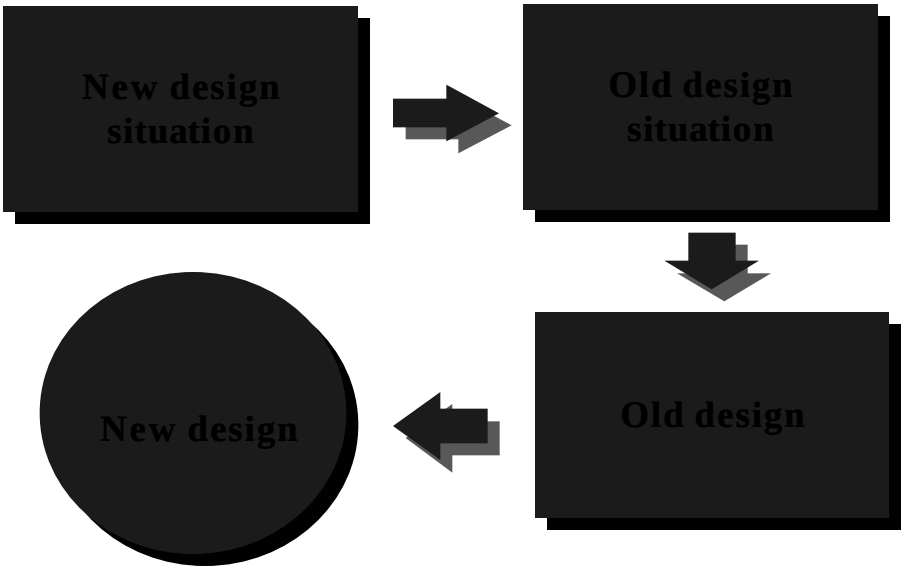
DISTANT ANALOGIES

MIT Class 4.208 Spring 2002

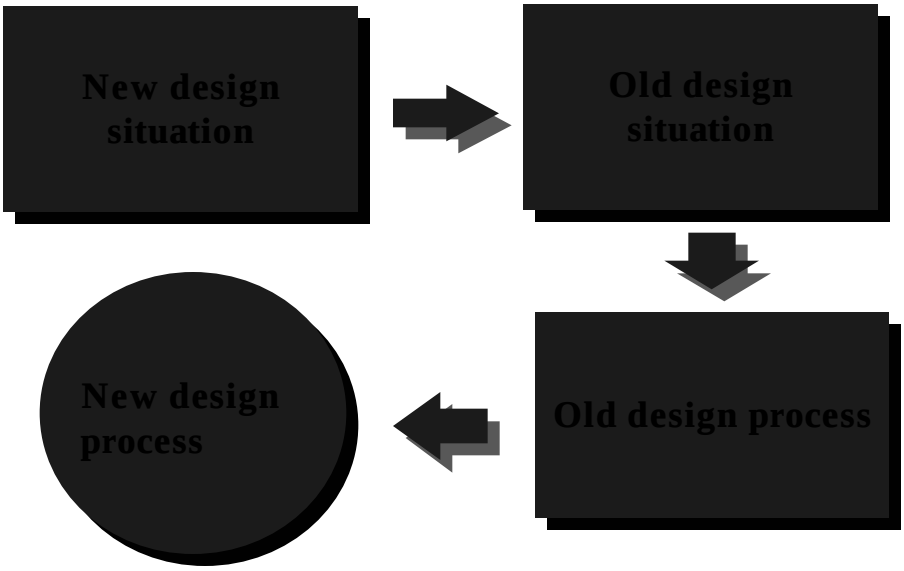
TYPES OF ANALOGIES

- Transformational
- Derivational

TRANSFORMATIONAL ANALOGY



DERIVATIONAL ANALOGY

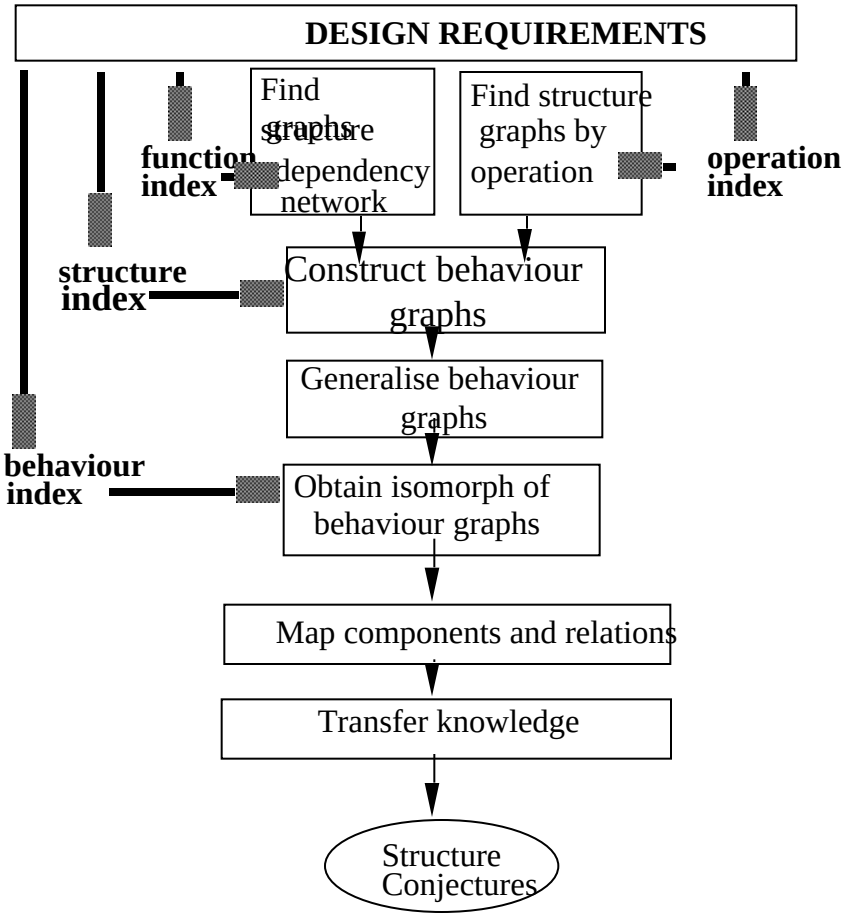


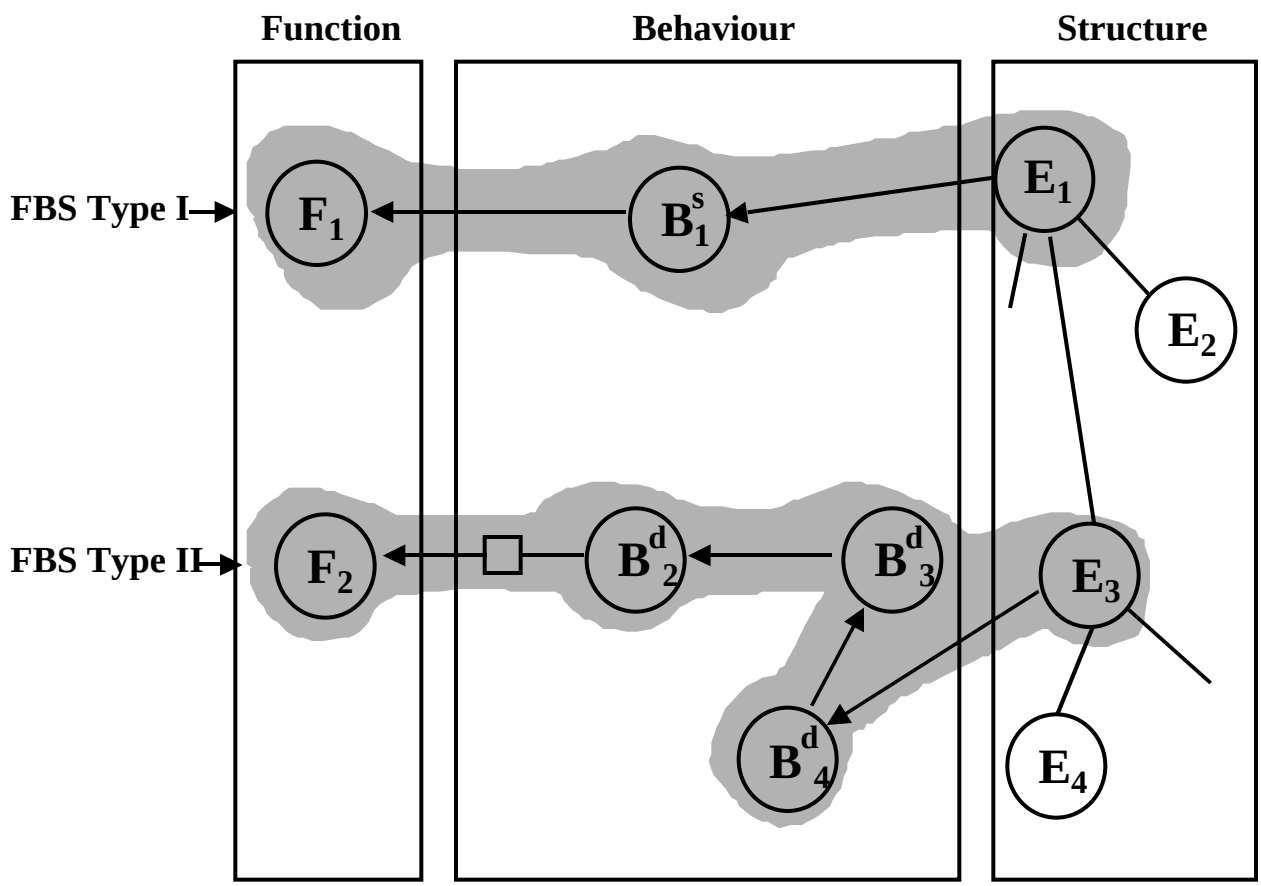
ISSUES FOR DISTANT ANALOGIES

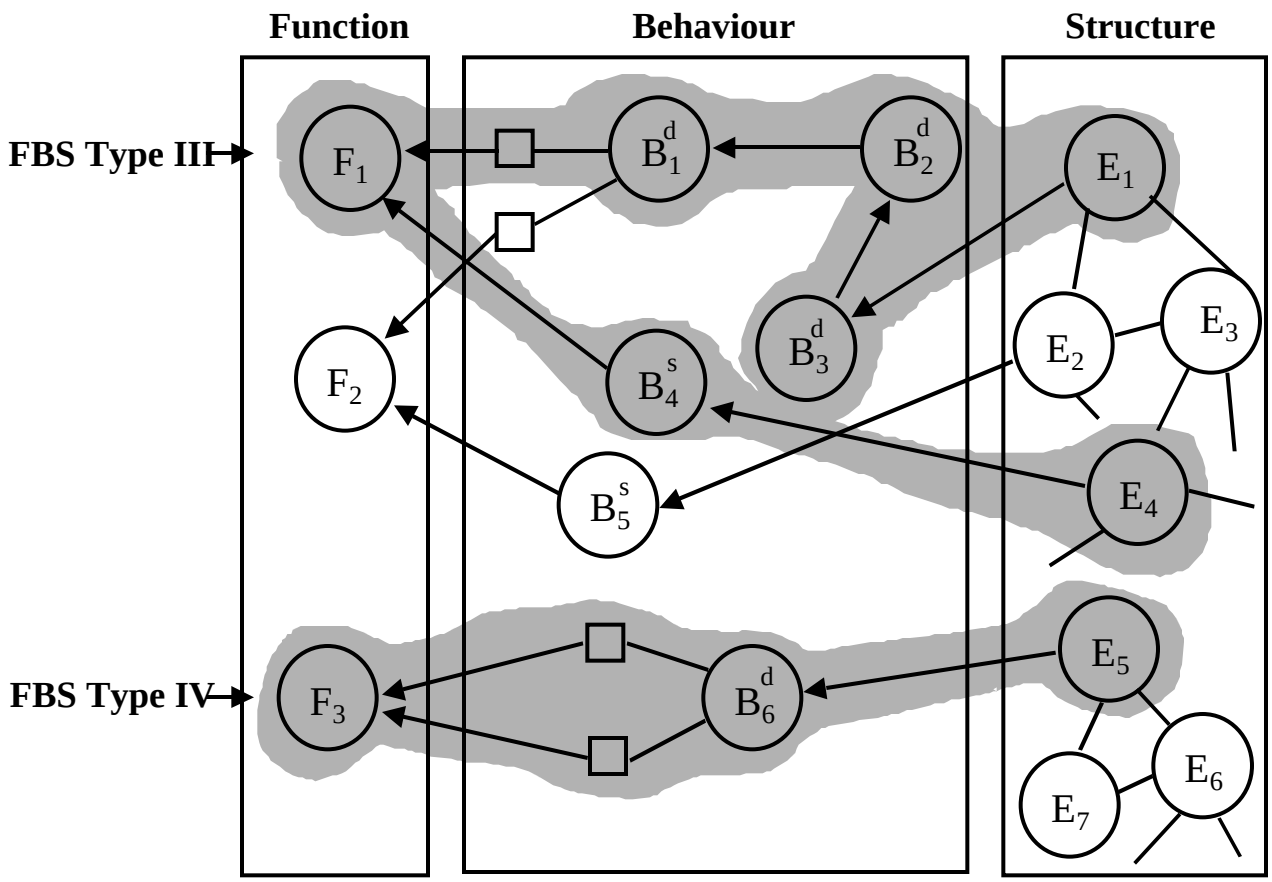
- Different domains produce distant analogies
  - No mapping terminology
