

# Basic Grammars

shapes



spatial relations



addition rules



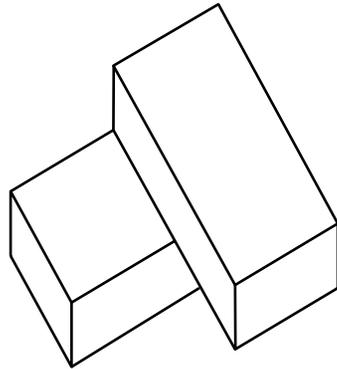
basic grammar

**spatial relation A + B**

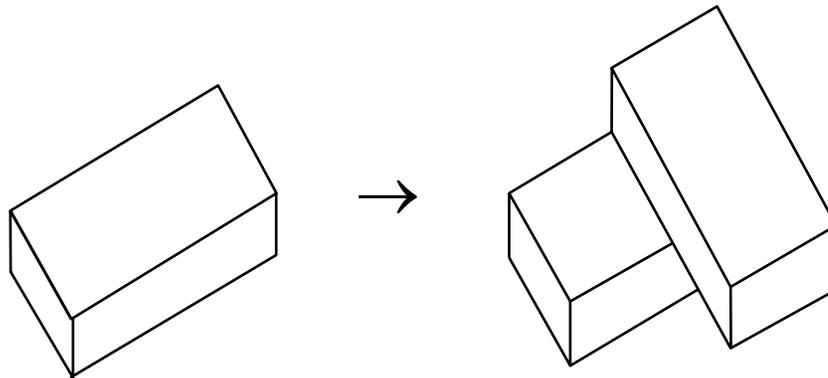
addition rules

$$A \rightarrow A + B$$

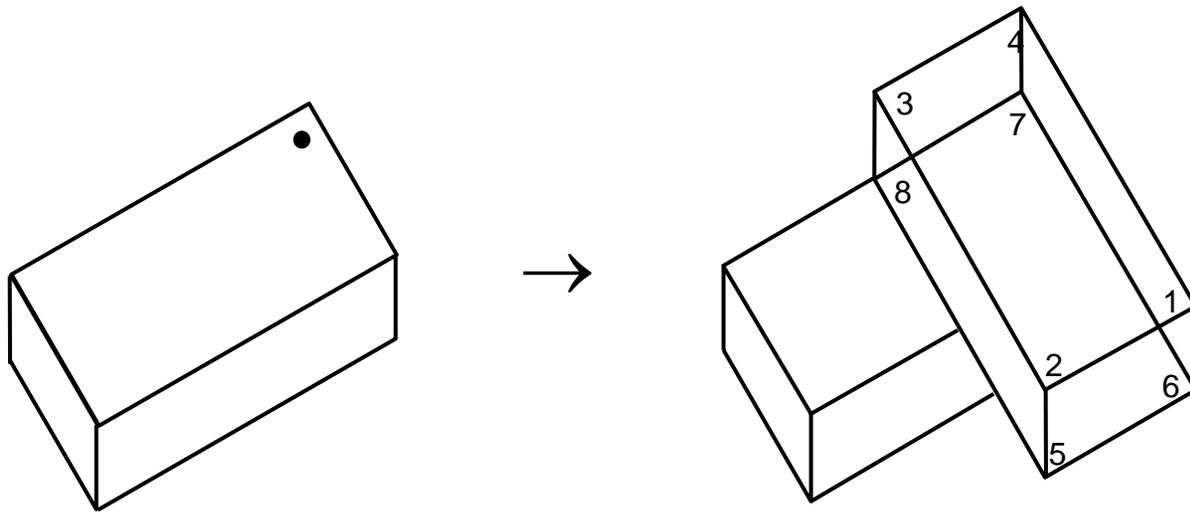
$$B \rightarrow A + B$$



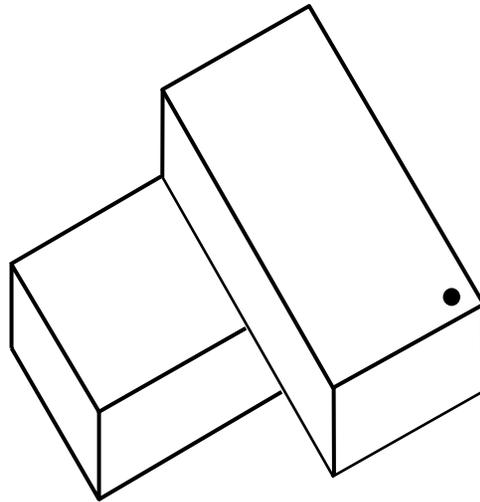
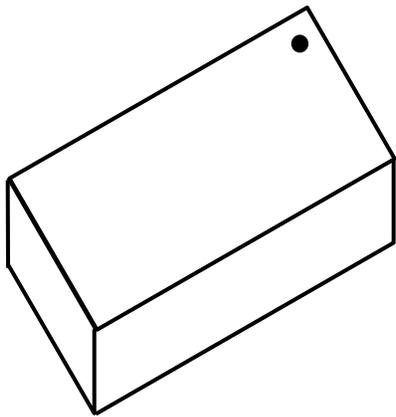
spatial relation  $A + B$  between two oblongs

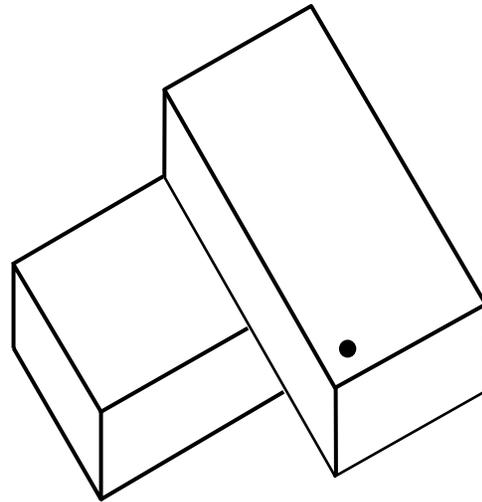
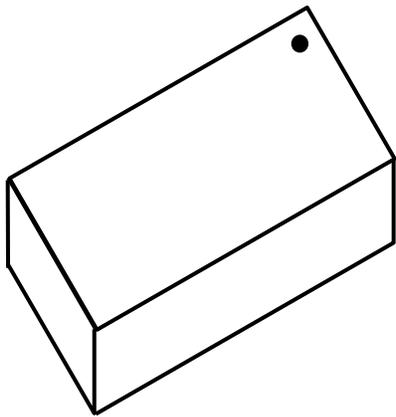


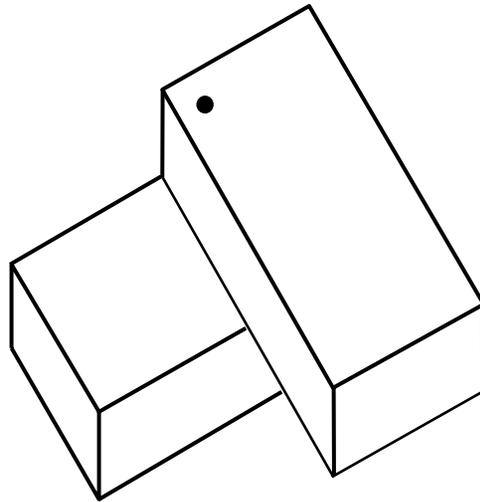
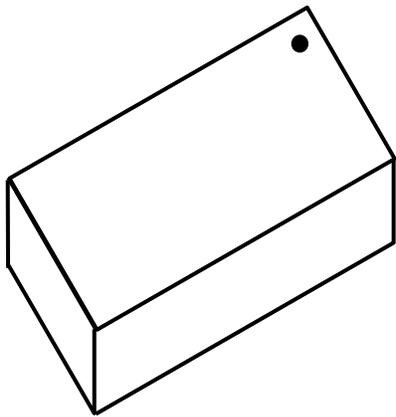
addition rule  $A \rightarrow A + B$  based on the spatial relation

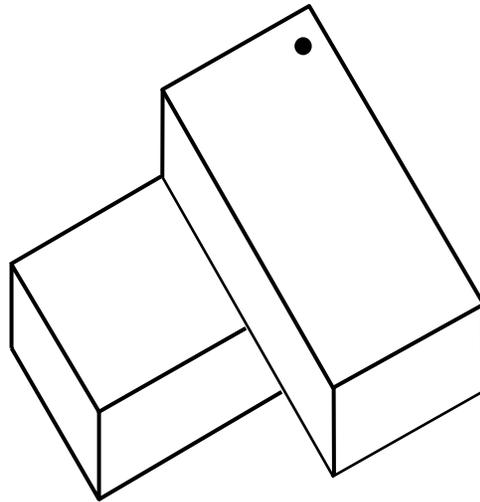
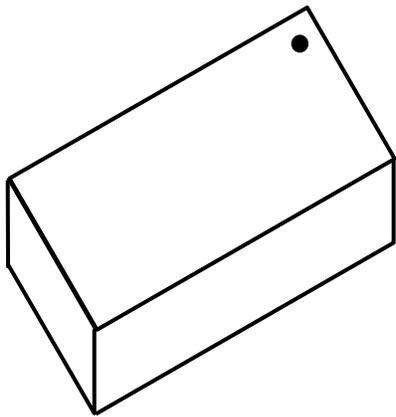


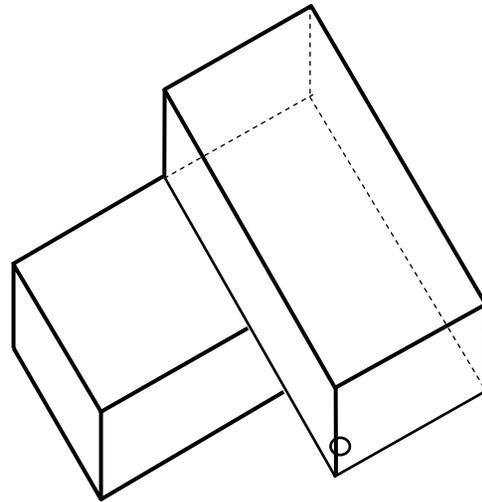
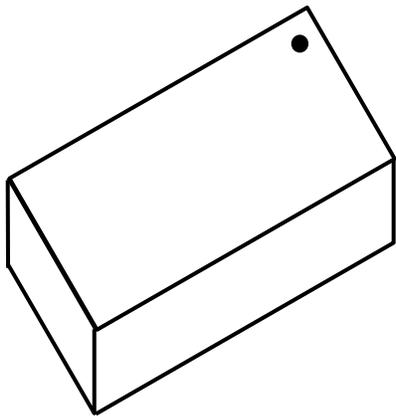
different labelings of the rule  $A \rightarrow A + B$

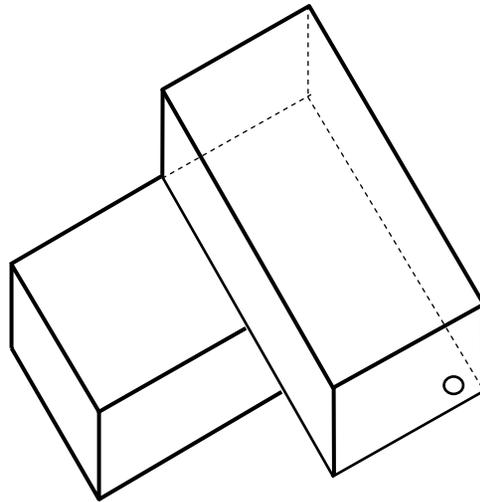
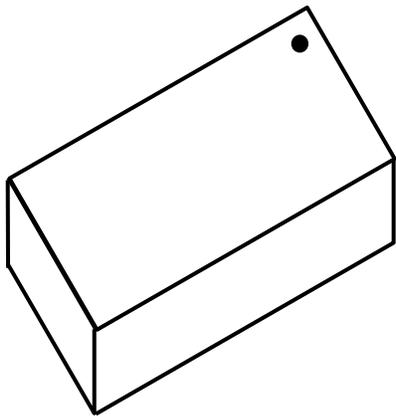


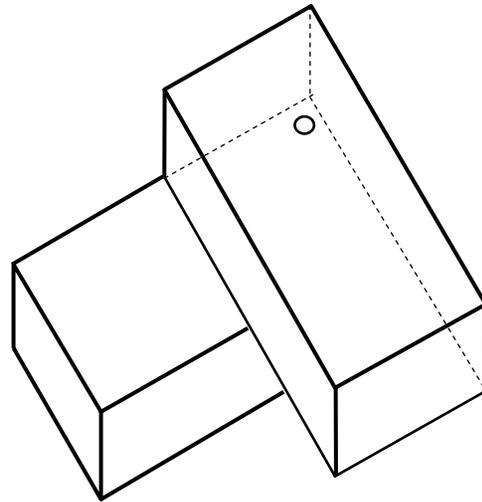
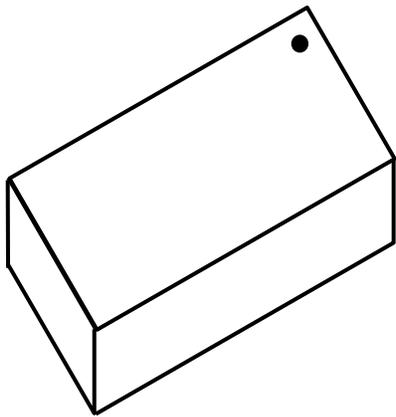


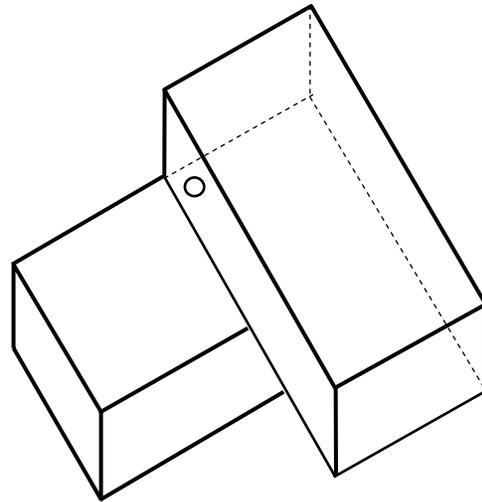
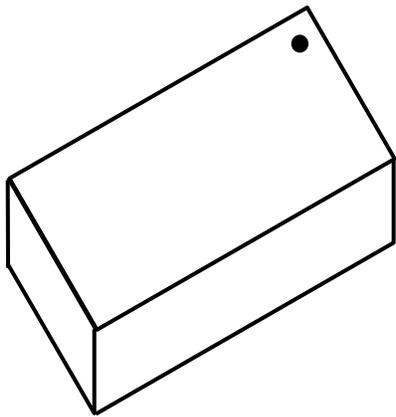


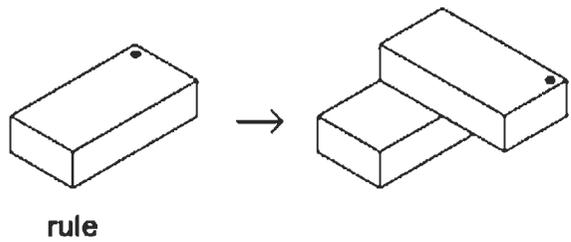




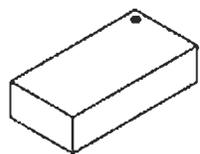




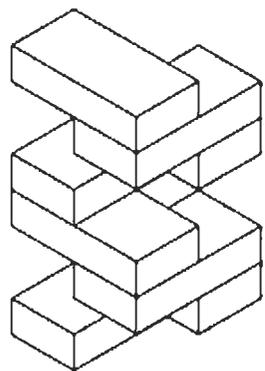




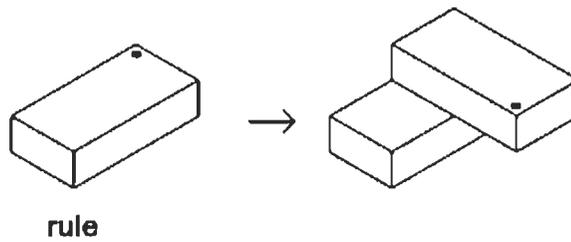
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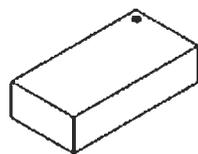
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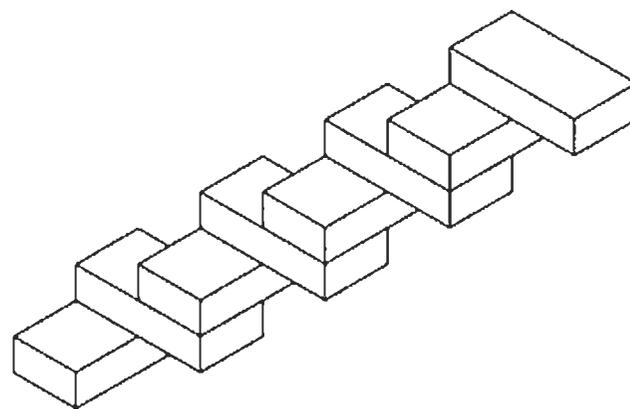
**design**



