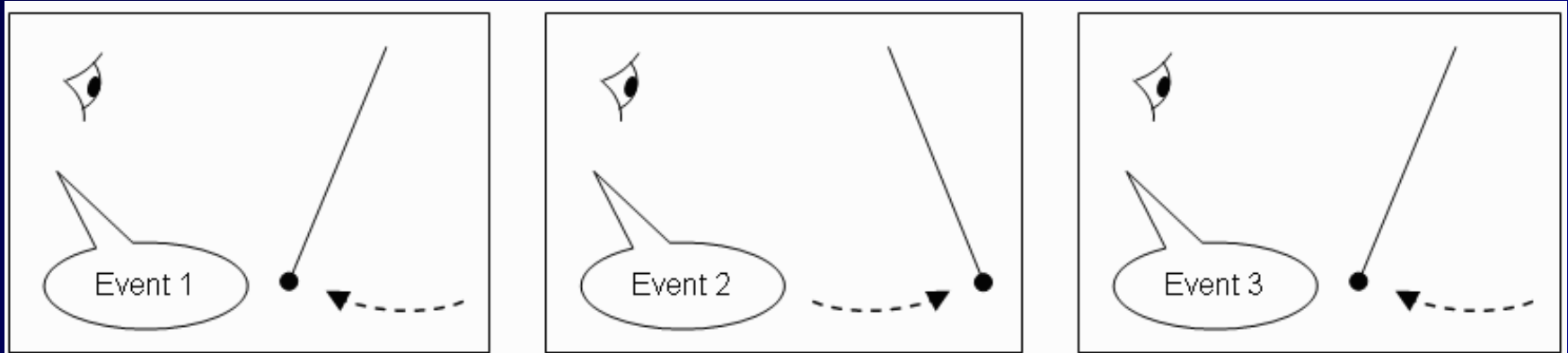


Figure 18: Pendulum events used to measure clock time

System time and System Events

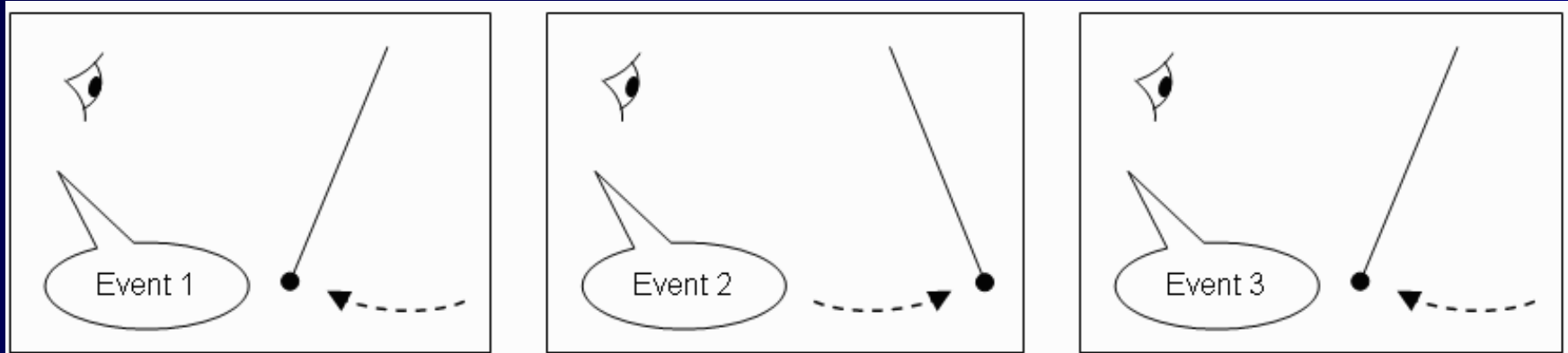
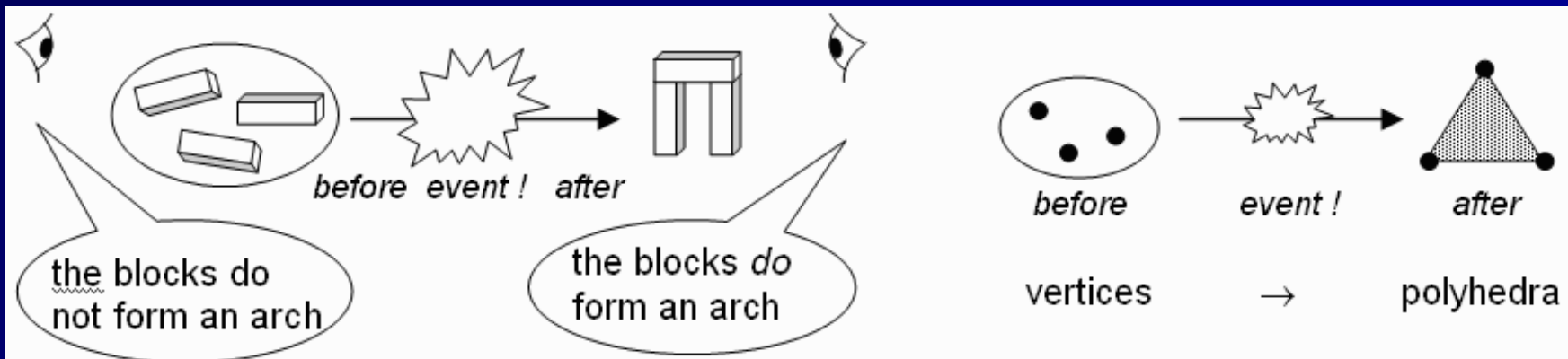