  - No structure in common
- How to connect designs in different domains?

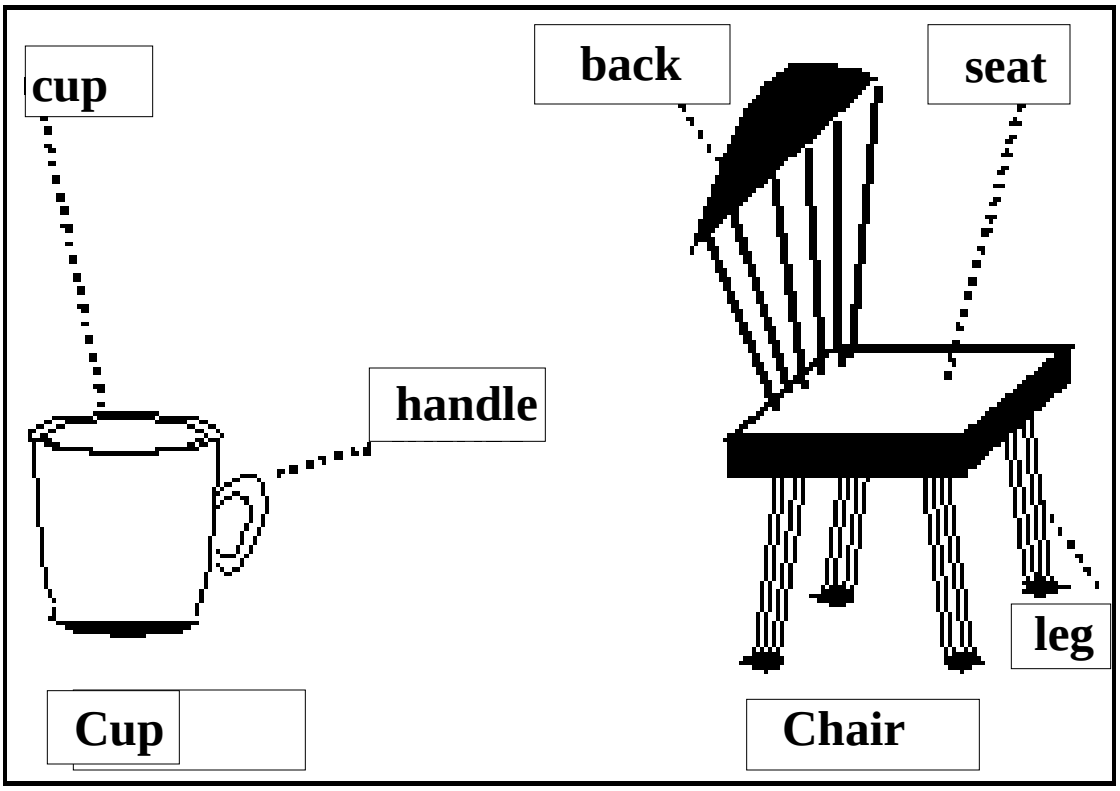
ANALOGIES FROM DIFFERENT DOMAINS

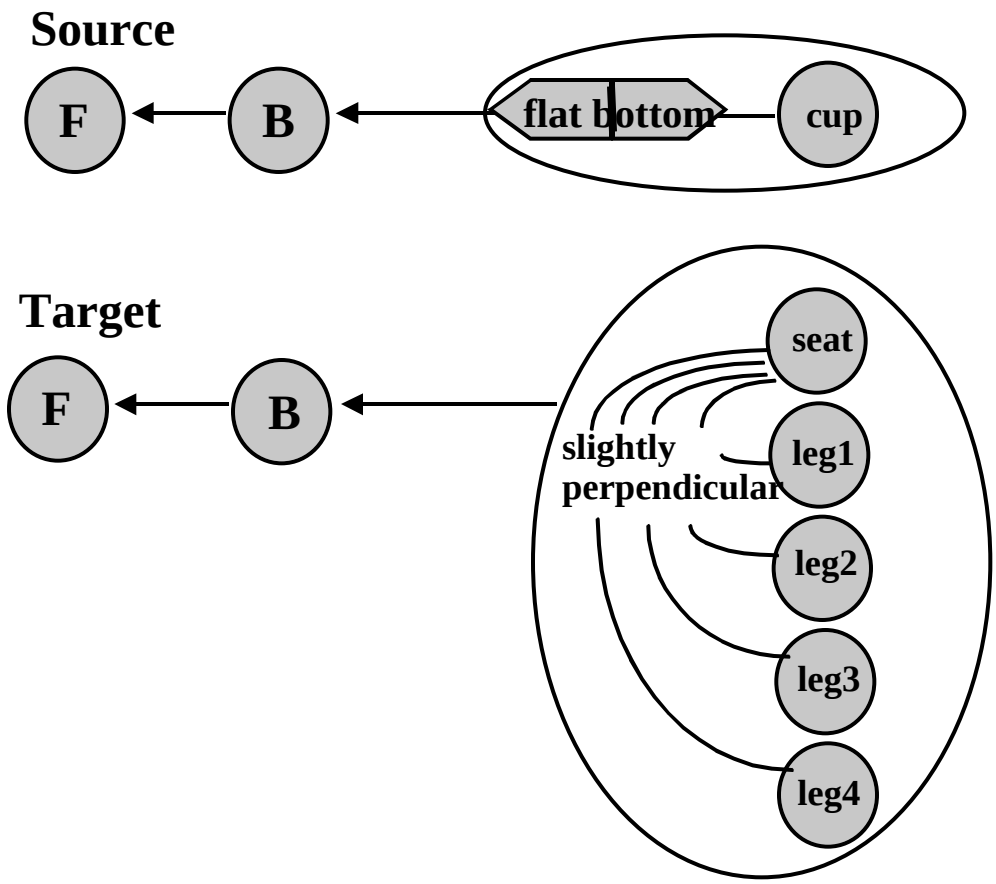
- Cannot use structure as index
- Cannot necessarily use behavior
- Use “goal achievement”
  - How function is achieved through behavior
  - How behavior is arrived at from structure
- Index through how goals are achieved and then map structures