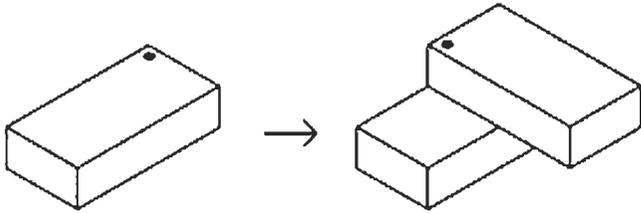
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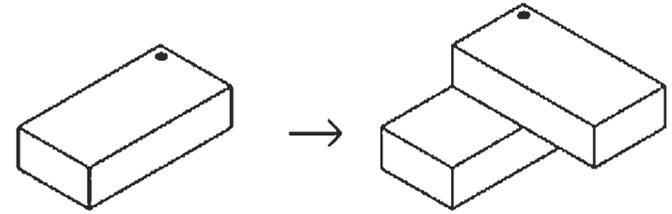
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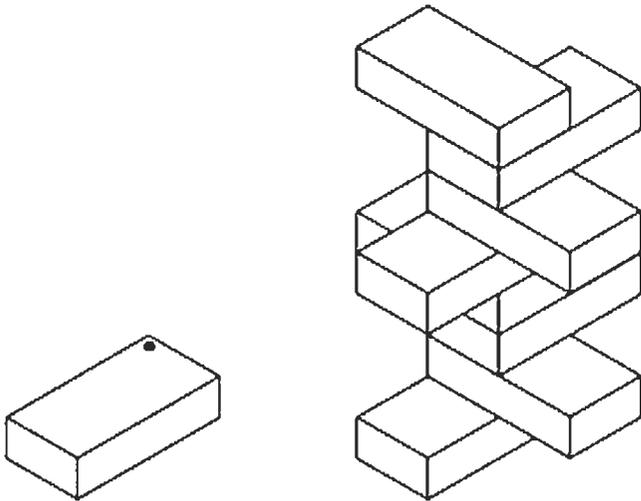
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**rule**

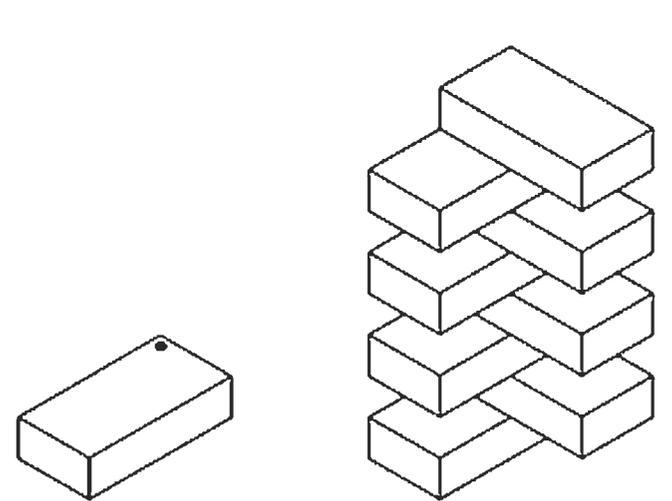


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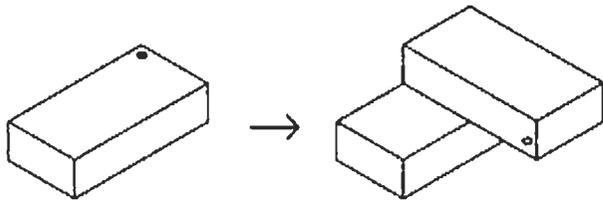
**initial shape**

**design**

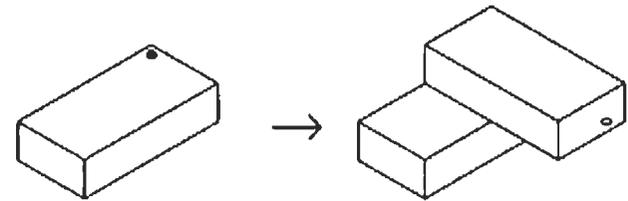


**initial shape**

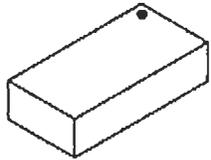
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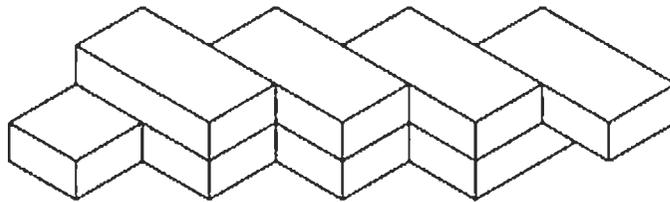
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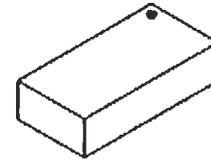
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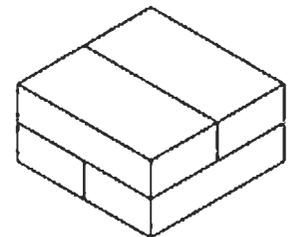
**initial shape**



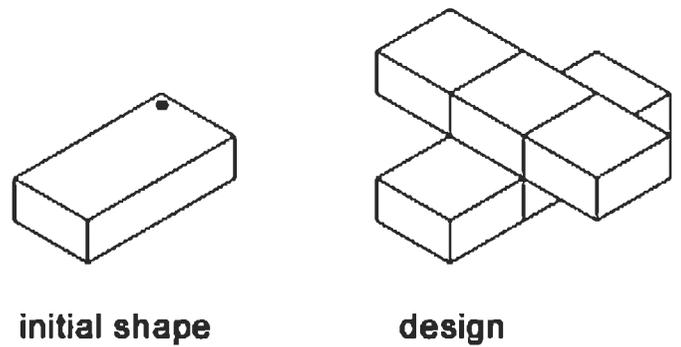
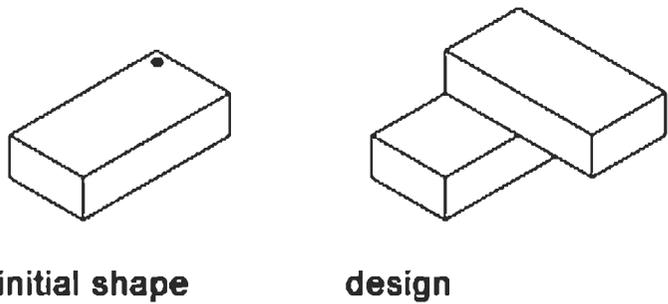
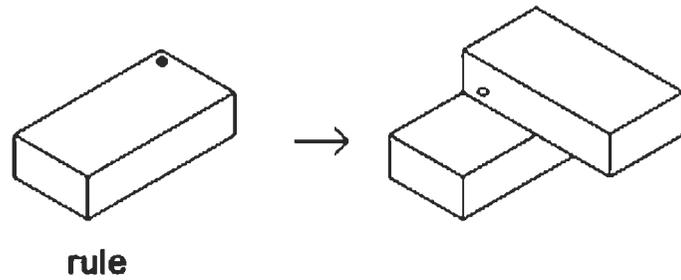
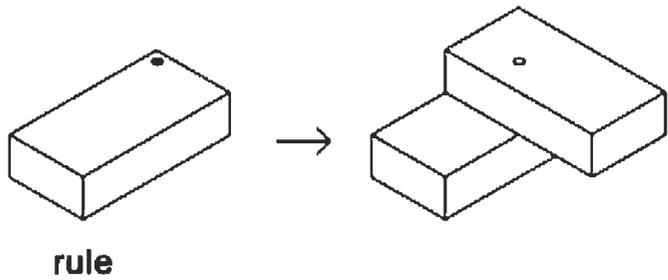
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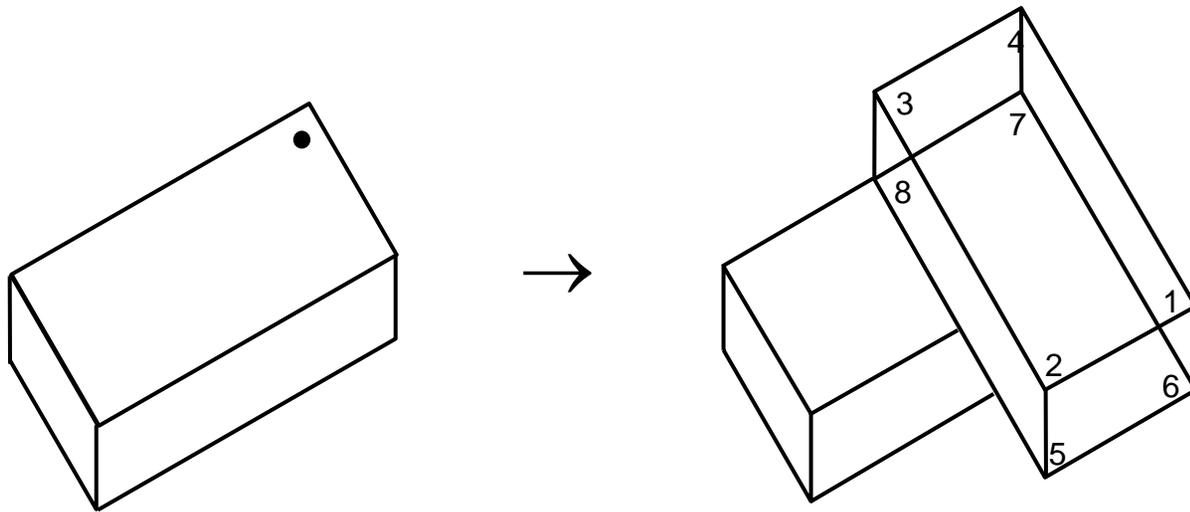


**initial shape**

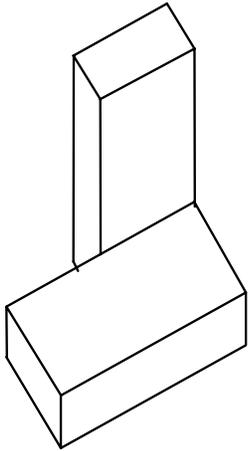


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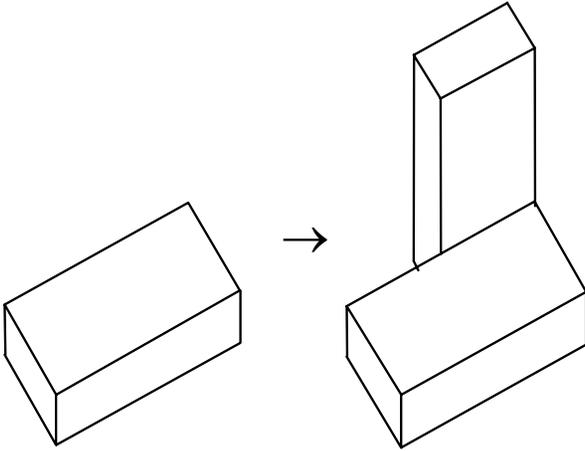




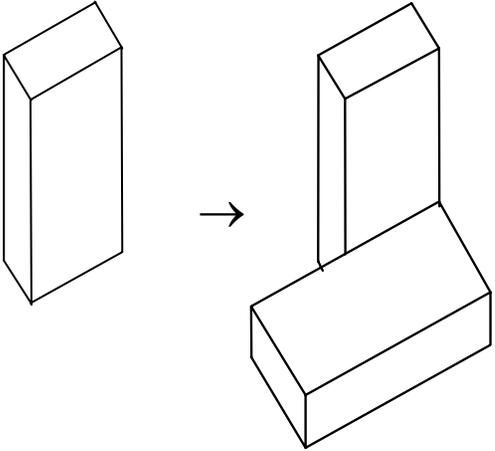
different labelings of the rule  $A \rightarrow A + B$



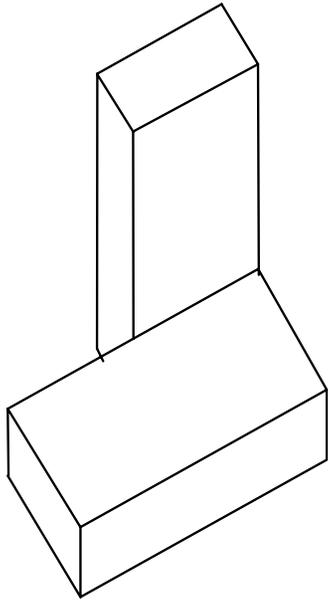
spatial relation A + B  
between two oblongs



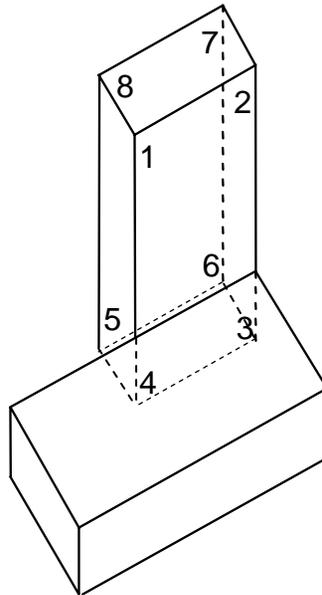
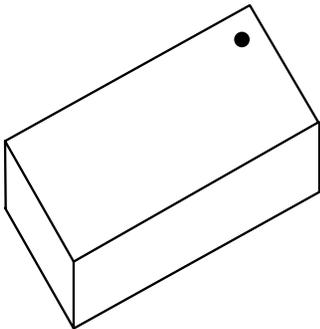
$A \rightarrow A + B$



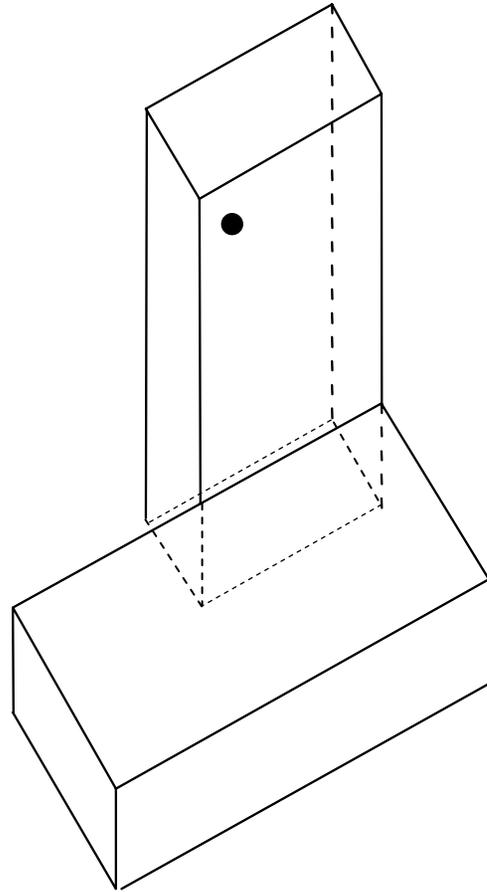
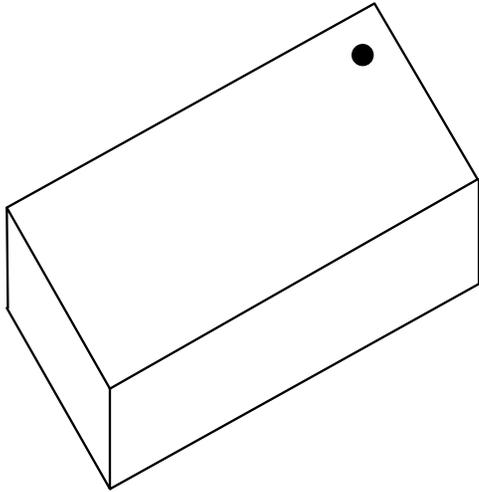
$B \rightarrow A + B$