Figure 18: Pendulum events used to measure clock time



(a) assembling elements to form a structural event

(b) a polyhedral event

Figure 19. The formation of polyhedral structure marks system events

System time and System Events

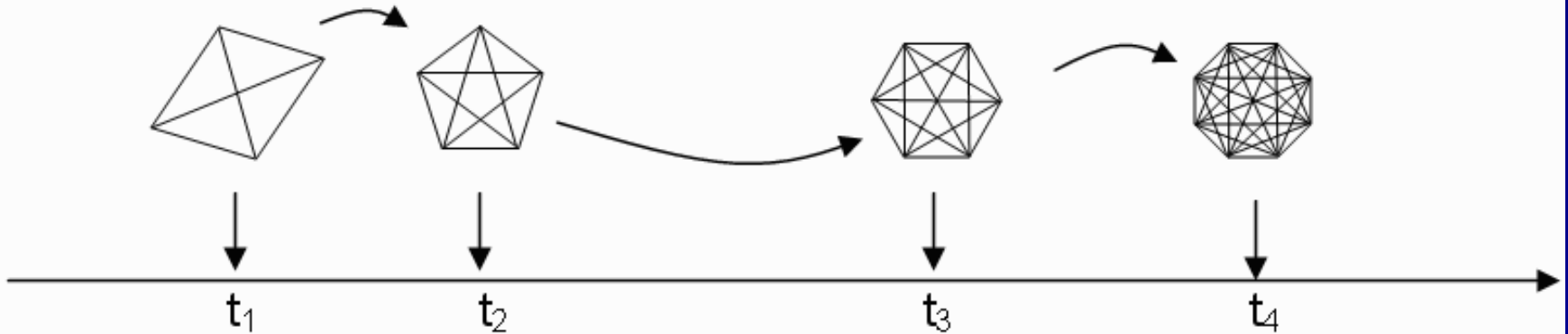


Figure 21. System event dynamics form trajectories in a non-linear way in clock time