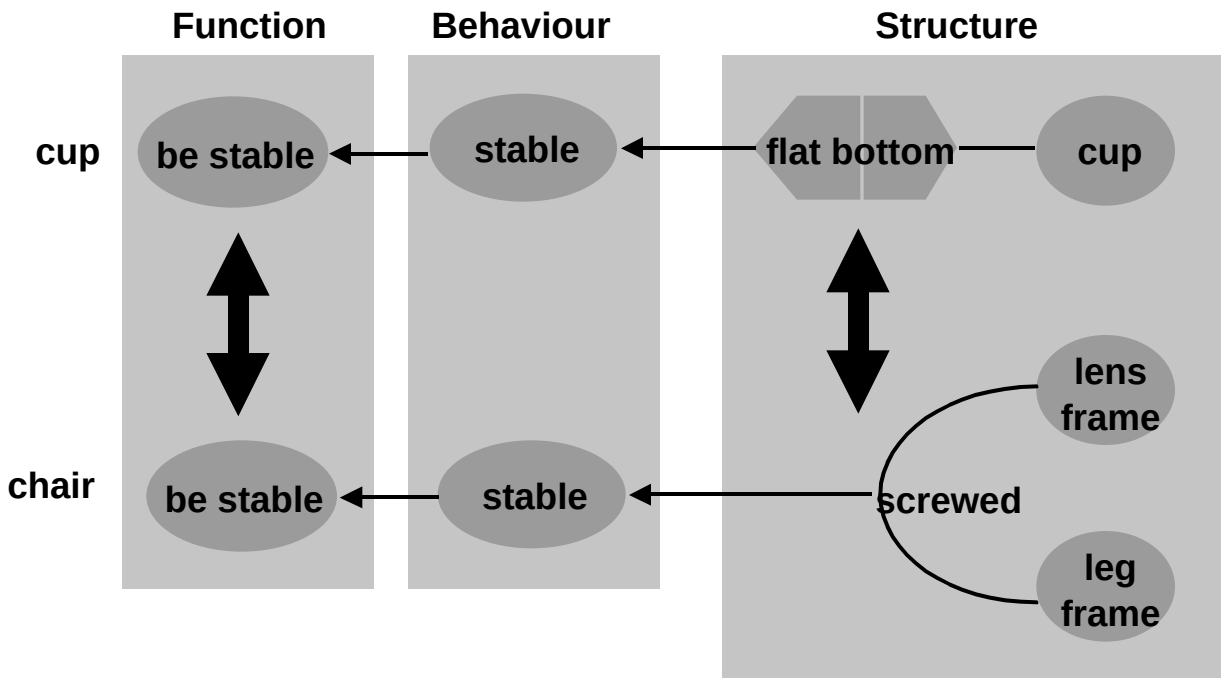

DESIGN REQUIREMENTS
Find structure graphs
Find structure graphs by operation
function index
operation index
structure index
behaviour index
dependency network
Construct behaviour graphs
Generalise behaviour graphs
Obtain isomorph of behaviour graphs
Map components and relations
Transfer knowledge
Structure Conjectures


Function
Behaviour
Structure
FBS Type I
FBS Type II
F_1
B^s_1
E_1
E_2
F_2
B^d_2
B^d_3
E_3
B^d_4
E_4


Function
Behaviour
Structure
FBS Type III
FBS Type IV
F1
F2
F3
B1d
B2d
B3d
B4s
B5s
B6d
E1
E2
E3
E4
E5
E6
E7


cup
handle
Cup
back
seat
leg
Chair


Source
F
B
flat bottom
cup
Target
F
B
seat
slightly
perpendicular
leg1
leg2
leg3
leg4


Function
Behaviour
Structure
cup
be stable
stable
flat bottom
cup
lens frame
chair
be stable
stable
screwed
leg frame

>(command)

This is a small design system by analogy.

Following design prototypes are stored in the system:

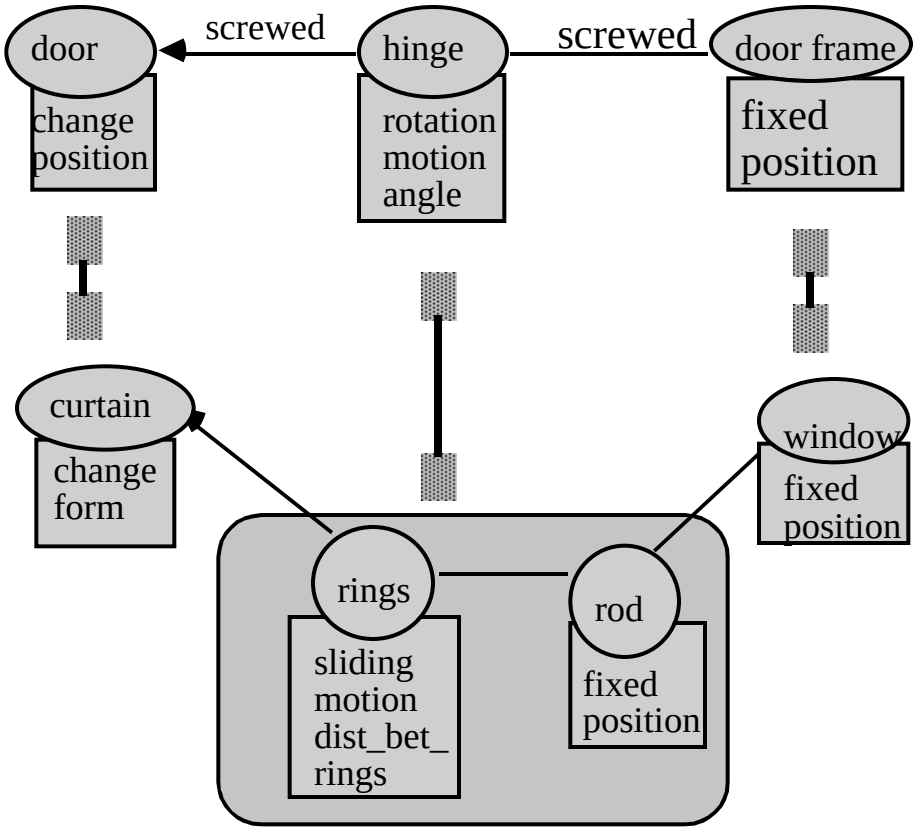
(WINDOW COMPUTER PROPELLING_PENCIL UMBRELLA TELEPHONE WATER_TAP DOOR CURTAIN_SYSTEM)

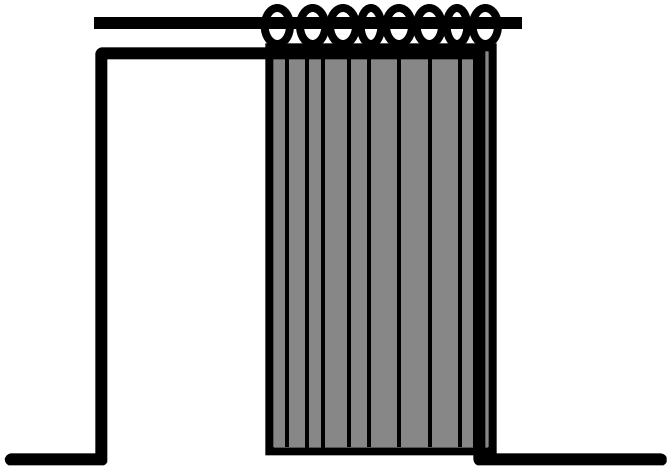
Please enter a design prototype name which appears in the previous list: (target)