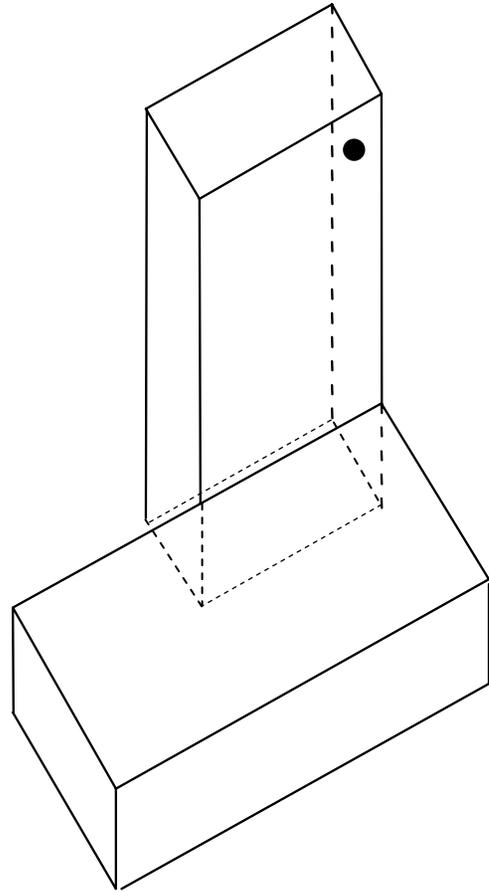
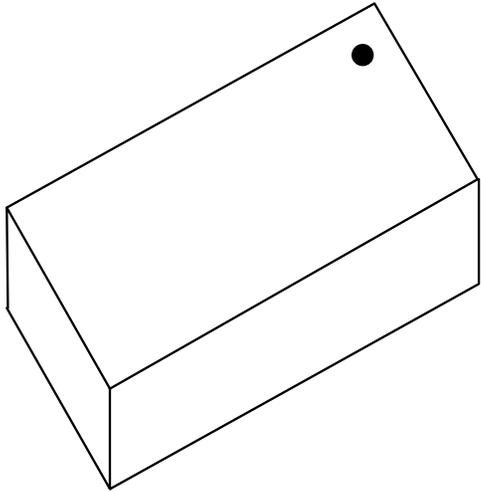


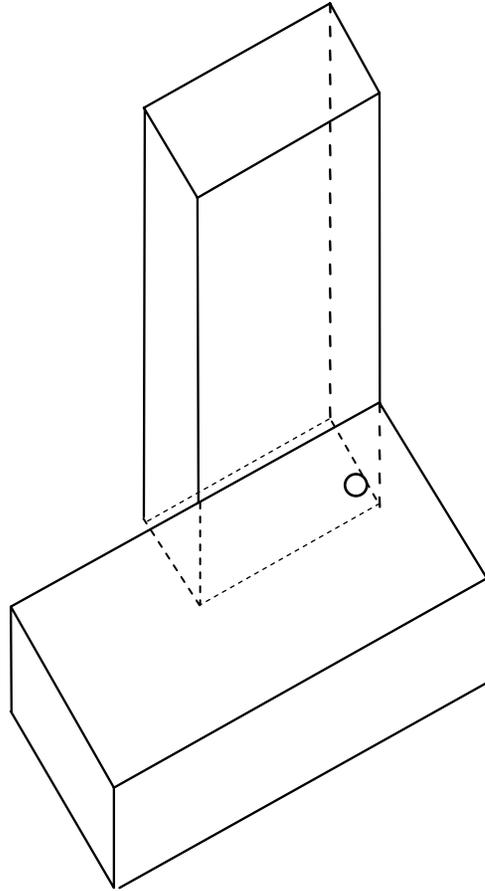
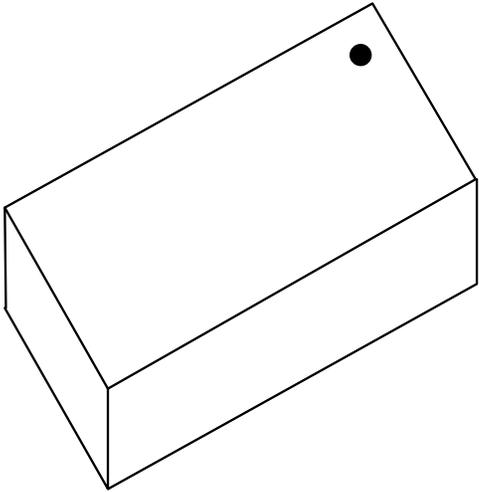
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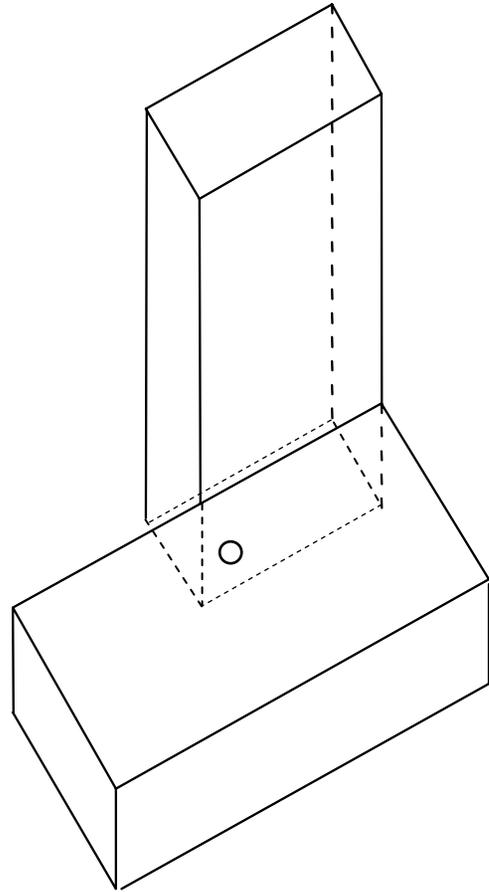
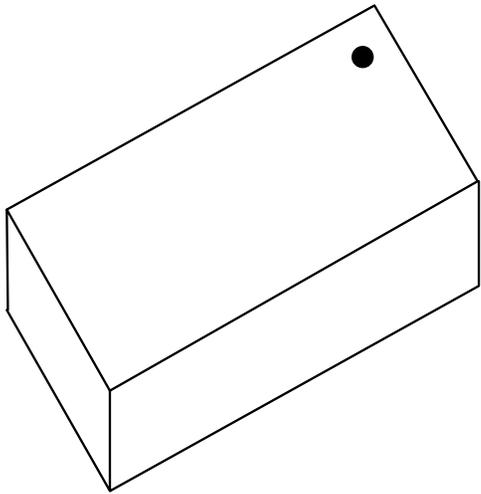


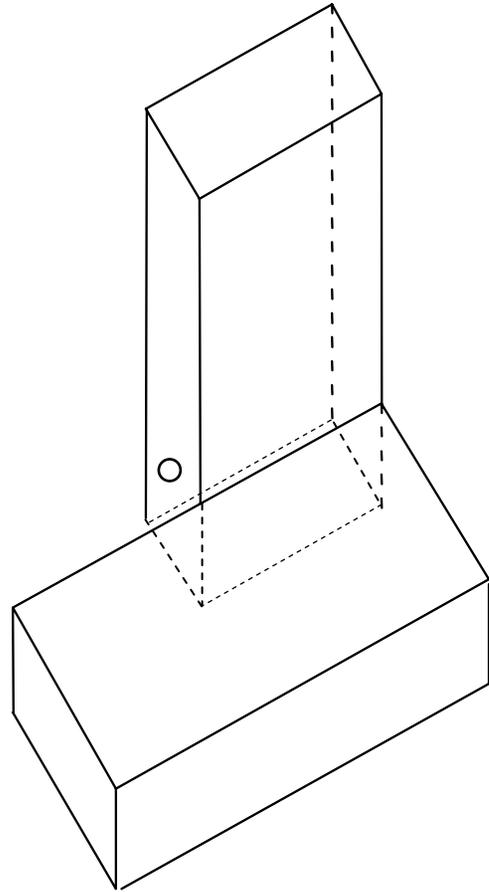
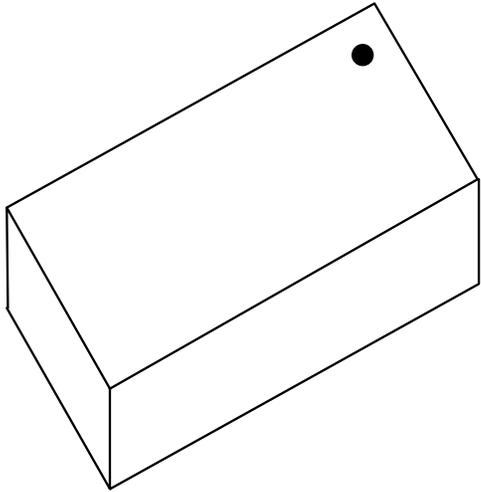
different labelings of the rule  $A \rightarrow A + B$

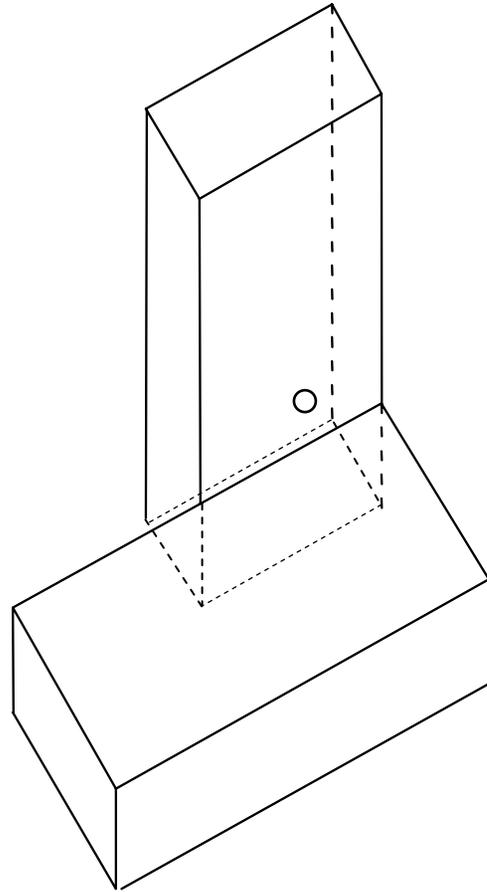
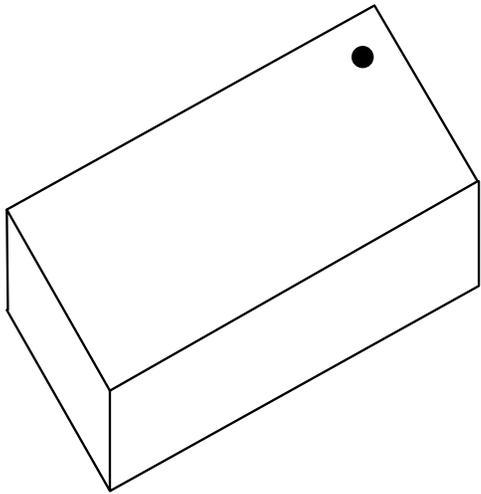


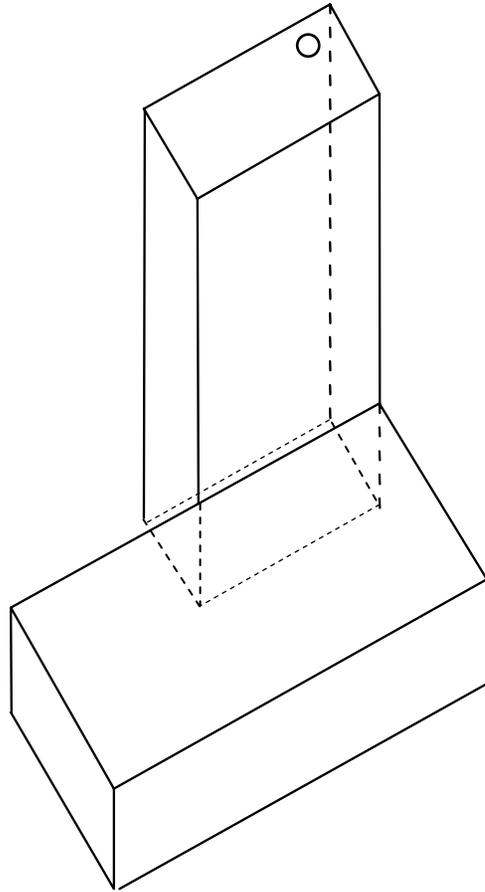
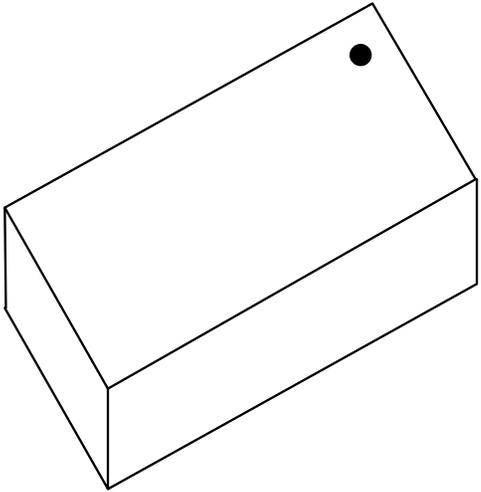


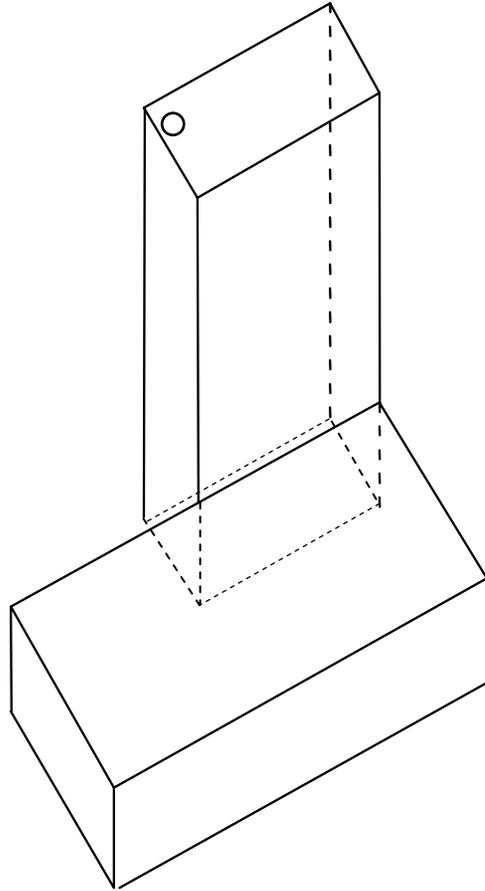
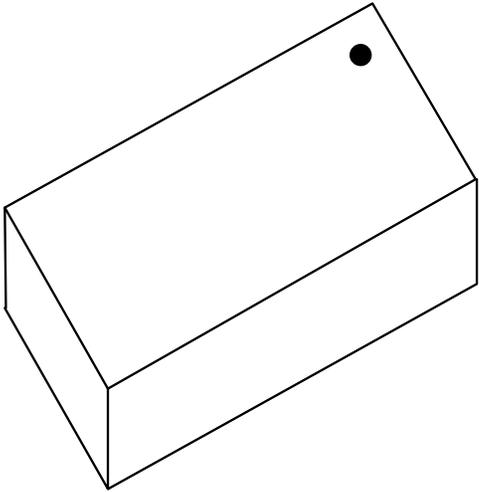


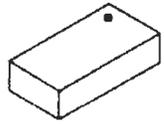




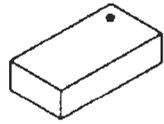




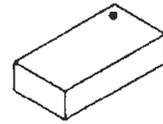




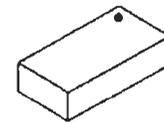
initial shape



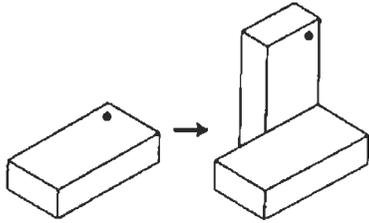
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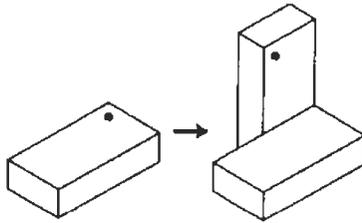
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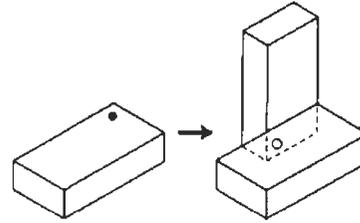
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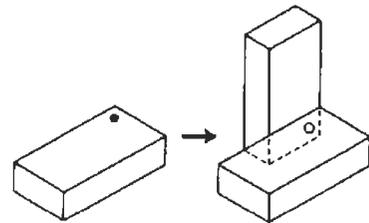
rule



