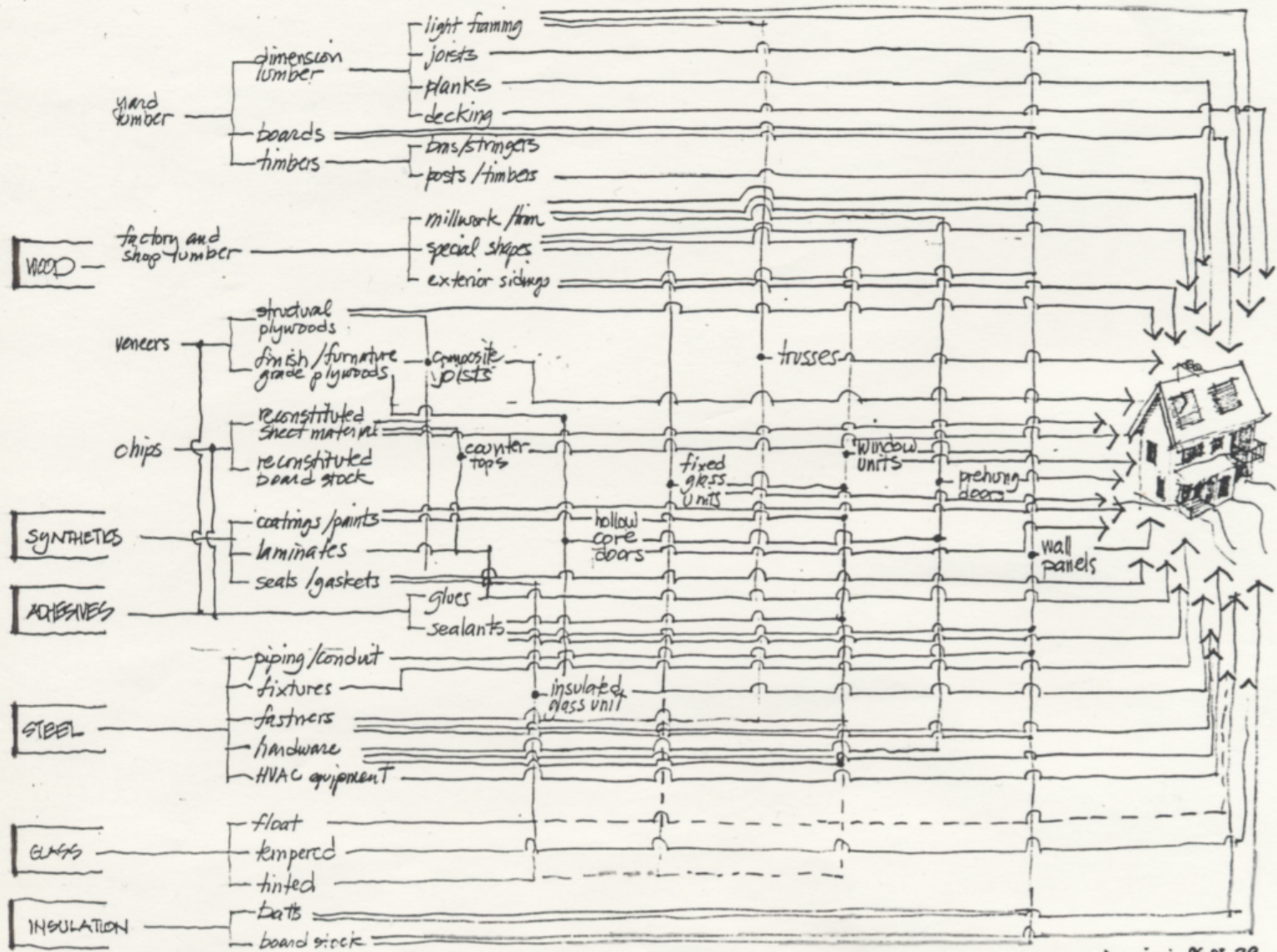


# THE ECOLOGY OF PRODUCTION

and the significance of  
**Distributed Control**

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For a long time, since I first began to build, I've been interested in where the products I used came from.



\* revision 05.05.29

...from rudimentary states to more complex artifacts.....thru various stages of production....