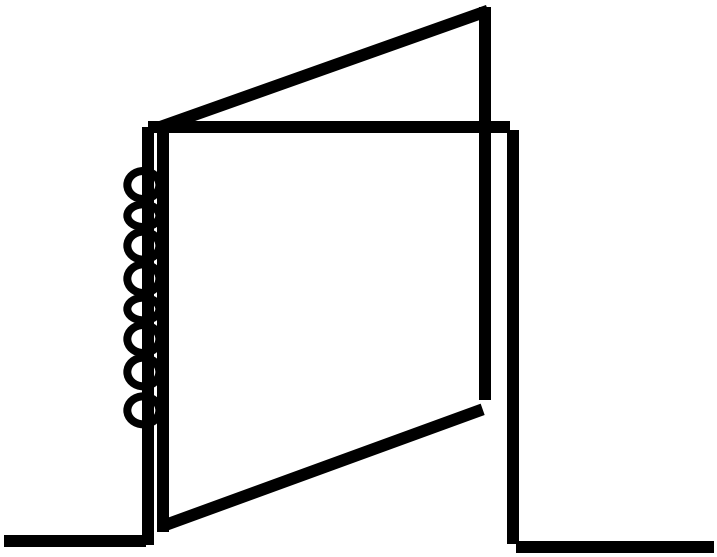
door

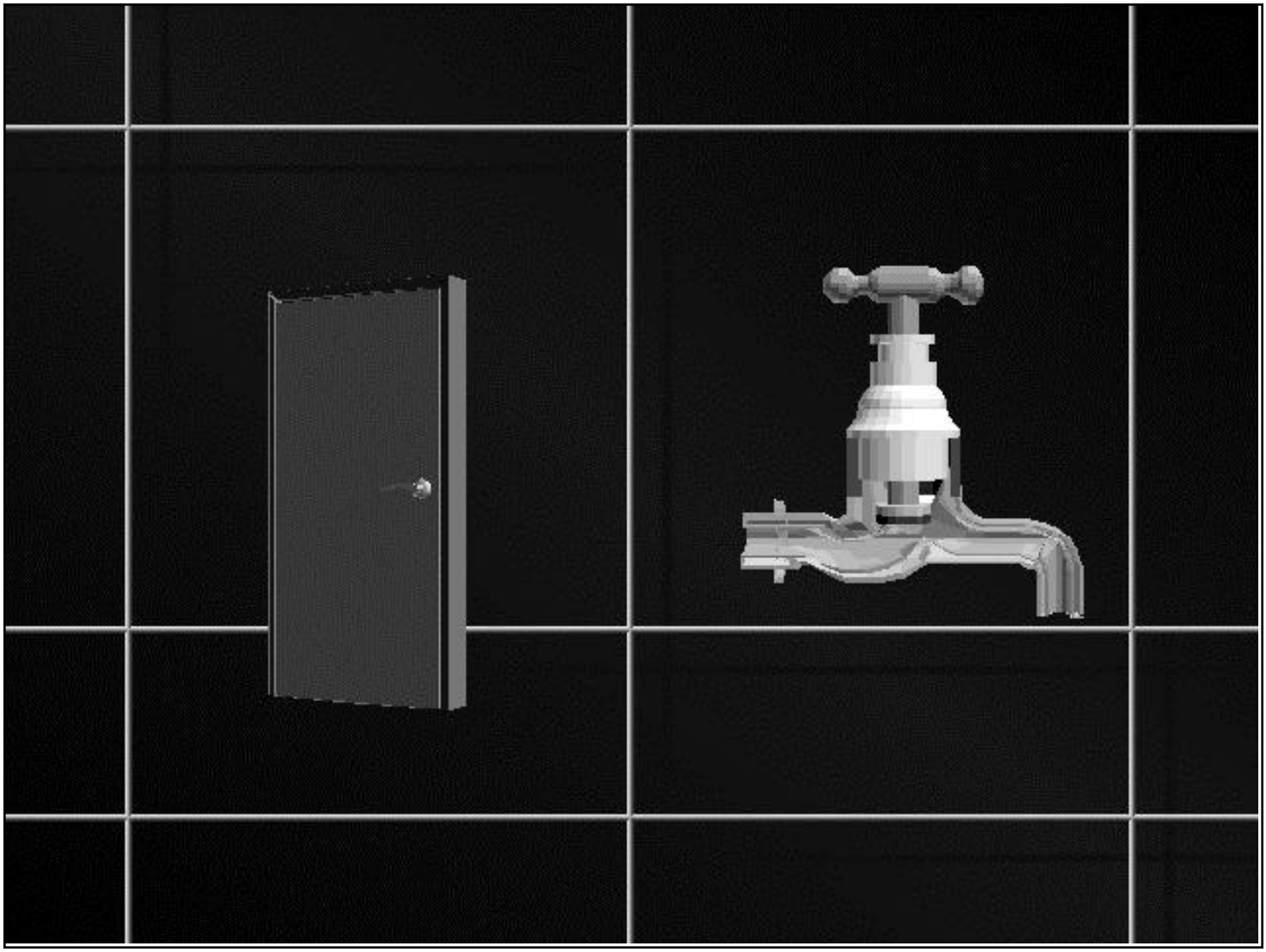
Analogy candidates are:

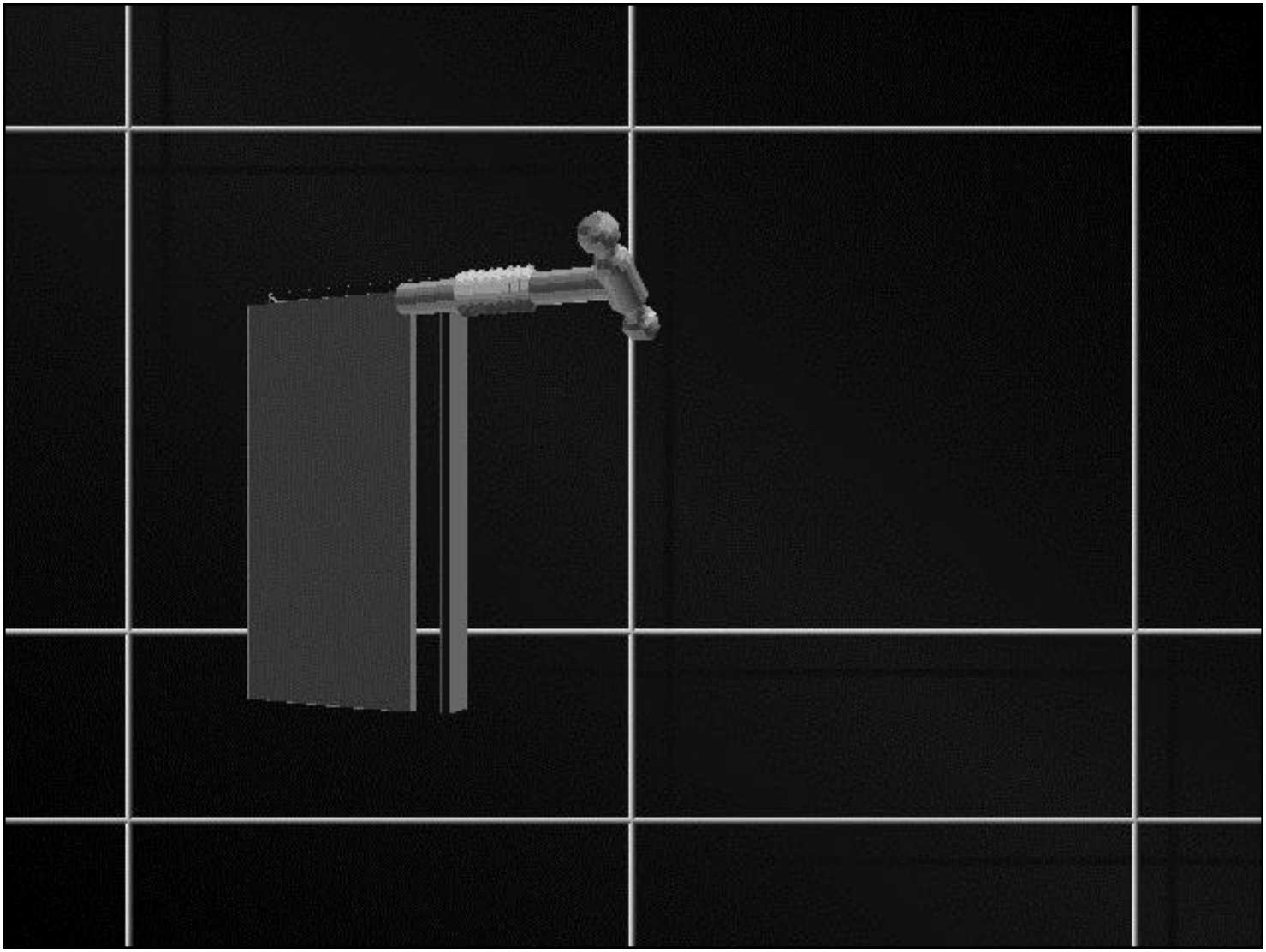
Found prototypes (CURTAIN_SYSTEM WATER_TAP WINDOW) with the same goal achievement path as prototype DOOR.


door
change position
screwed
hinge
rotation motion angle
screwed
door frame
fixed position
curtain
change form
window
fixed position
rings
sliding motion dist_bet_ rings
rod
fixed position