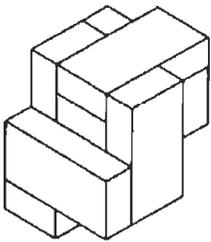
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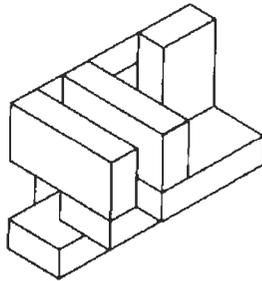
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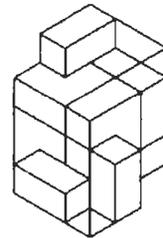
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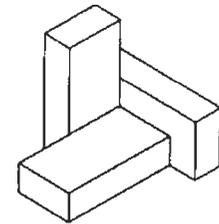
design



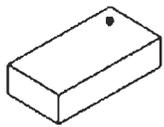
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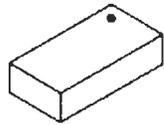
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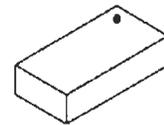
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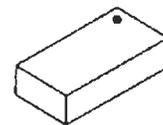
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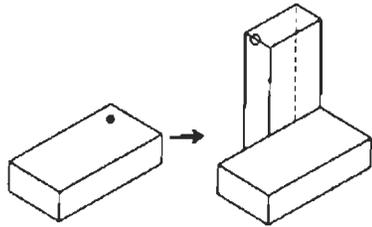
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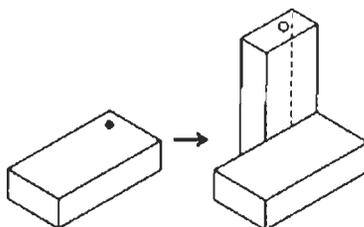
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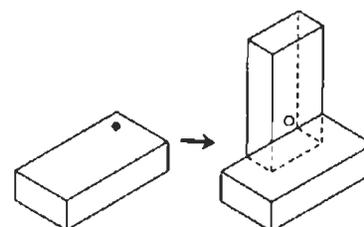
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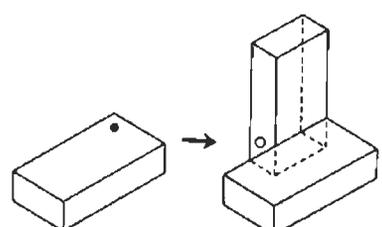
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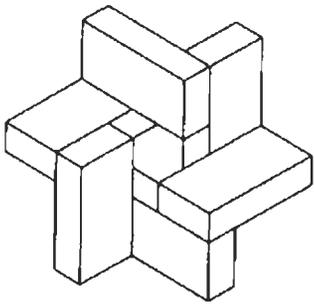
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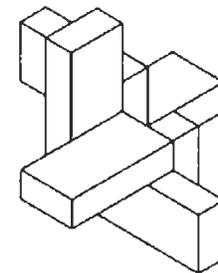
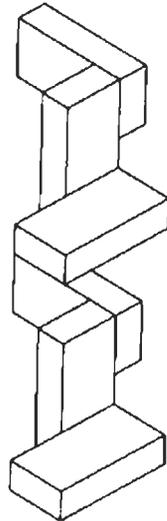
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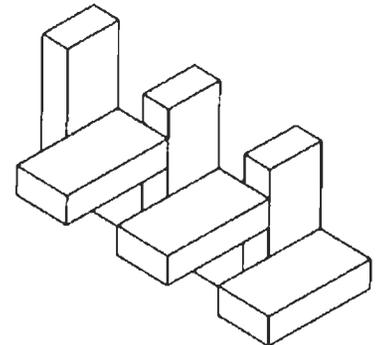
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design

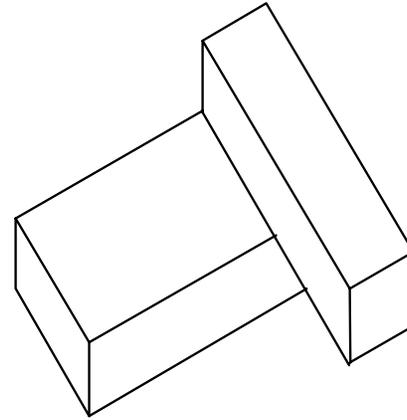
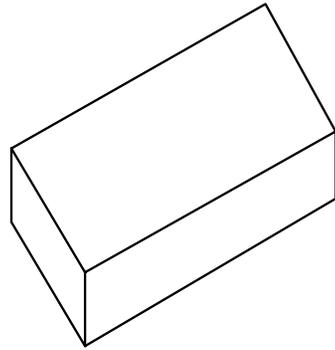
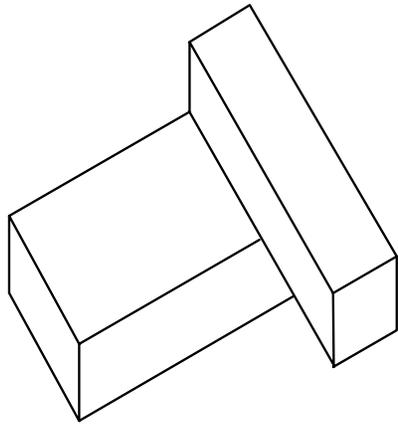


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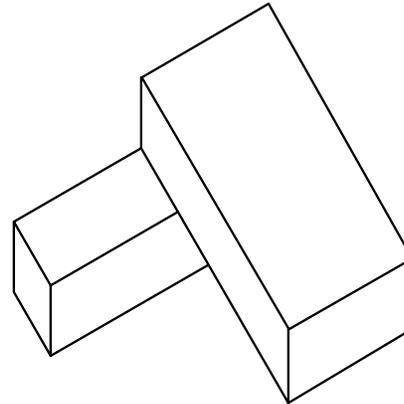
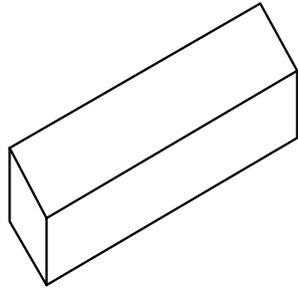


design

spatial relation A + B between two oblongs

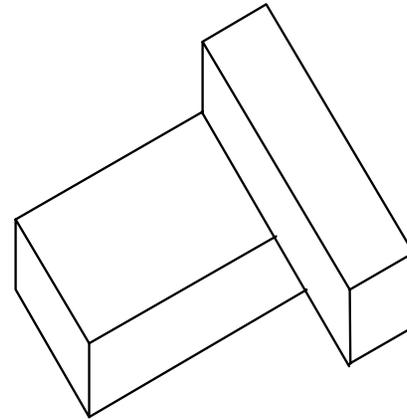
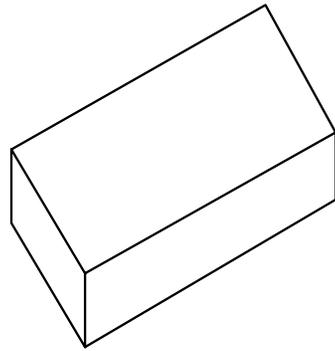
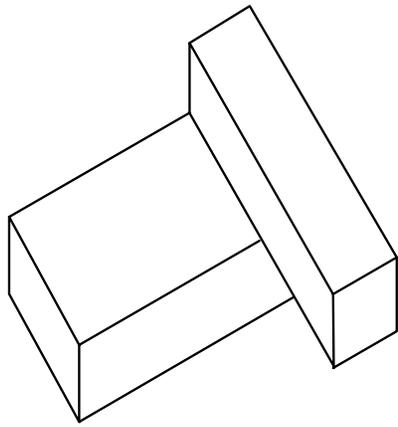


$A \rightarrow A + B$

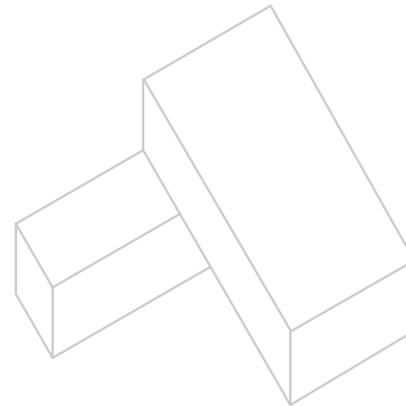
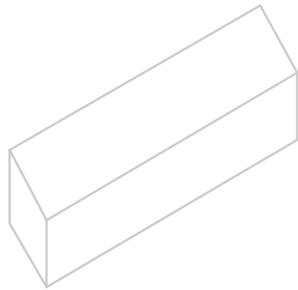


$B \rightarrow A + B$

spatial relation A + B between two oblongs

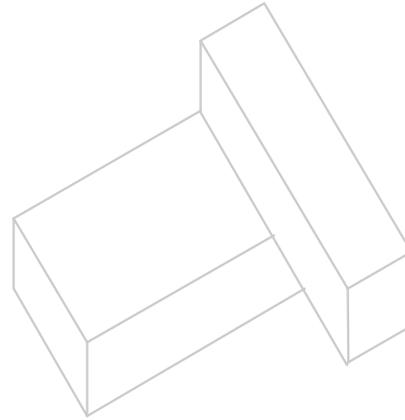
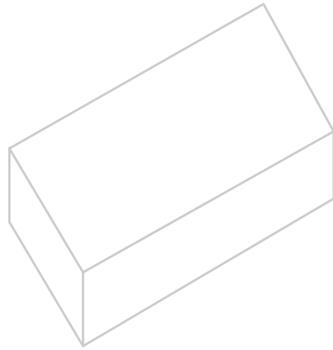
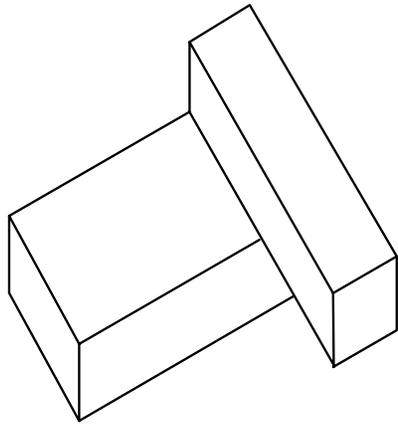


$A \rightarrow A + B$

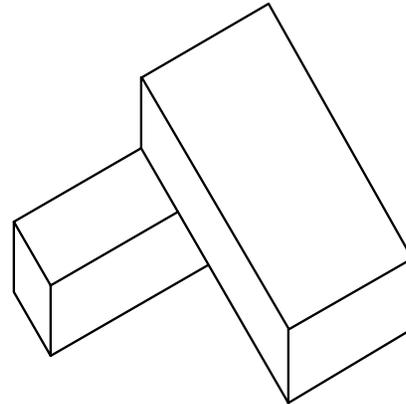
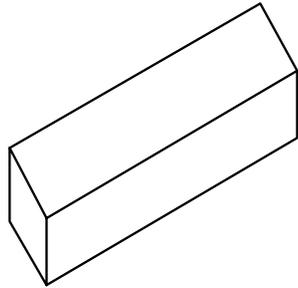


$B \rightarrow A + B$

spatial relation A + B between two oblongs

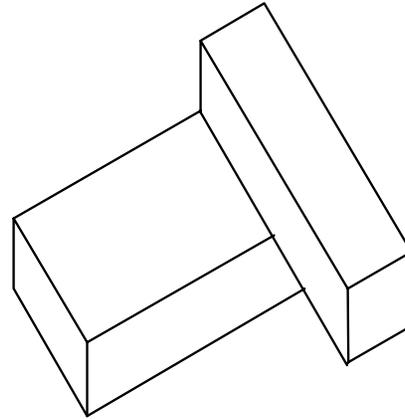
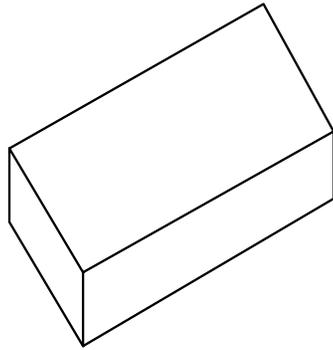
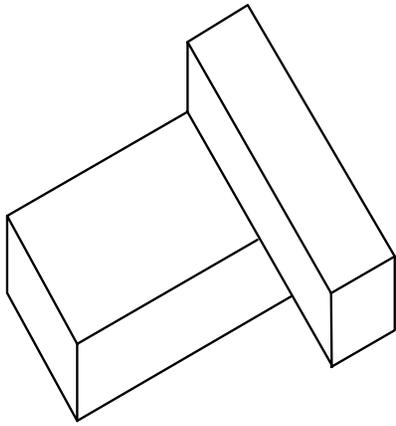


$A \rightarrow A + B$

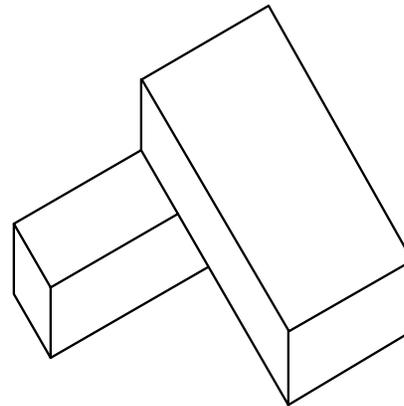
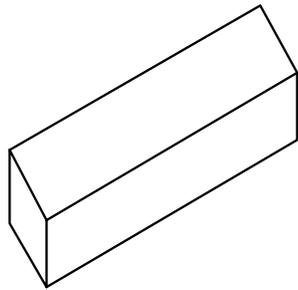


$B \rightarrow A + B$

spatial relation A + B between two oblongs

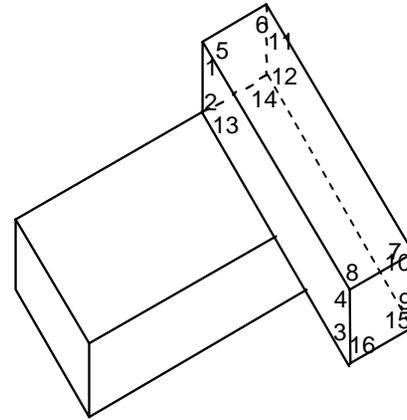
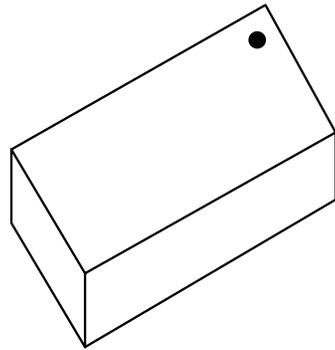
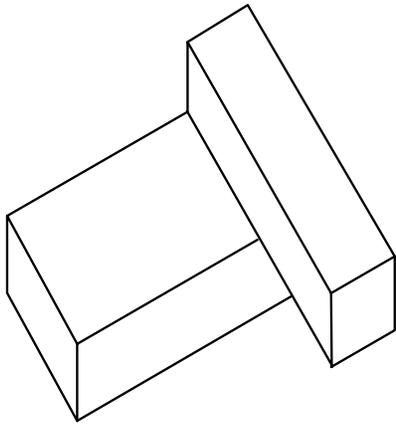


$A \rightarrow A + B$

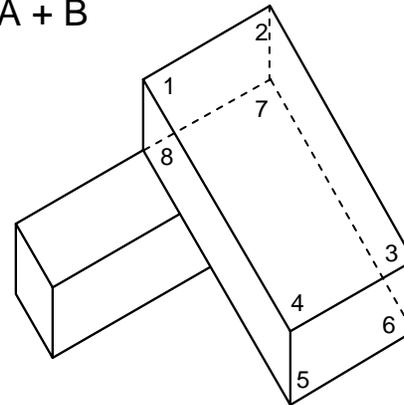
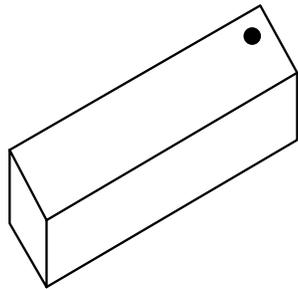


$B \rightarrow A + B$

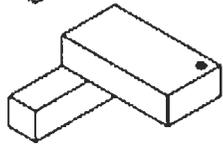
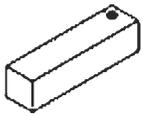
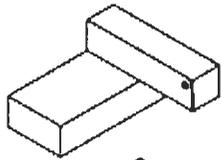
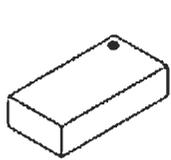
spatial relation  $A + B$  between two oblongs