Planning involves changing *relations*

System time and System Events

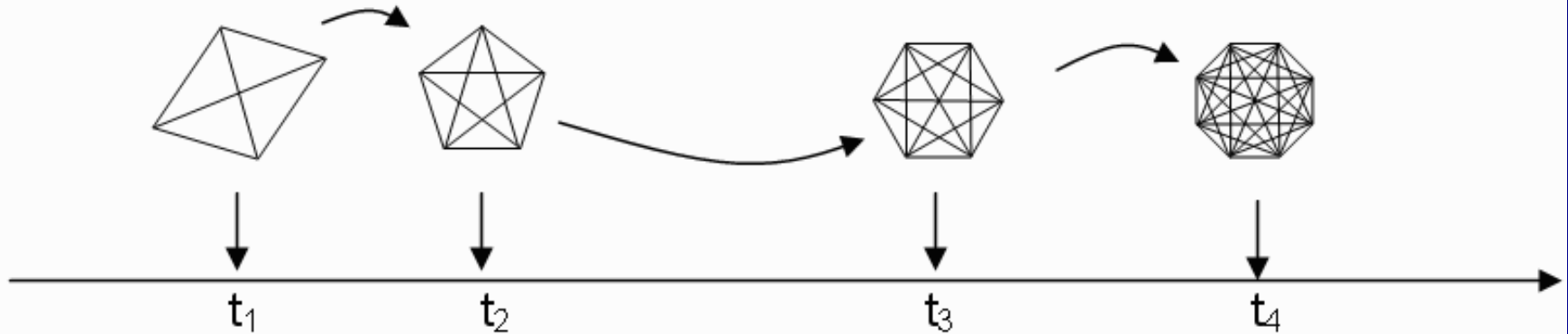
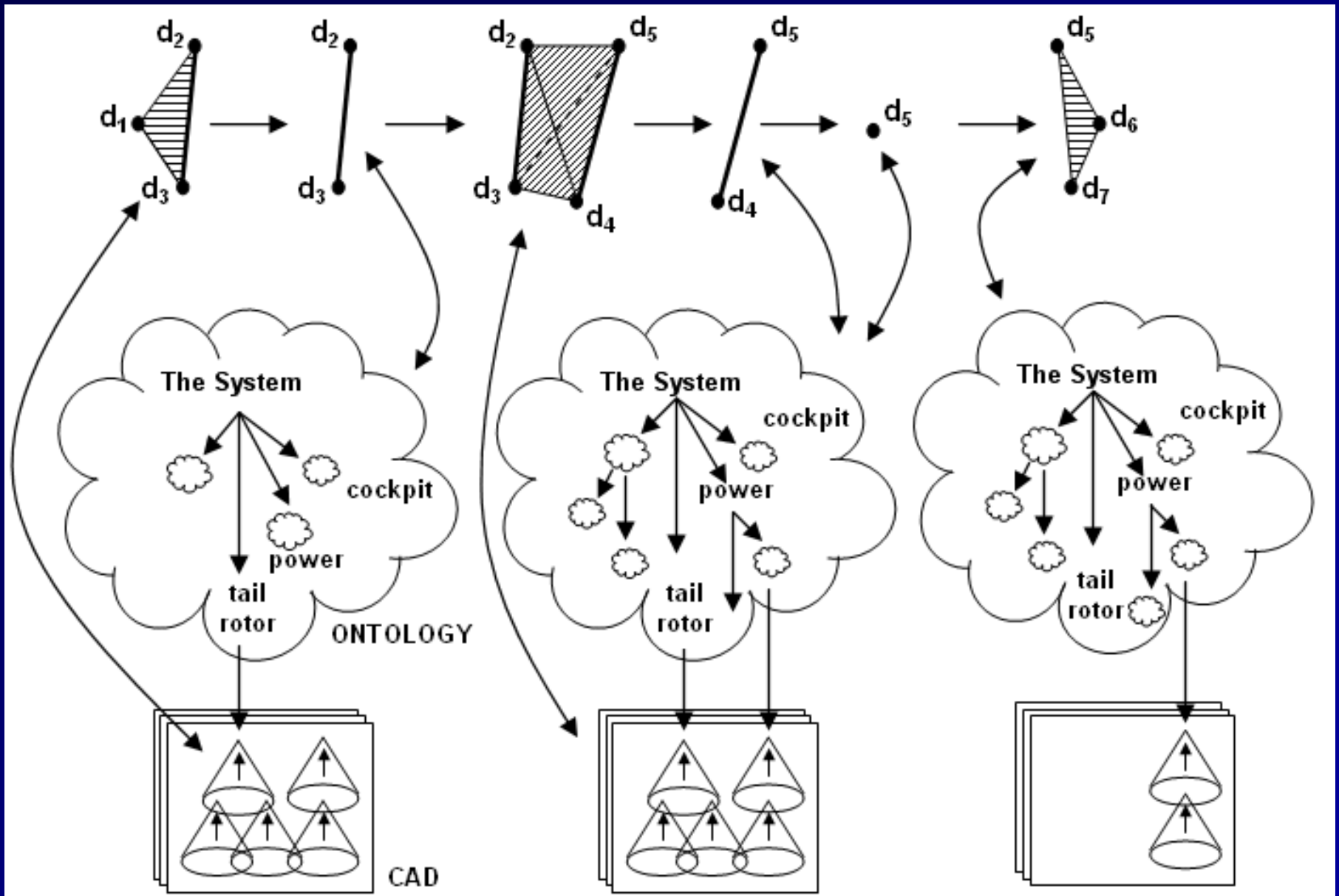


Figure 21. System event dynamics form trajectories in a non-linear way in clock time

Planning involves changing *relations*

... as well as trying to manage the traffic

Relational dynamics working up a design



Designers as scientists

If a designer creates a completely new system, they are the sole possessors of knowledge about that system.

Designers as scientists

If a designer creates a completely new system, they are the sole possessors of knowledge about that system.

The design process involves building a language and a science of the synthetic system.

Designers as scientists

If a designer creates a completely new system, they are the sole possessors of knowledge about that system.

The design process involves building a language and a science of the synthetic system.

Involves hypotheses, deduction, prediction, experiments, testing hypothesis.

Conclusions

***Everything* is multi-dimensional**

Conclusions

Everything is multi-dimensional

Need multi-dimensional Q-analysis - not just graphs

Conclusions

Everything is multi-dimensional

Need multi-dimensional Q-analysis - not just graphs

Design involves building multi-level languages

Conclusions

Everything is multi-dimensional

Need multi-dimensional Q-analysis - not just graphs

Design involves building multi-level languages

Complexity - the science of artificial systems

Conclusions

Everything is multi-dimensional

Need multi-dimensional Q-analysis - not just graphs

Design involves building multi-level languages

Complexity - the science of artificial systems

Designers - heroes of the complexity revolution

Conclusions

Everything is multi-dimensional

Need multi-dimensional Q-analysis - not just graphs

Design involves building multi-level languages

Complexity - the science of artificial systems

Designers - heroes of the complexity revolution

That's *Life* ...