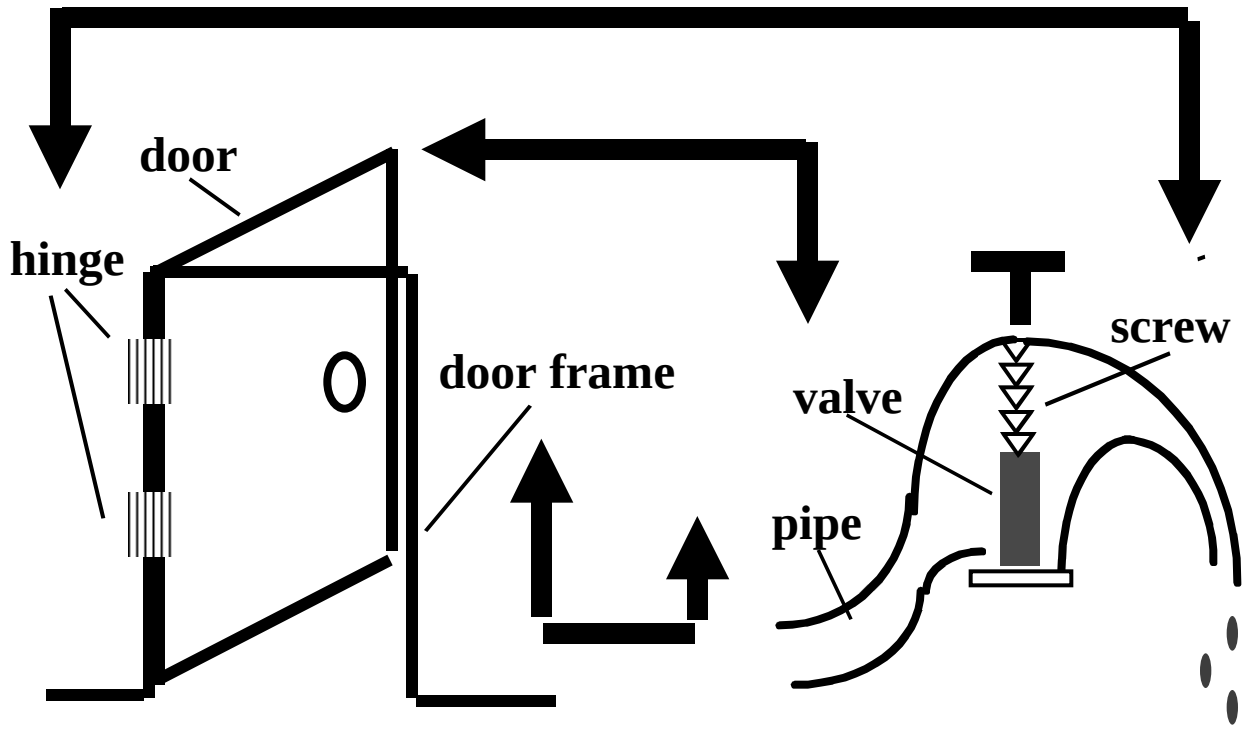


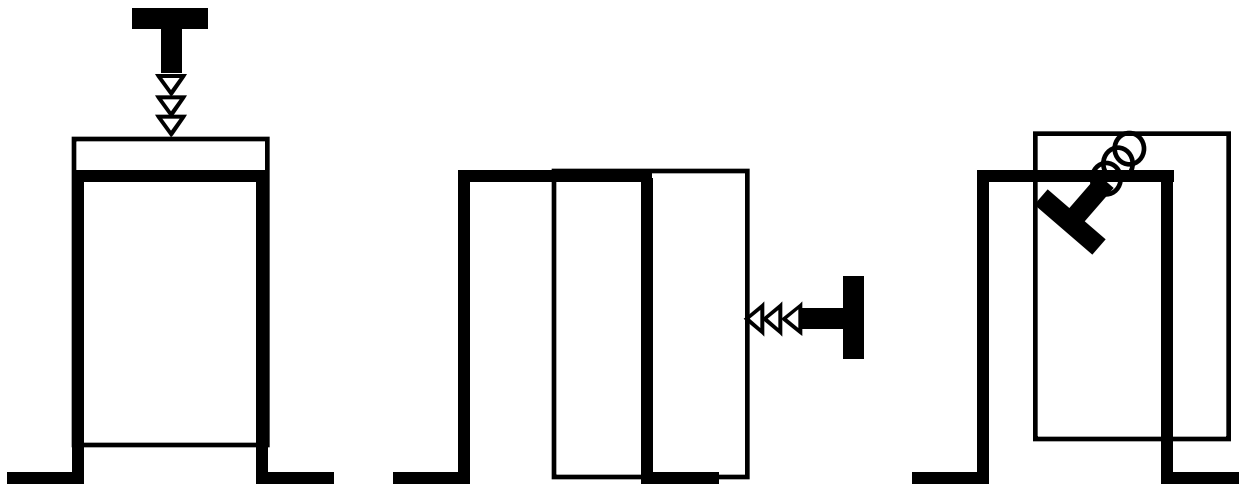
```
CANDIDATE INFERENCES:                    ; structure to be
======================                   transferred
STRUCTURE:
(MOVE-ALONG VALVE SCREW)
(SCREWED VALVE SCREW)
(PERPENDICULAR-FIXED HANDLE SCREW)

CONTEXT:                                 ; context to be transferred
(FIXED PIPE WALL)
==================================
FOR CONJECTURE FROM ANALOGICAL
INFERENCES, ANSWER:                      ; start evaluation
   ' Y ' for ACCEPT;
  ' M ' for MODIFICATION;
  ' N ' for REJECTION.
==================================
```

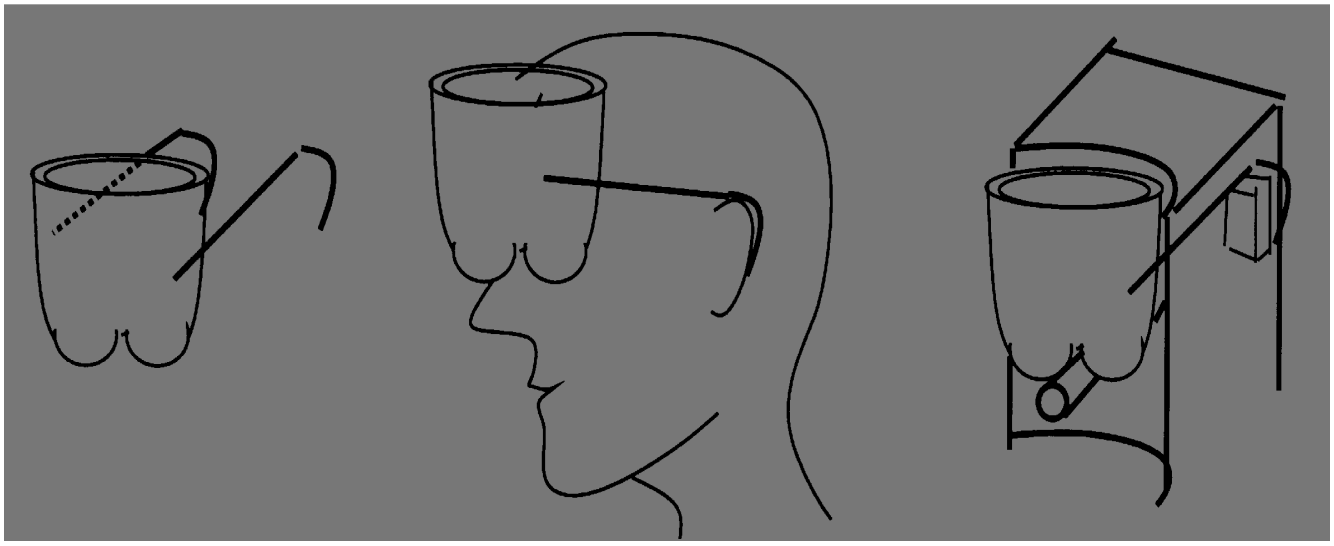
(PERPENDICULAR-FIXED HANDLE SCREW) ? y

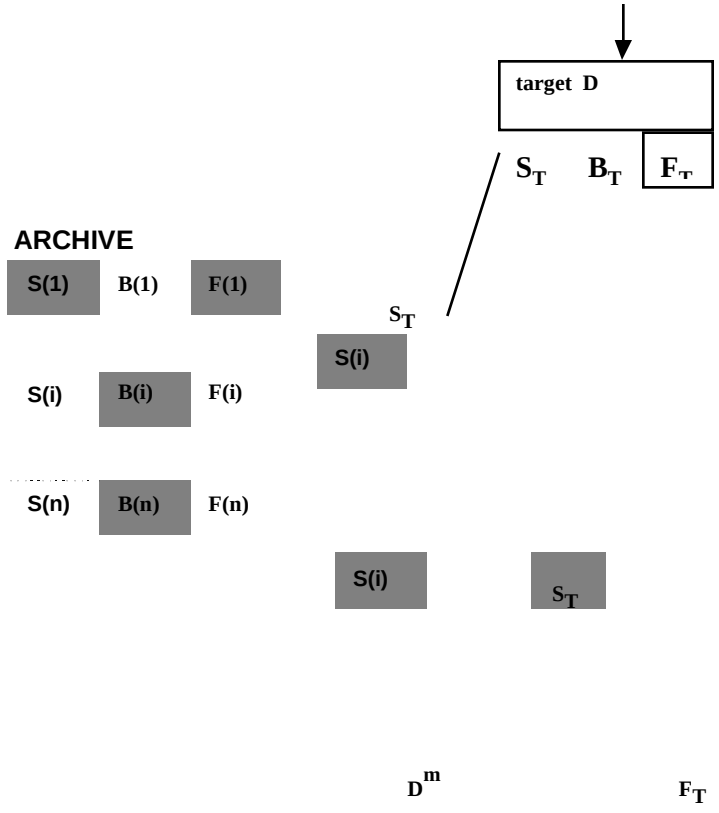
((FIXED DOOR-FRAME WALL)) ? y
((MOVIE-ALONG DOOR SCREW)) ? y
((SCREWED DOOR SCREW)) ? y
=========
CONJECTURES:
==========
(PERPENDICULAR-FIXED HANDLE SCREW)
(SCREWED DOOR SCREW)
(MOVE-ALONG DOOR SCREW)

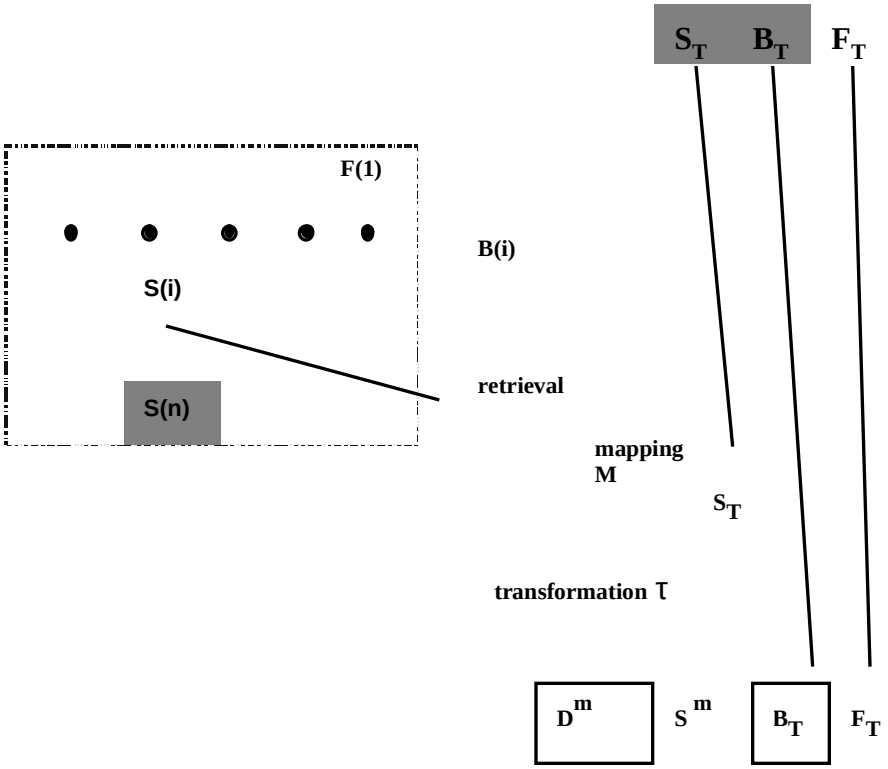
CONTEXT:
(FIXED DOOR-FRAME WALL)