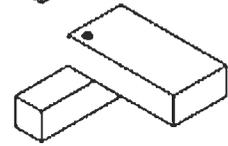
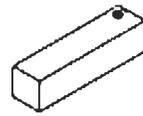
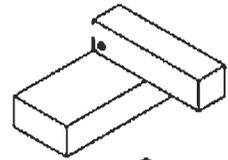
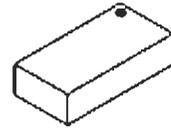
different labelings of the rule  $A \rightarrow A + B$



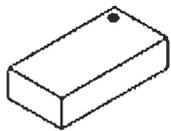
different labelings of the rule  $B \rightarrow A + B$



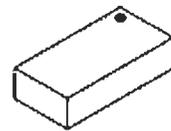
rules



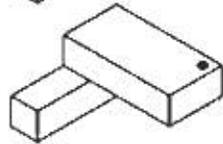
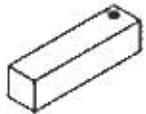
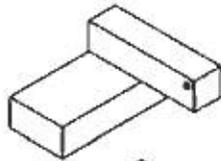
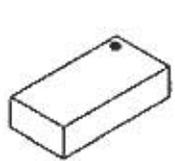
rules



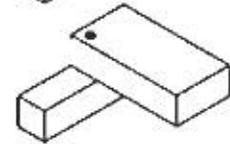
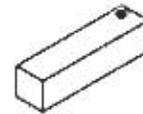
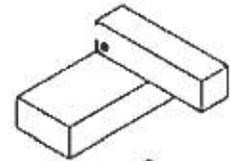
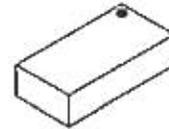
initial shape



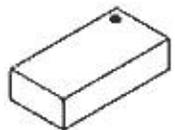
initial shape



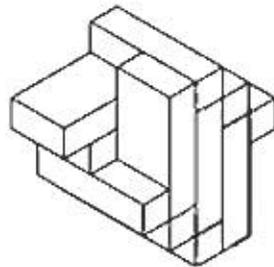
rules



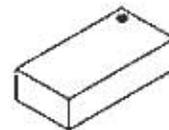
rules



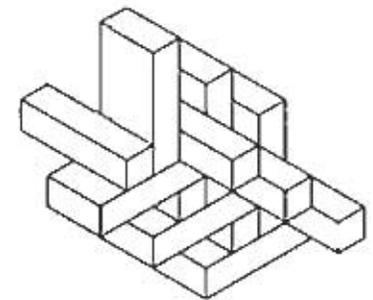
initial shape



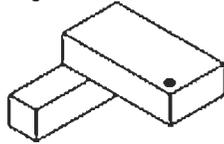
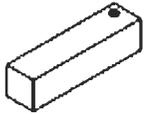
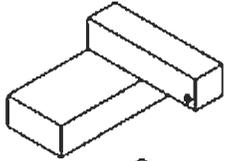
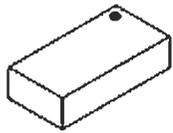
design



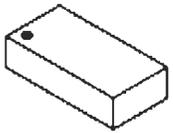
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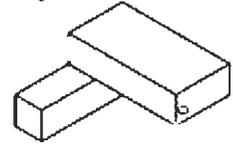
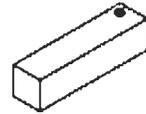
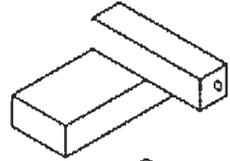
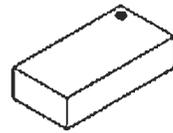
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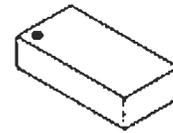
rules



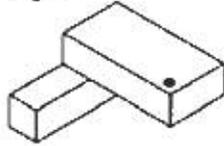
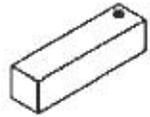
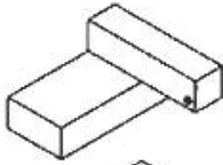
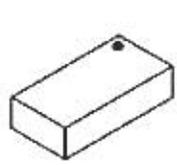
initial shape



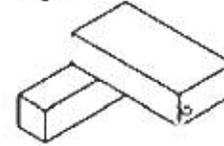
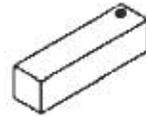
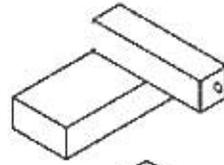
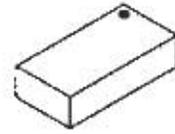
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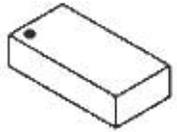
initial shape



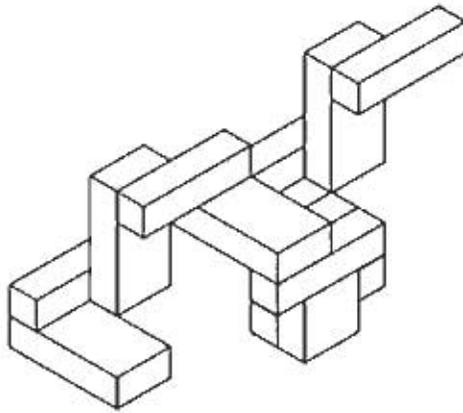
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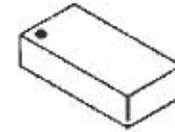
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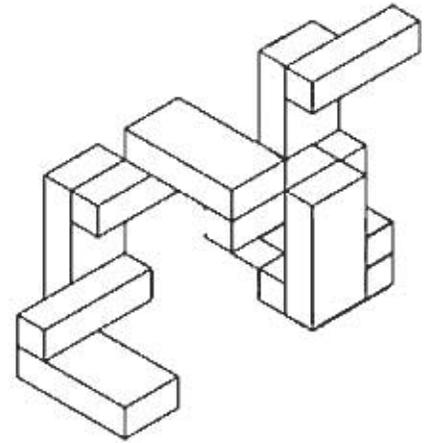
initial shape



design in language



initial shape



design in language

## **Hierarchy of shape grammars**

basic grammars

nondeterministic basic grammars

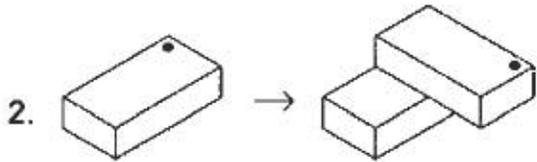
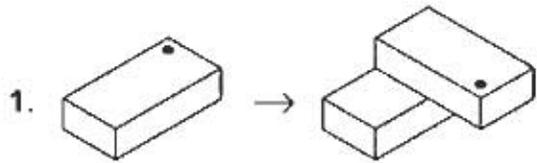
additive grammars

unrestricted grammars

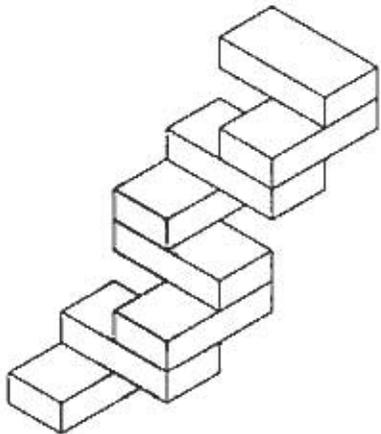
## Basic grammar

A linearly ordered set of basic rules  $r_1, r_2, r_3, \dots, r_n$   
where each rule applies to the shape added by  
the previous rule  $r_{n-1}$

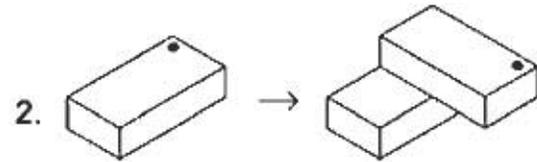
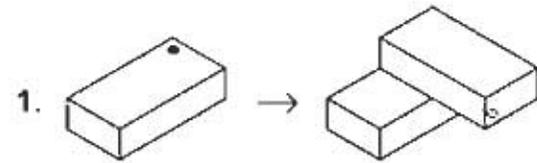
Initial shape: the shape on the left-side of the first rule



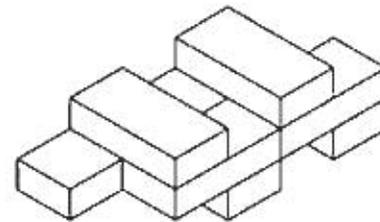
**basic grammar**



**design**

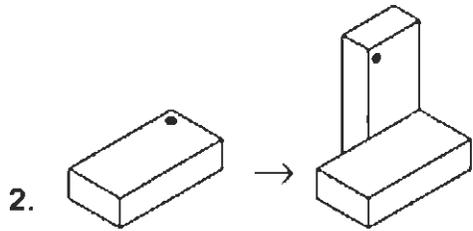
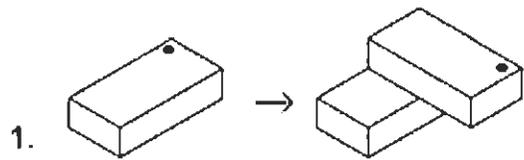


**basic grammar**

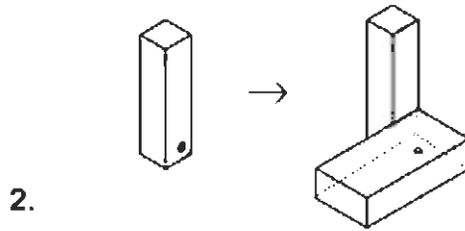
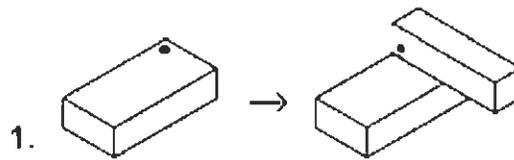


**design**

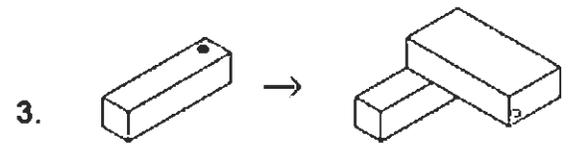
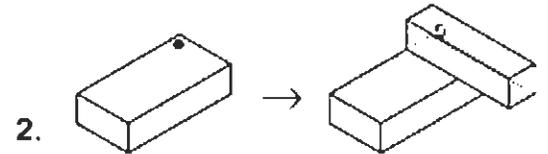
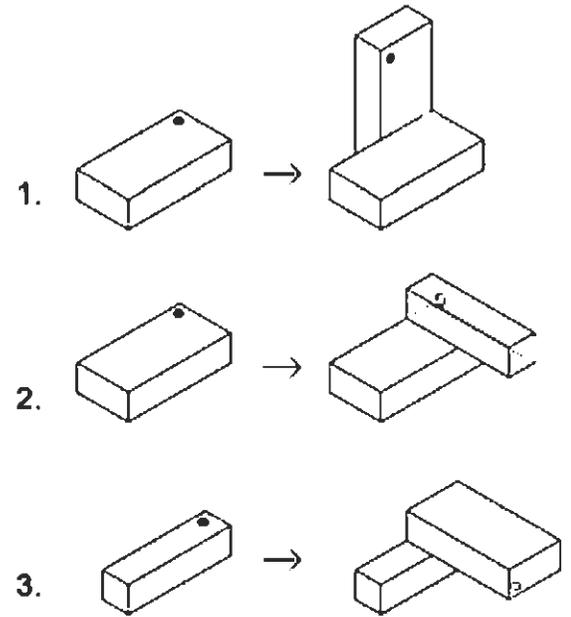
**BASIC GRAMMARS**  
one spatial relation, different labelings



**basic grammar**



**basic grammar**



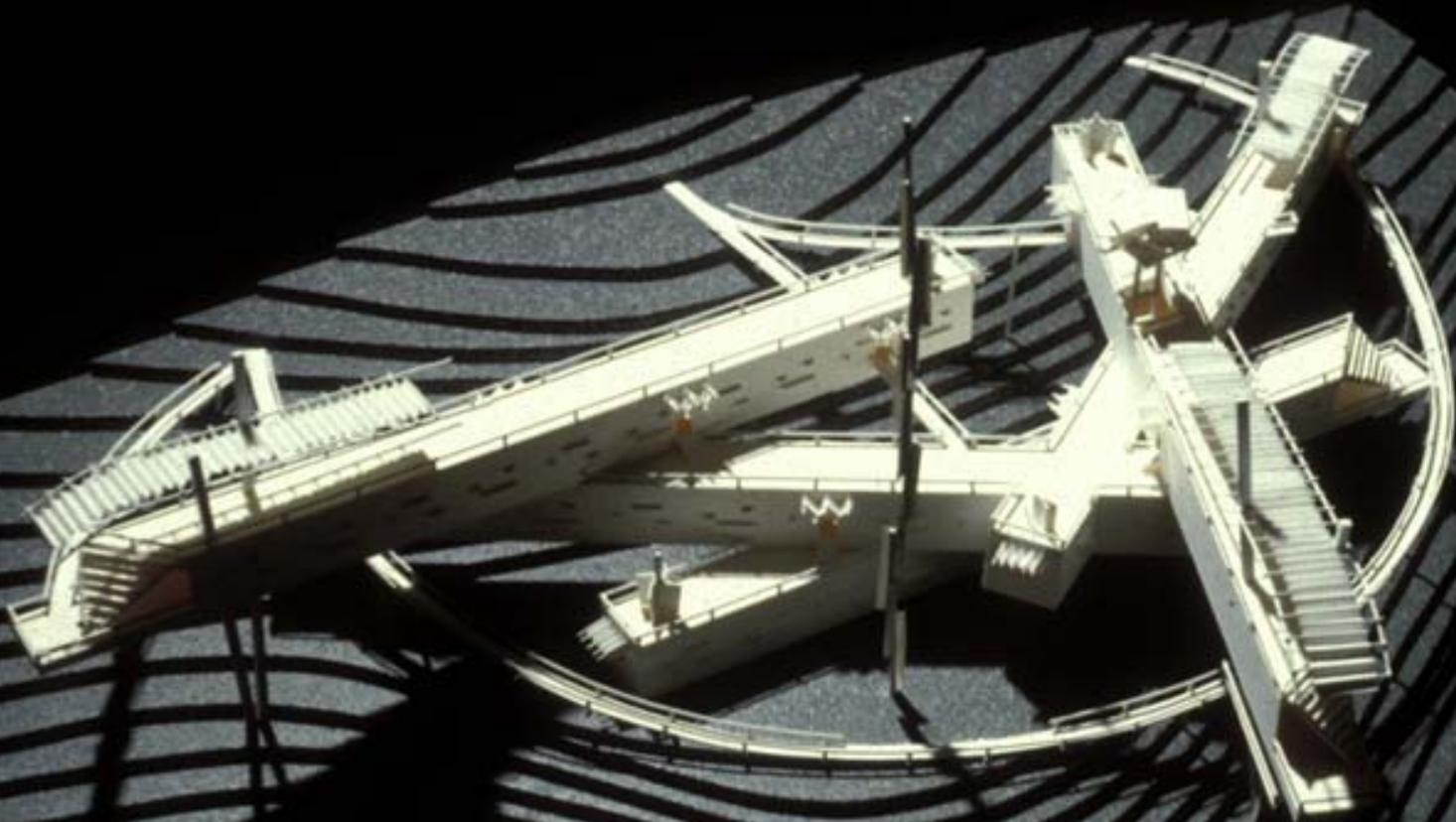
**basic grammar**

**BASIC GRAMMARS**  
**different spatial relations**

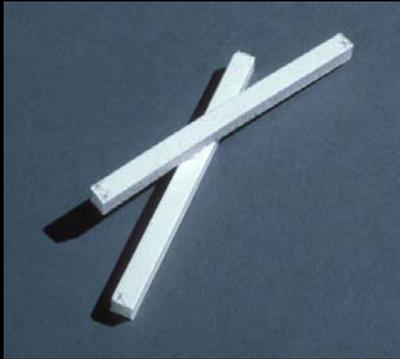
## **Design projects:**

basic grammars using one spatial relation

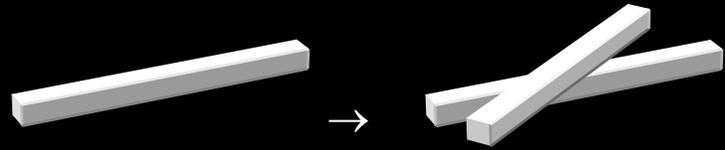
historical museum, San Gimignano, Italy (Randy Brown)



spatial relation

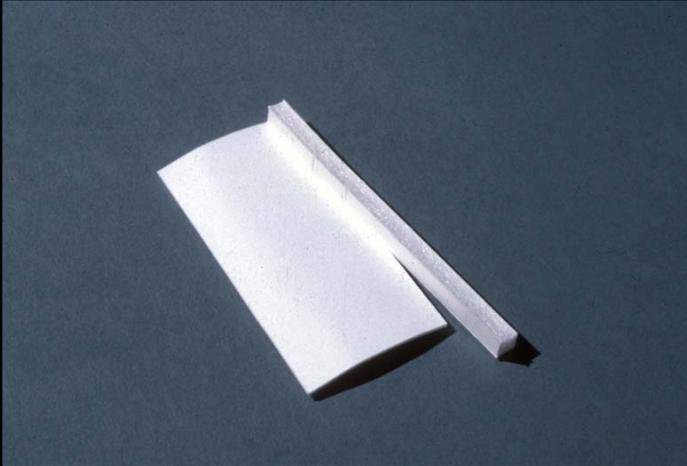


rule

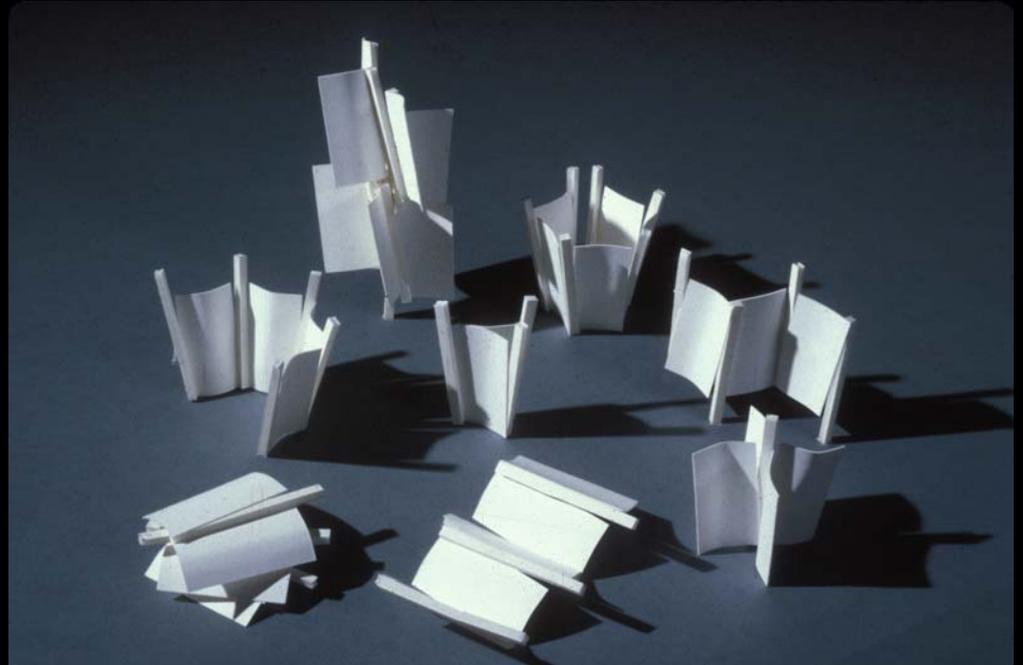


basic designs

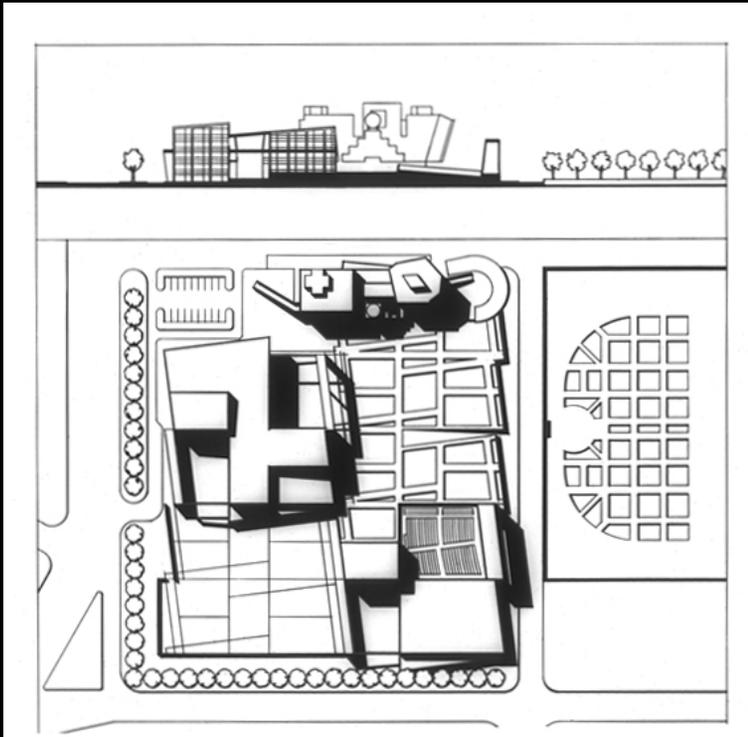




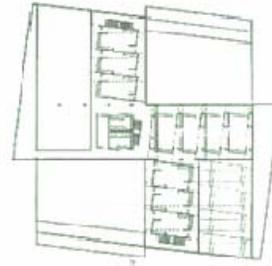
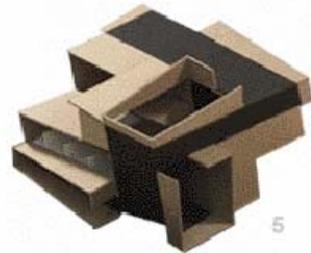
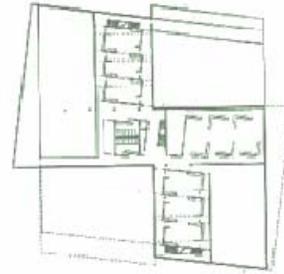
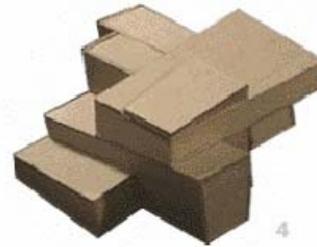
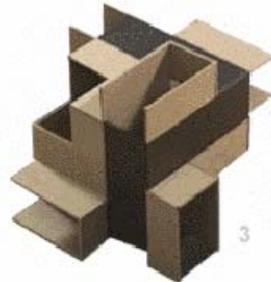
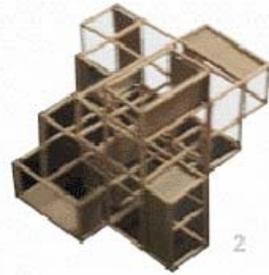
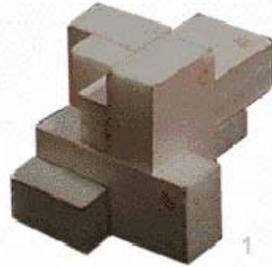
spatial relation



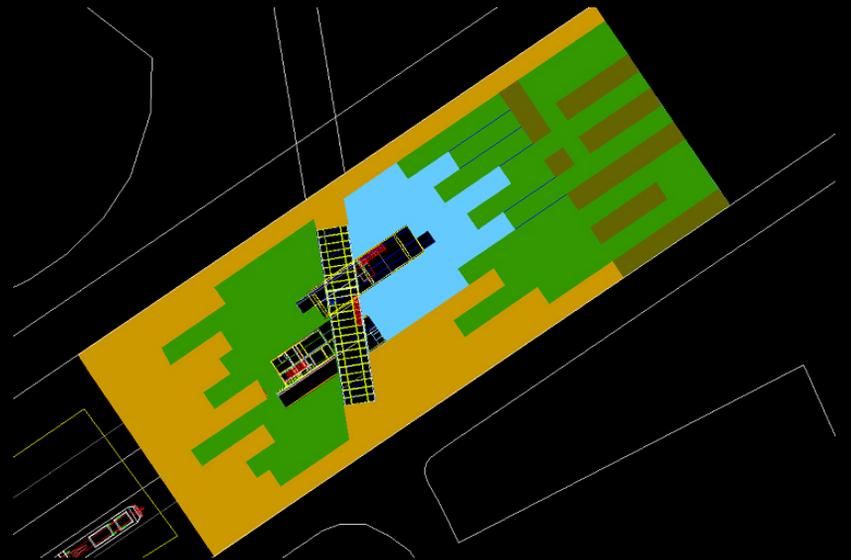
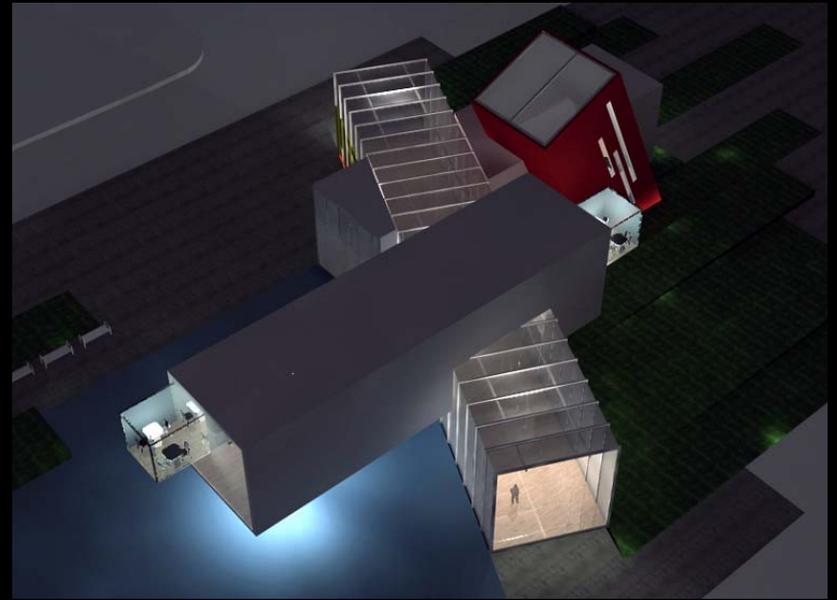
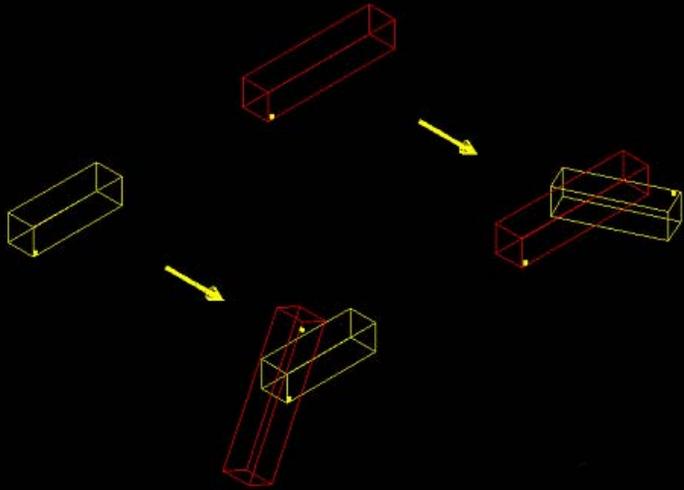
basic designs



elementary school complex, Los Angeles  
(Michael Brown)



elementary school complex, Los Angeles (Michael Brown)

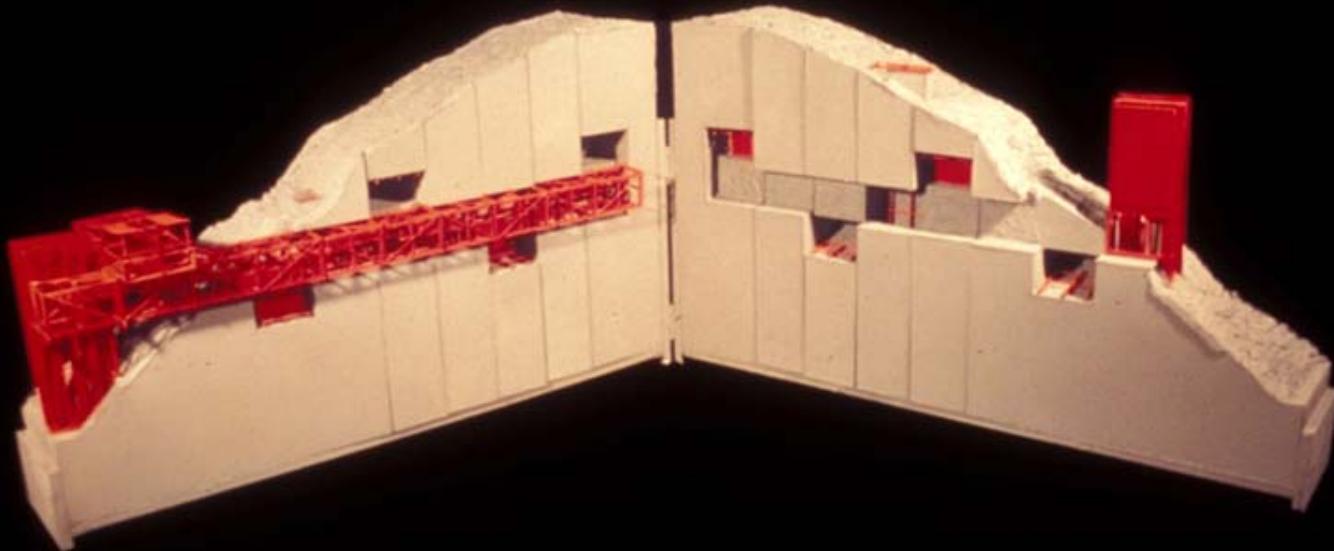
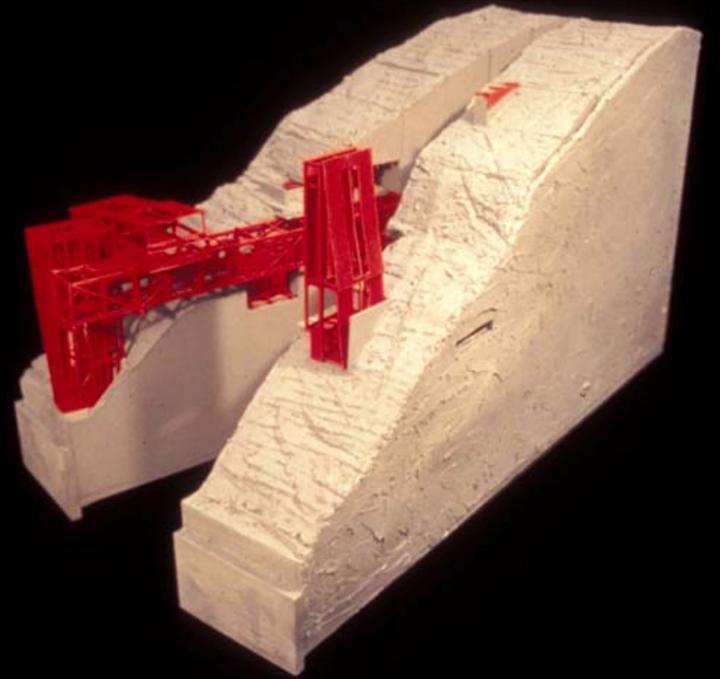


subway station, MIT campus (Gane, Gichuhi, Tian)

memorial to mining workers (Michael Wilcox)