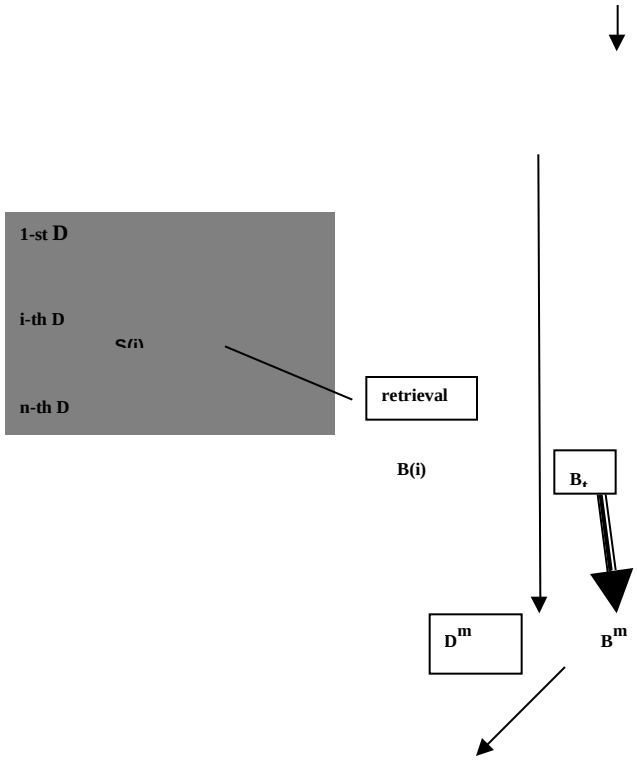

door
hinge
door frame
valve
screw
pipe

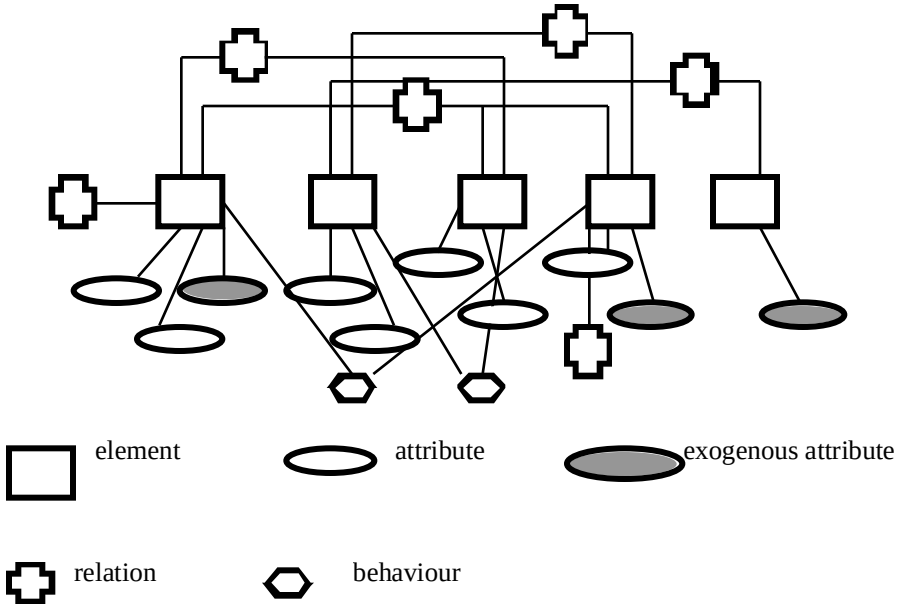




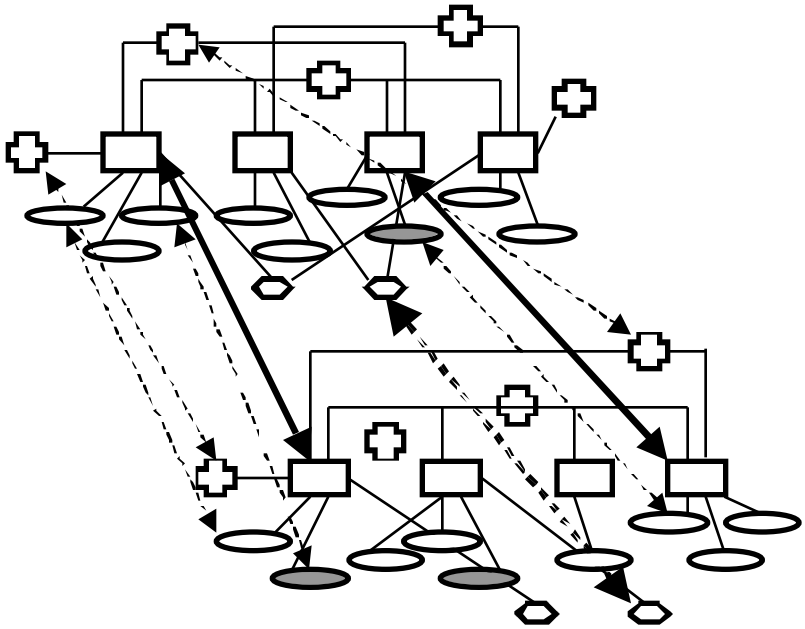

target D
S_T
B_T
F_T
ARCHIVE
S(1)
B(1)
F(1)
S_T
S(i)
S(i)
B(i)
F(i)
S(n)
B(n)
F(n)
S(i)
S_T
D^m
F_T


S_T B_T F_T
F(1)
B(i)
S(i)
retrieval
S(n)
mapping
M
S_T
transformation τ
D^m
S^m
B_T
F_T