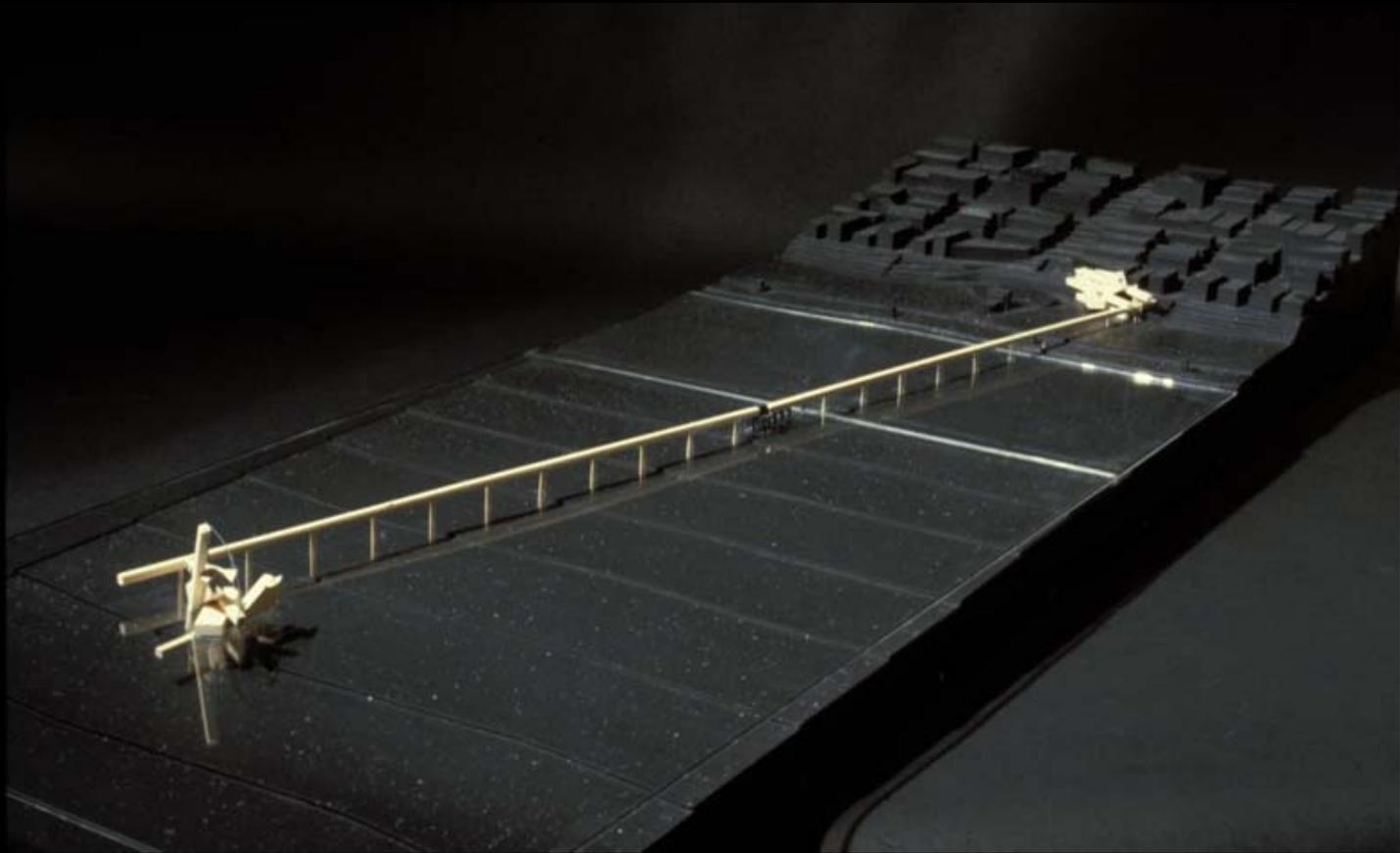


memorial to mining workers (Michael Wilcox)

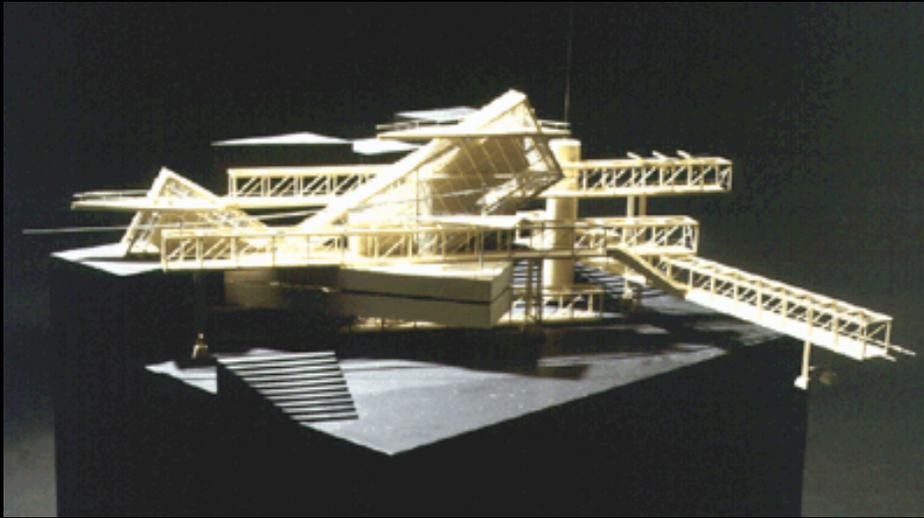


## **Design projects:**

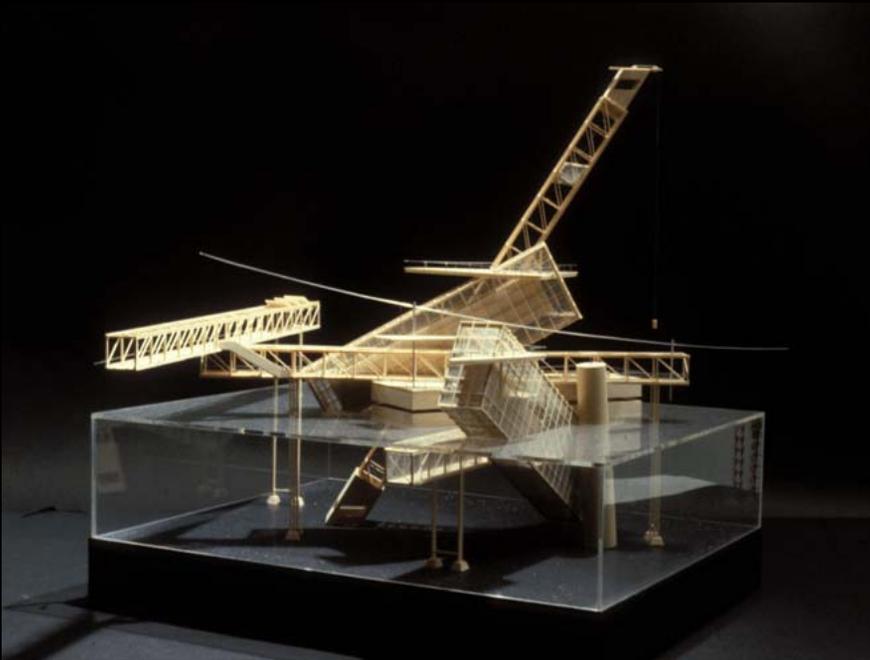
basic grammars using two spatial relations



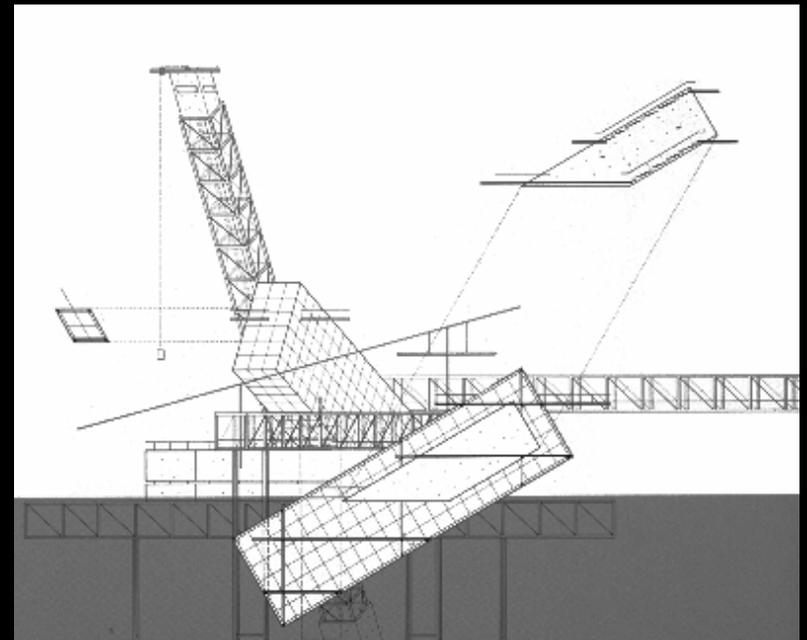
pier, ocean observatory and education facility, Manhattan Beach, CA  
(Randy Brown)

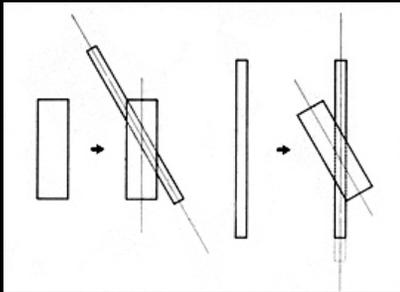


land building

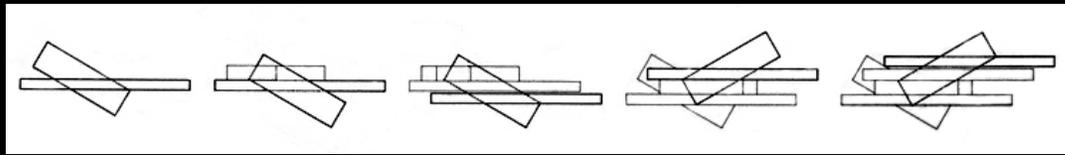


ocean building

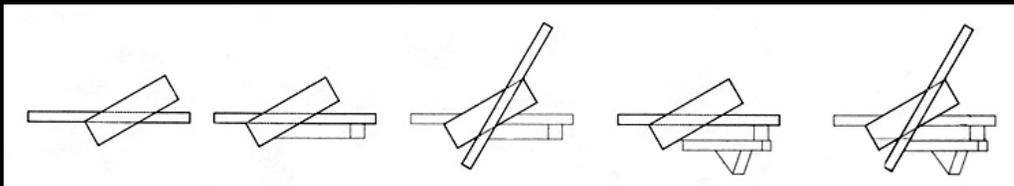




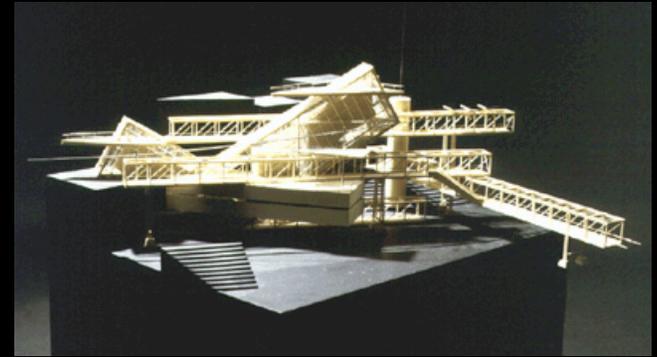
basic rules

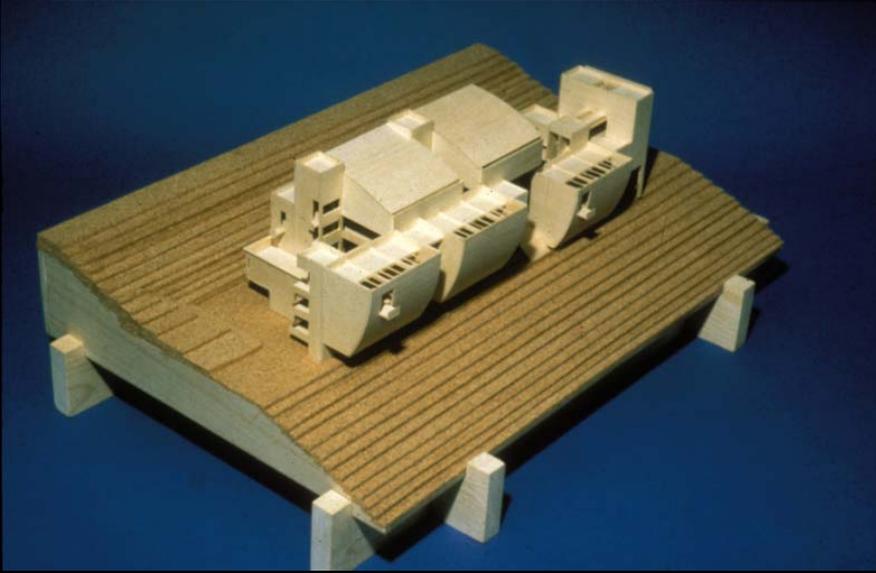


land building computation

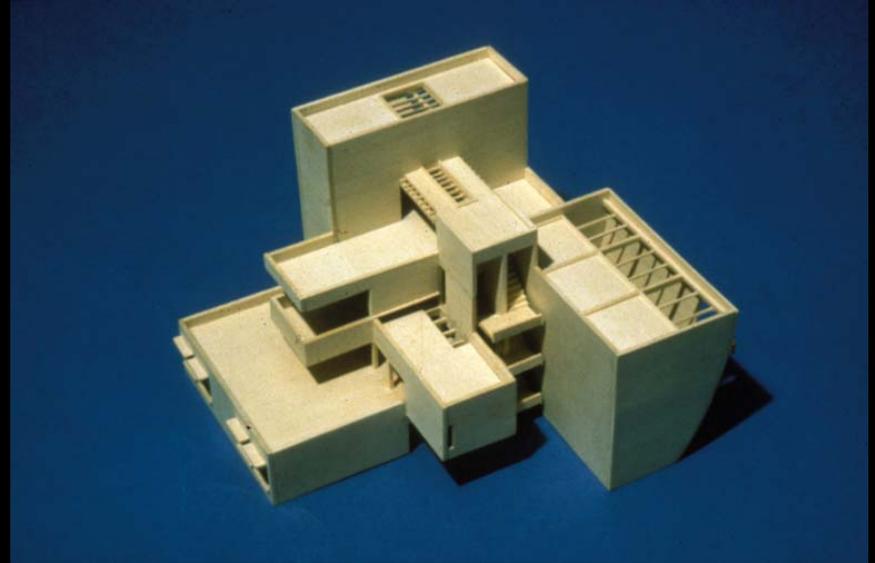
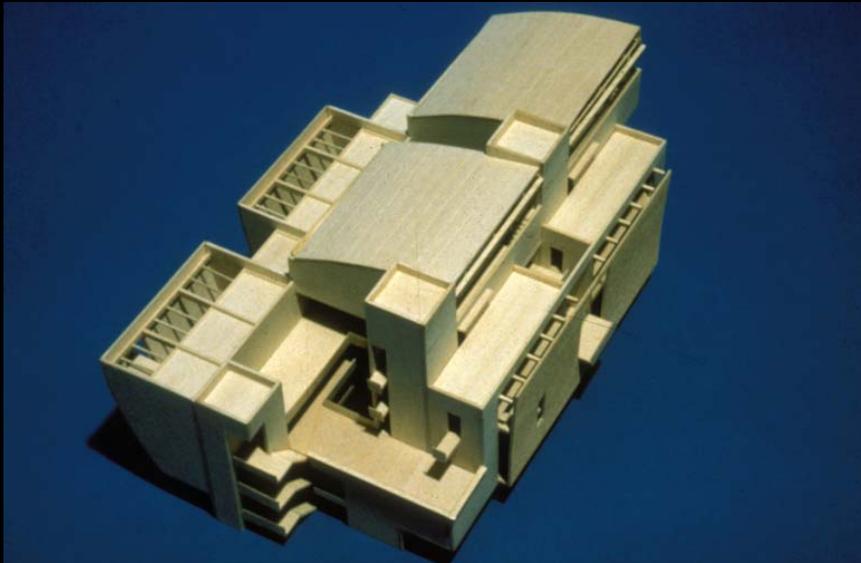


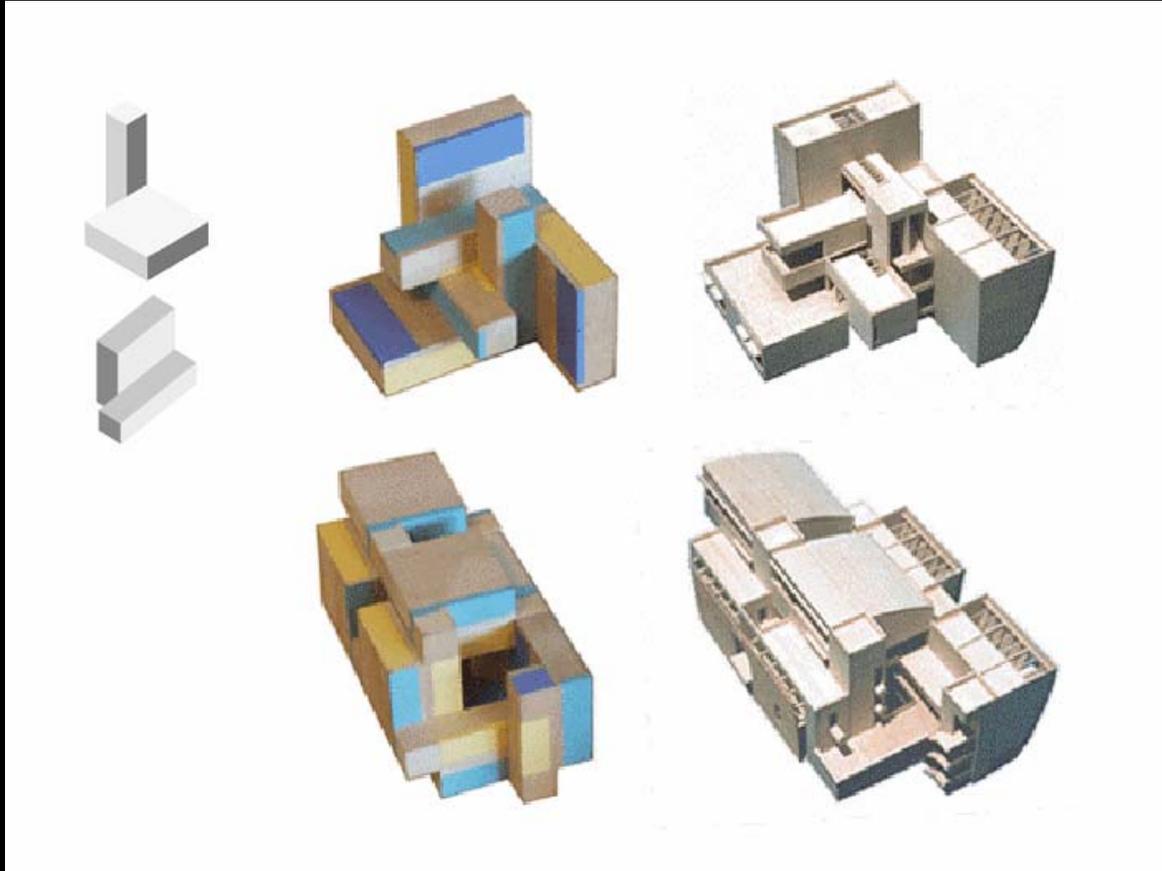
ocean building computation



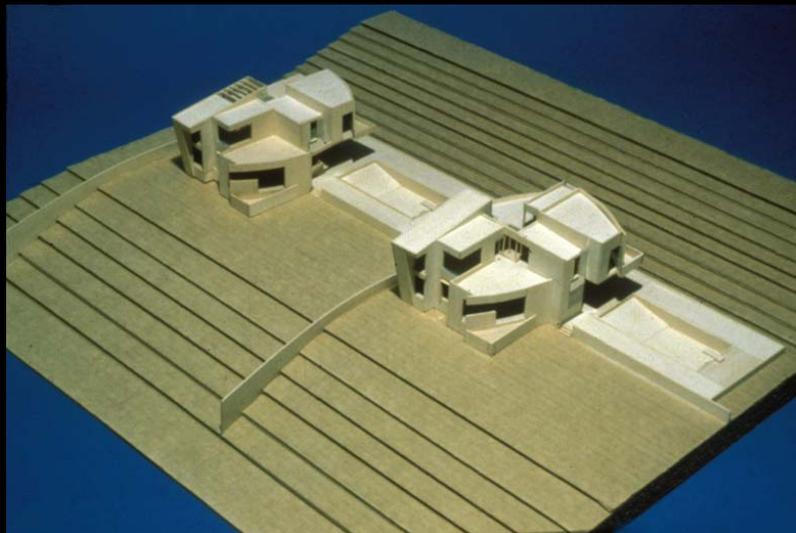


cultural history museum, Los Angeles  
(Jin-Ho Park)

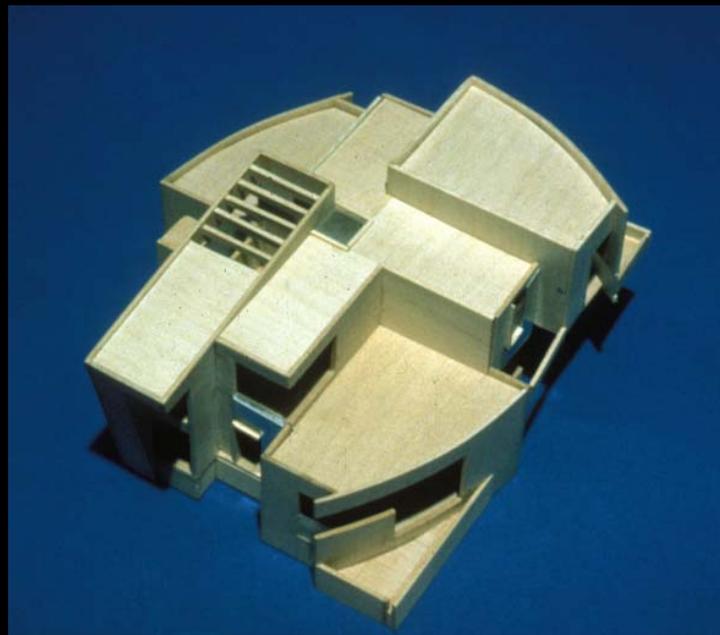


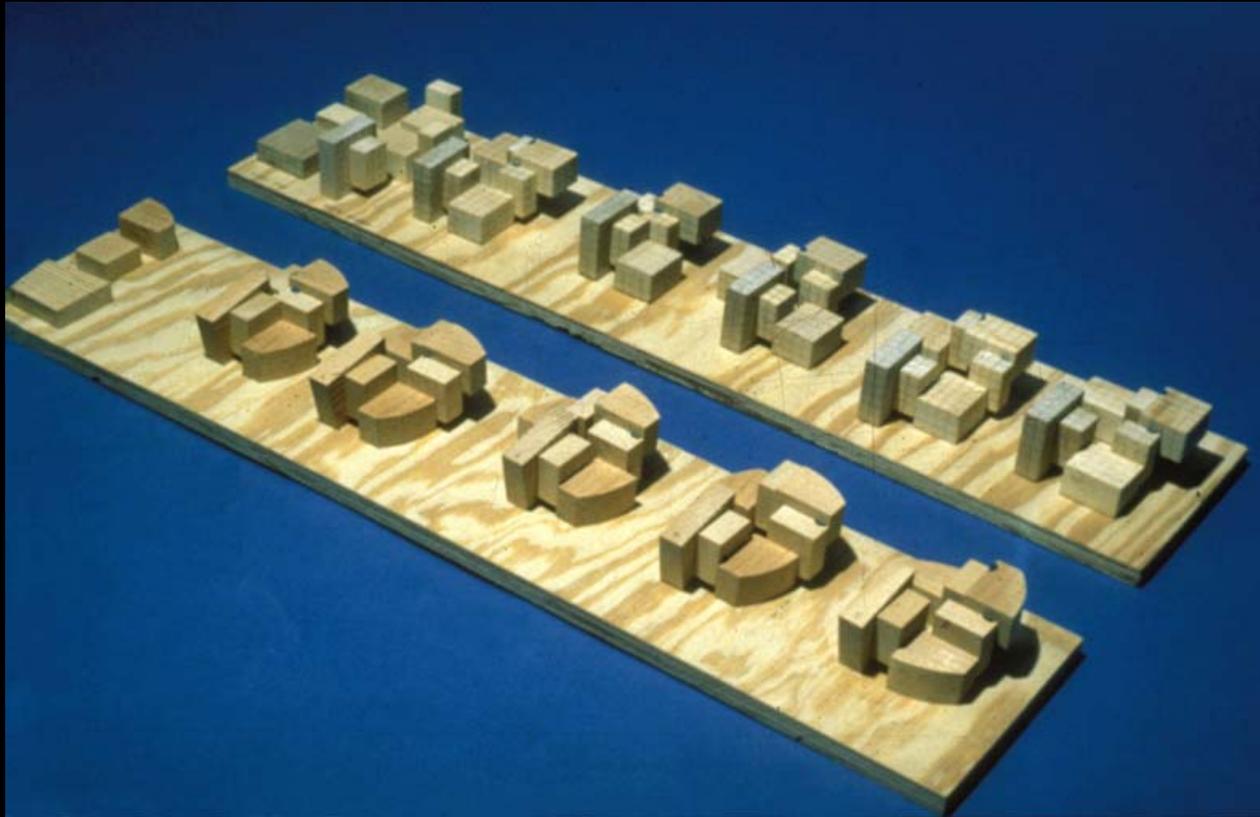


cultural history museum, Los Angeles (Jin-Ho Park)

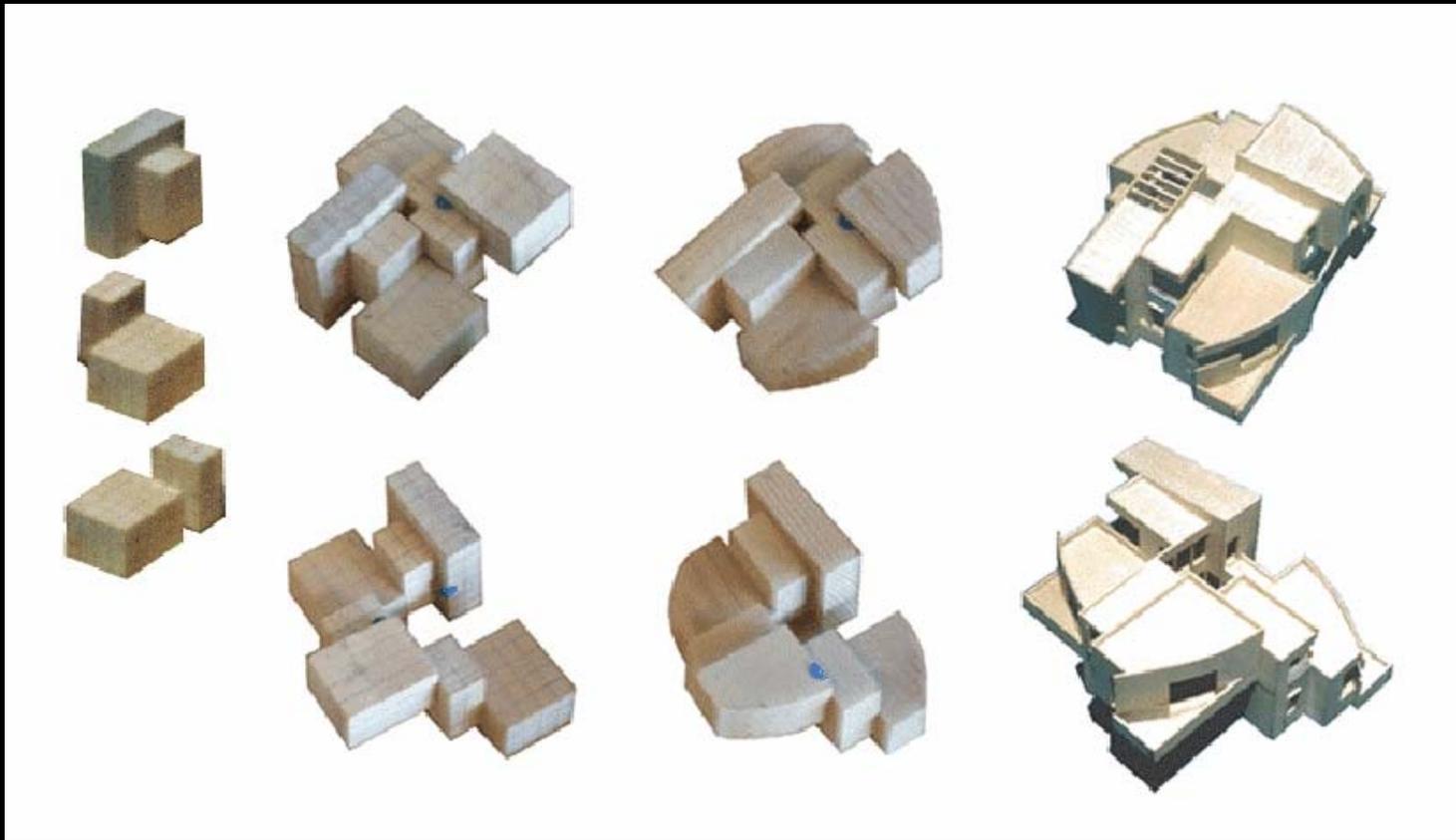


courtyard houses, Malibu, CA  
(Jin-Ho Park)





courtyard houses, Malibu, CA (Jin-Ho Park)

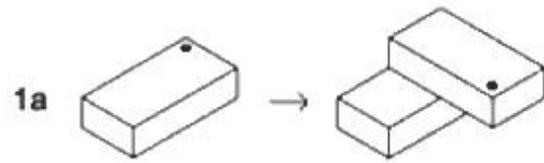


courtyard houses, Malibu, CA (Jin-Ho Park)

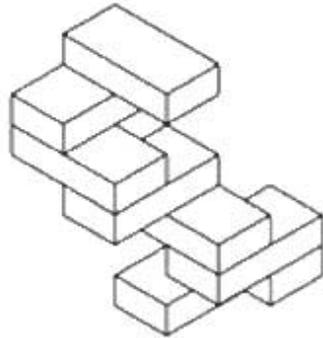
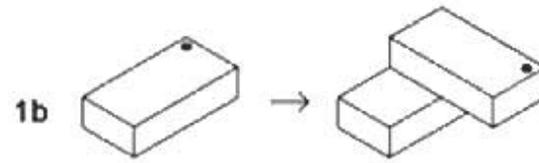
## **Nondeterministic basic grammar**

A partially ordered set of basic rules where each rule applies to the shape added by a previous rule

Initial shape: the shape on the left-side of the first rule

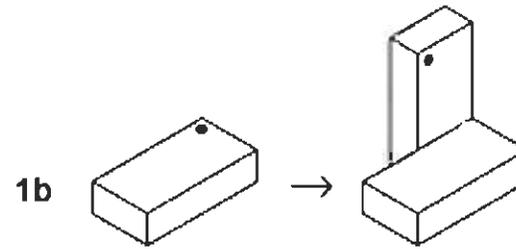
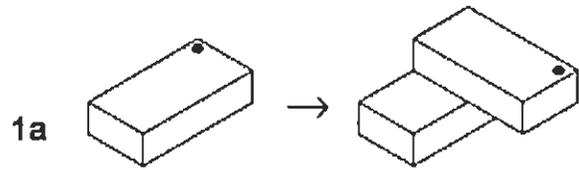


ND basic grammar



design

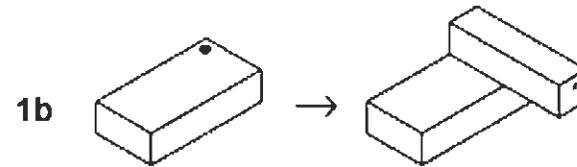
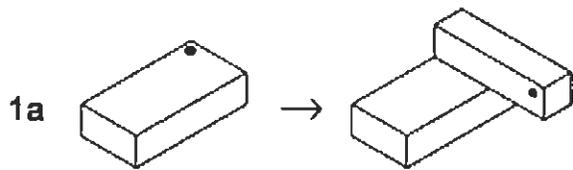
**NONDETERMINISTIC BASIC GRAMMARS**



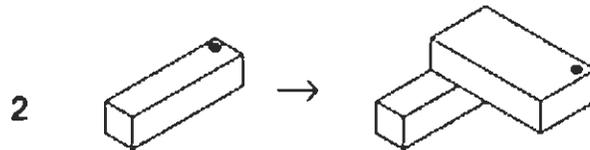
1a 1b

ND basic grammar

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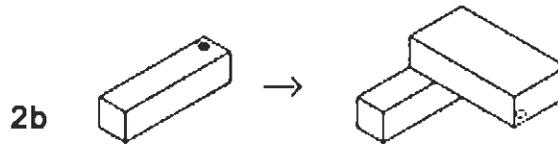
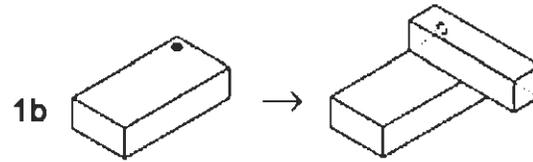
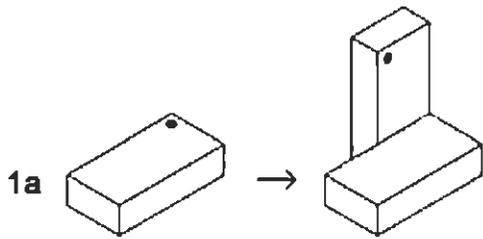
1a 1b  
  
 2



ND basic grammar

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**NONDETERMINISTIC BASIC GRAMMARS**



1a    1b  
      ↓  
      2b

ND basic grammar

### NONDETERMINISTIC BASIC GRAMMARS