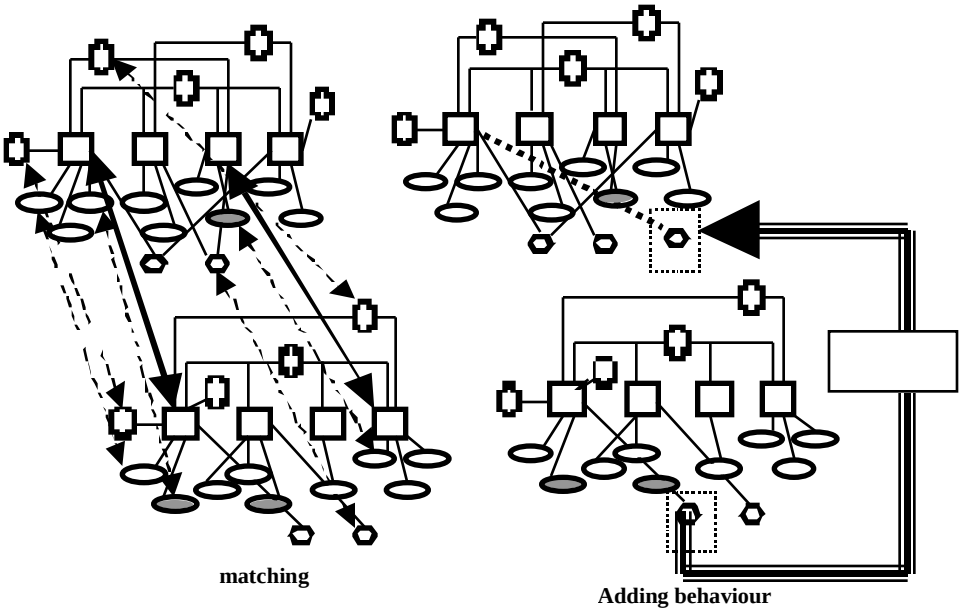

1-st D
i-th D
S(i)
n-th D
retrieval
B(i)
B
D^m
B^m



Structure+behaviour graph of design prototype

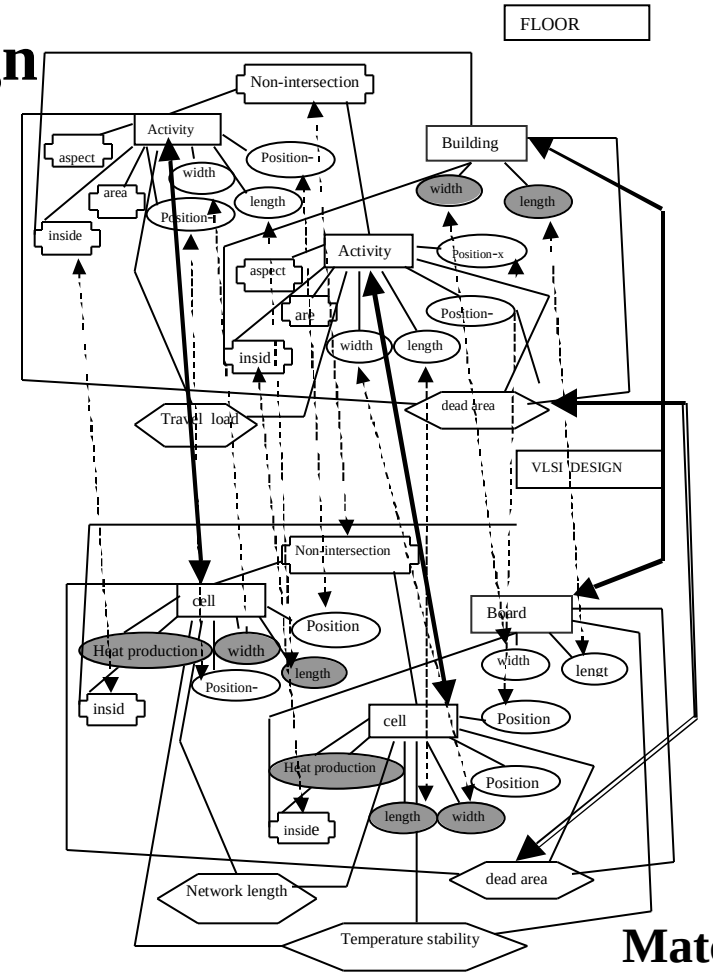


Structure matching



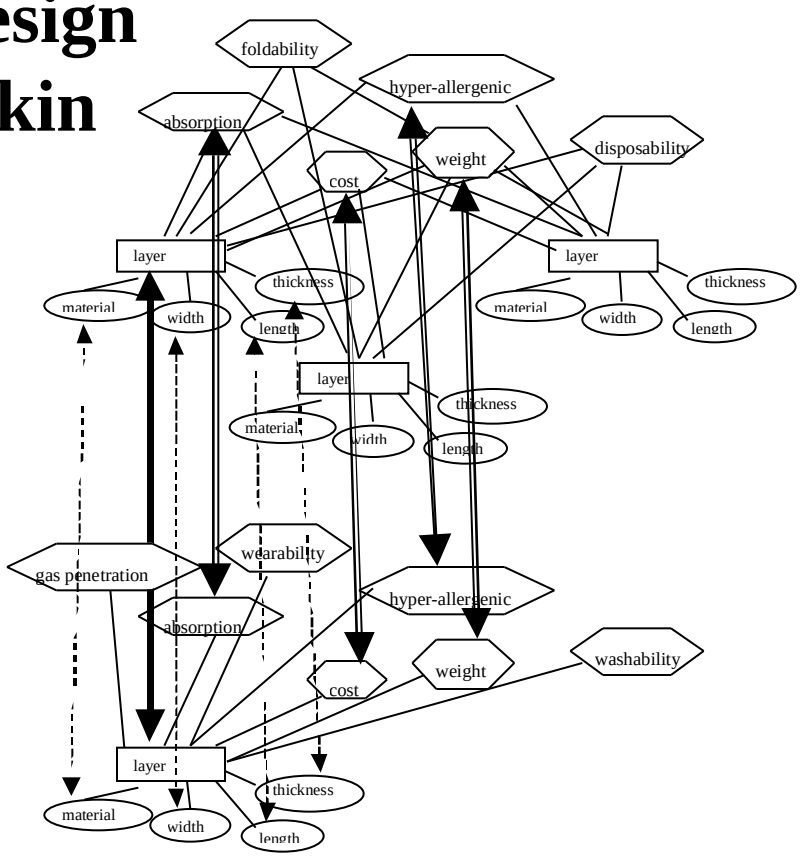
Mapping behaviour

Floor design from VLSI design

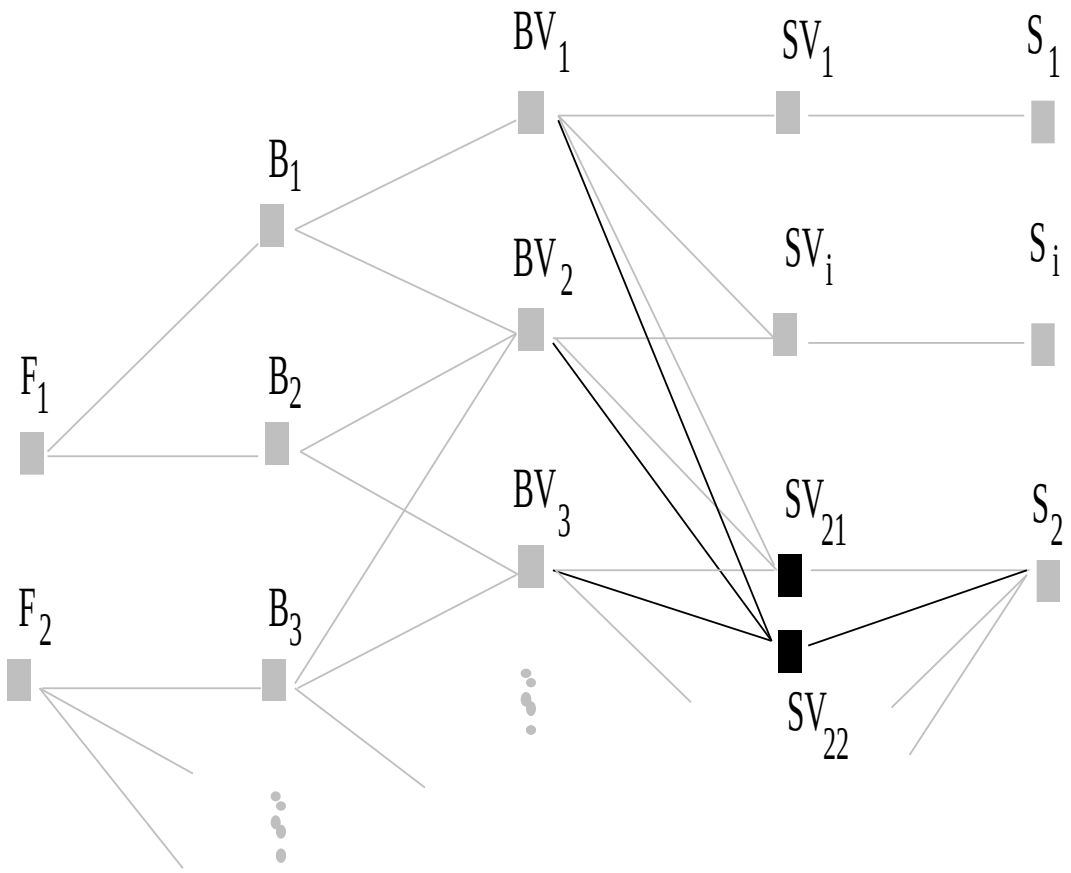


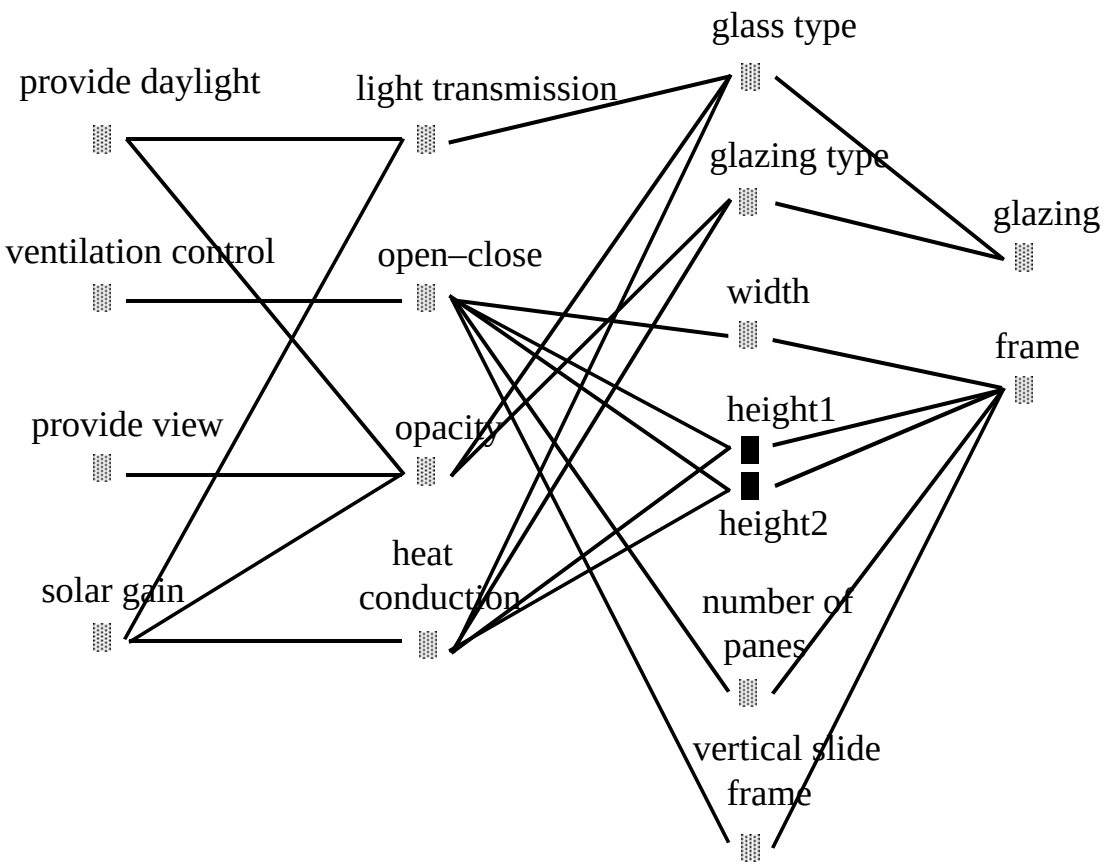
Matching structure

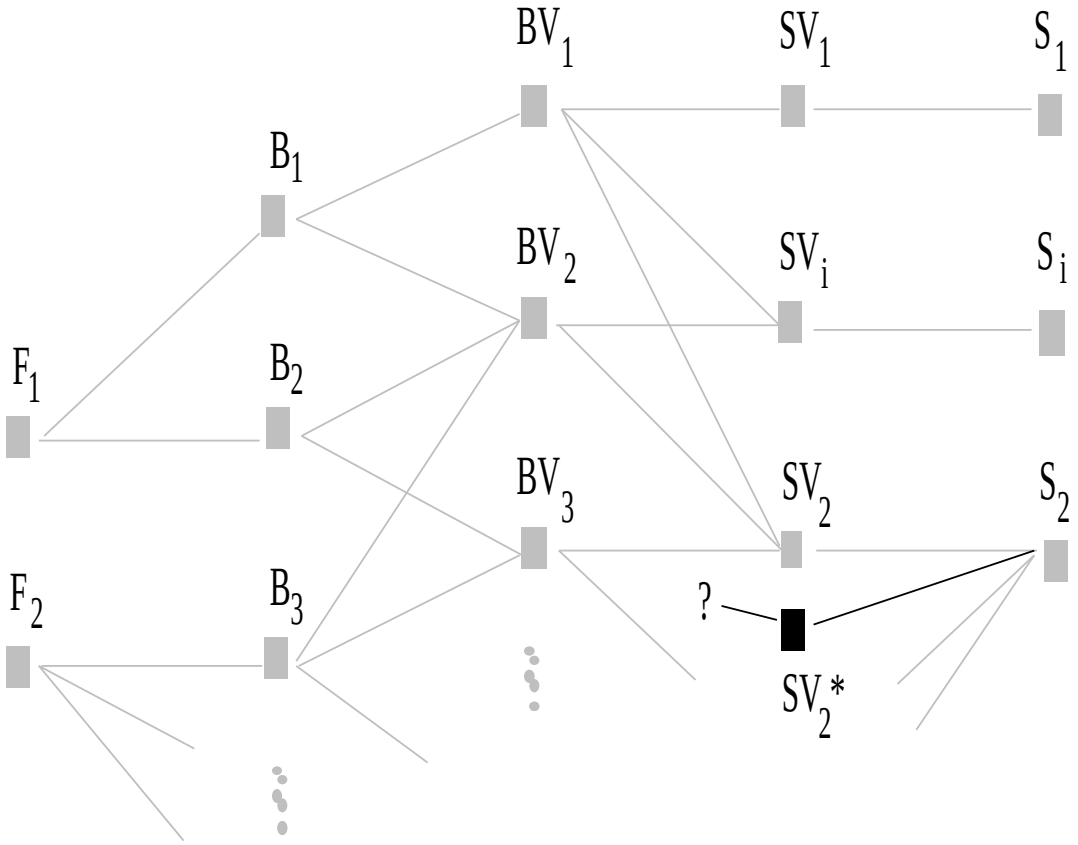
Diaper design from napkin design

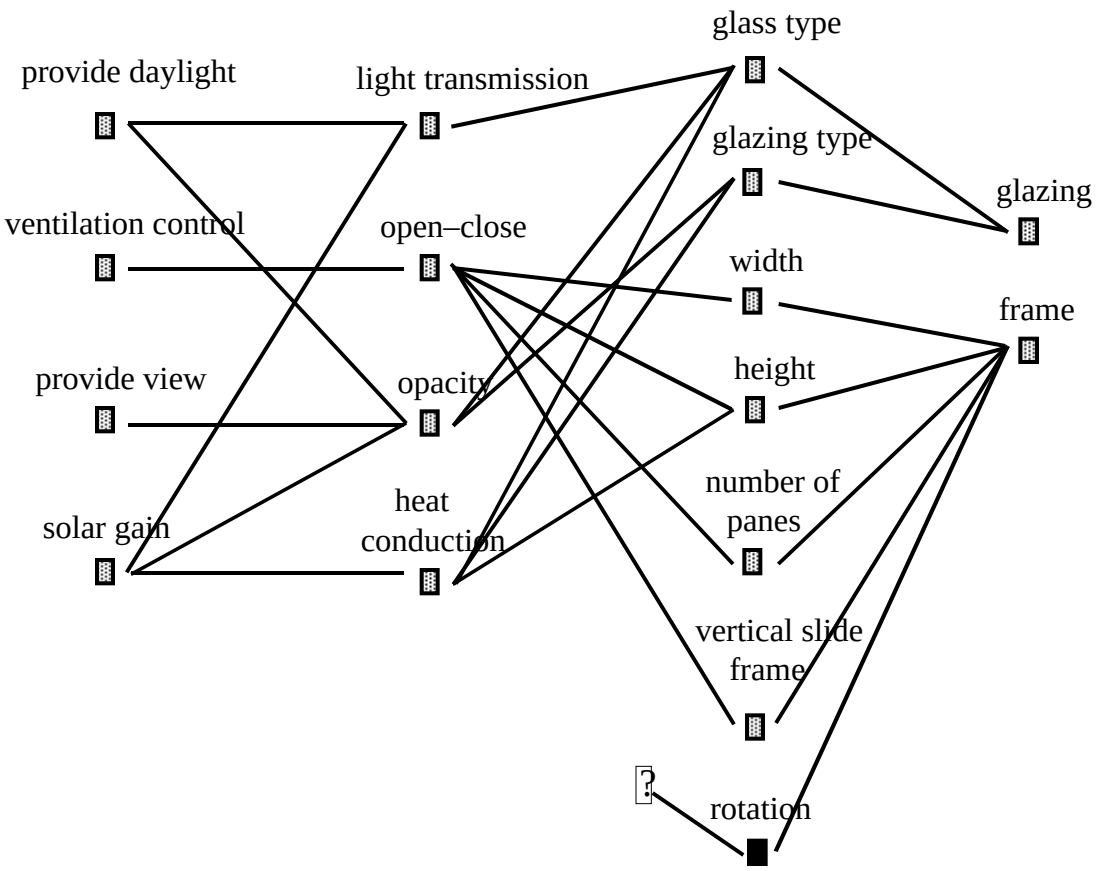


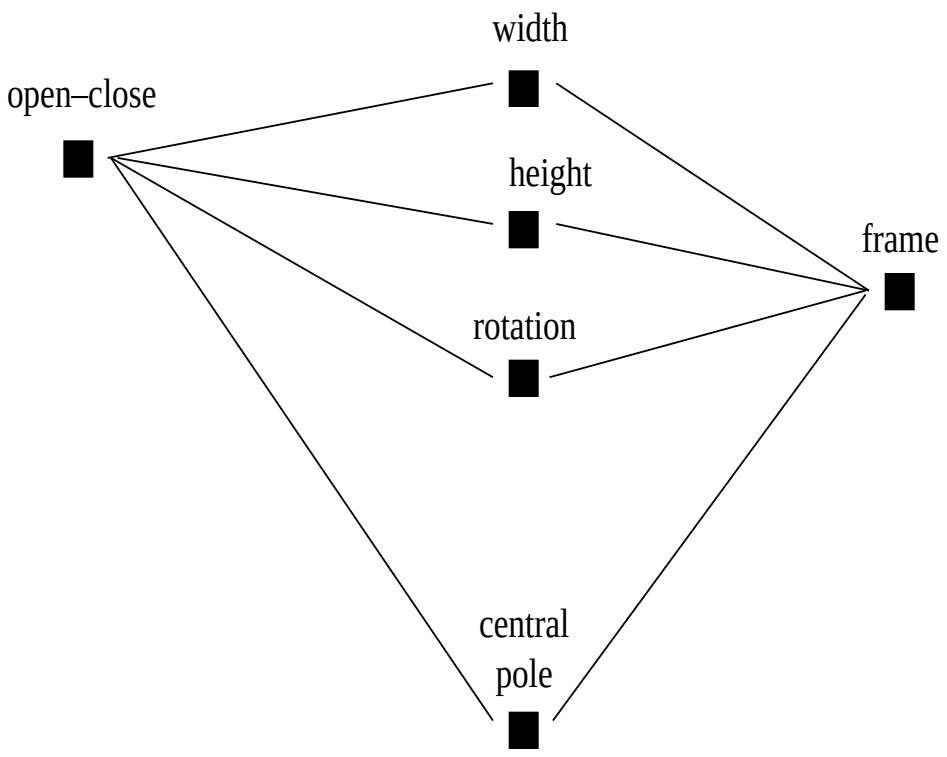
Matching structure

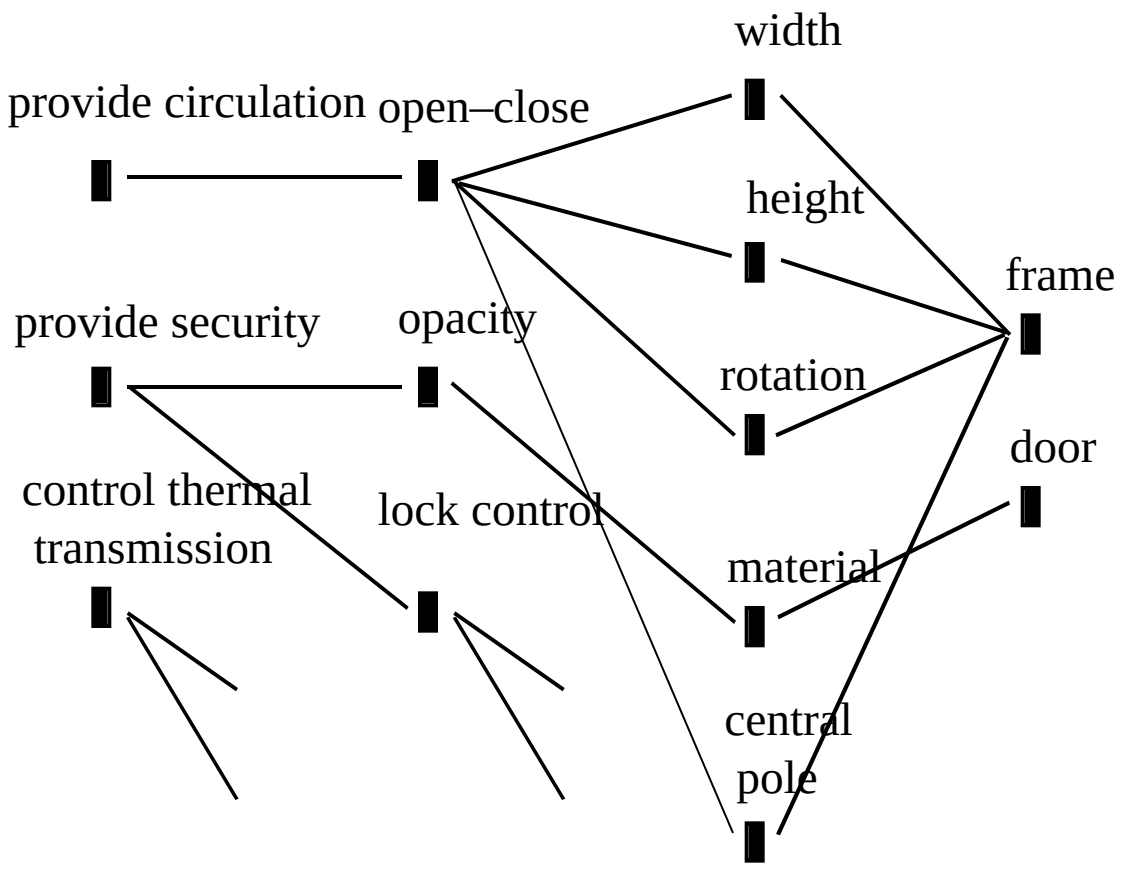

BV1
SV1
S1
B1
BV2
SVi
Si
F1
B2
BV3
SV21
S2
F2
B3
SV22


glass type
provide daylight
light transmission
glazing type
glazing
ventilation control
open–close
width
frame
provide view
opacity
height1
height2
heat
conduction
solar gain
number of
panes
vertical slide
frame


BV1
SV1
S1
B1
BV2
SVi
Si
F1
B2
BV3
SV2
S2
F2
B3
?
SV2*


glass type
provide daylight
light transmission
glazing type
glazing
ventilation control
open–close
width
frame
provide view
opacity
height
number of
panes
solar gain
heat
conduction
vertical slide
frame
?
rotation


width
open–close
height
frame
rotation
central
pole


width
provide circulation
open–close
height
frame
provide security
opacity
rotation
door
control thermal
transmission
lock control
material
central
pole