**This interest comes from the fact that before I was a practicing architect, I was a builder.**



**I rebuilt and extended an old house, and used standard parts and also custom-designed and crafted parts...**



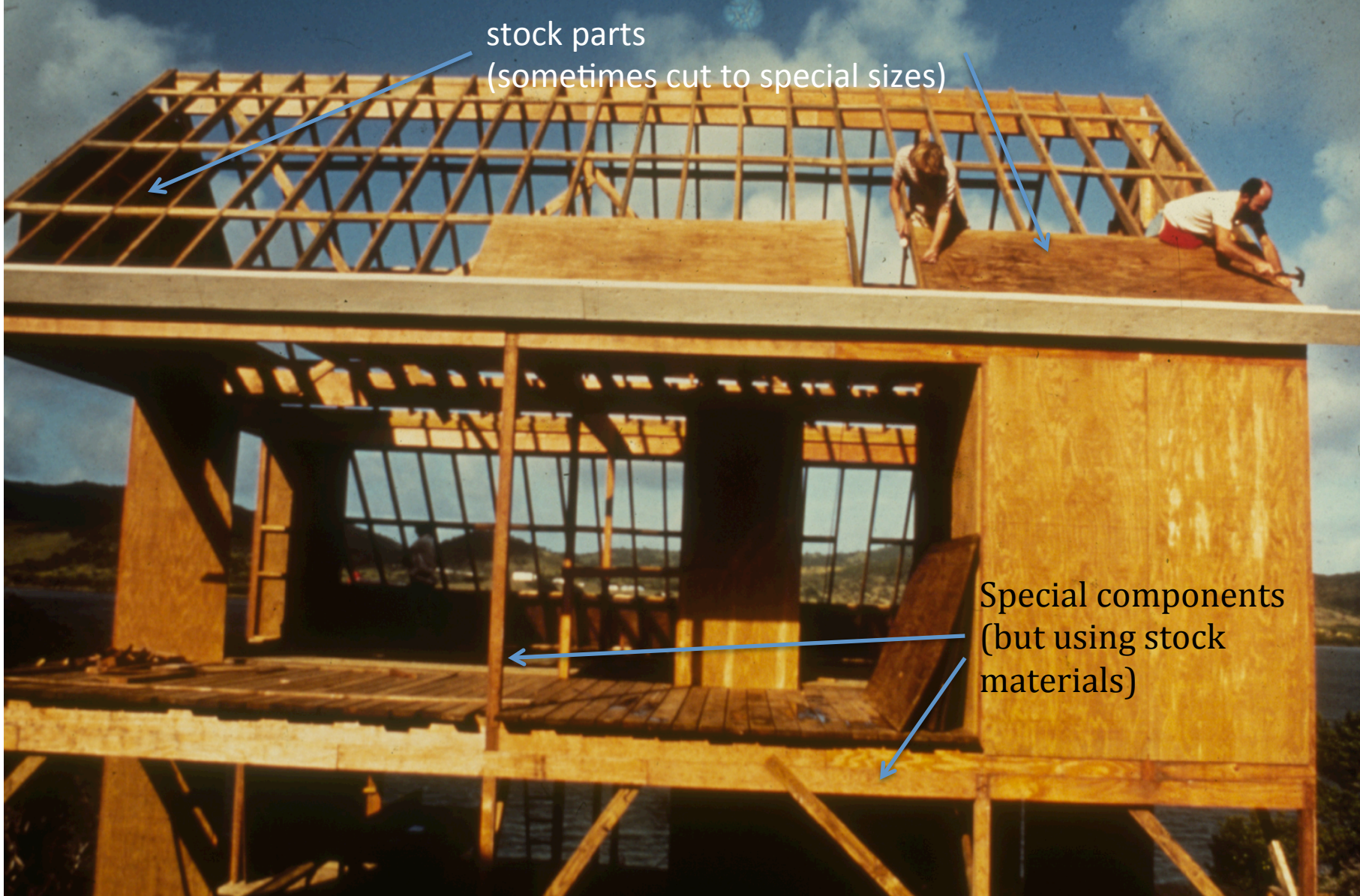
I designed and built an addition to a house, inspired by Frank Lloyd Wright' residential architecture...



Interlocking structural components based on a 1m module, made from stock plywood and dimension lumber



...houses in Puerto Rico, using a hybrid building system...designed to enable families to design their own houses. Elements were designed for any house, based on a dimensional module and a standard kit of parts...



stock parts  
(sometimes cut to special sizes)

Special components  
(but using stock  
materials)

**both stock parts and the special post-and beam components and wall panels...**

Later, when I became an architect, I was not so much concerned with building as designing...



And again found myself specifying stock parts and custom parts using stock products...



When it became possible to pursue a PhD in Design Theory and Methods at MIT, I decided try to understand more about what I had learned in building and designing...particularly about the chains of production...and to find general principles if possible...



**I'd like to explain what I did and why.**

Definition of words used all the time in the literature to explain building industry dynamics never really made sense to me...

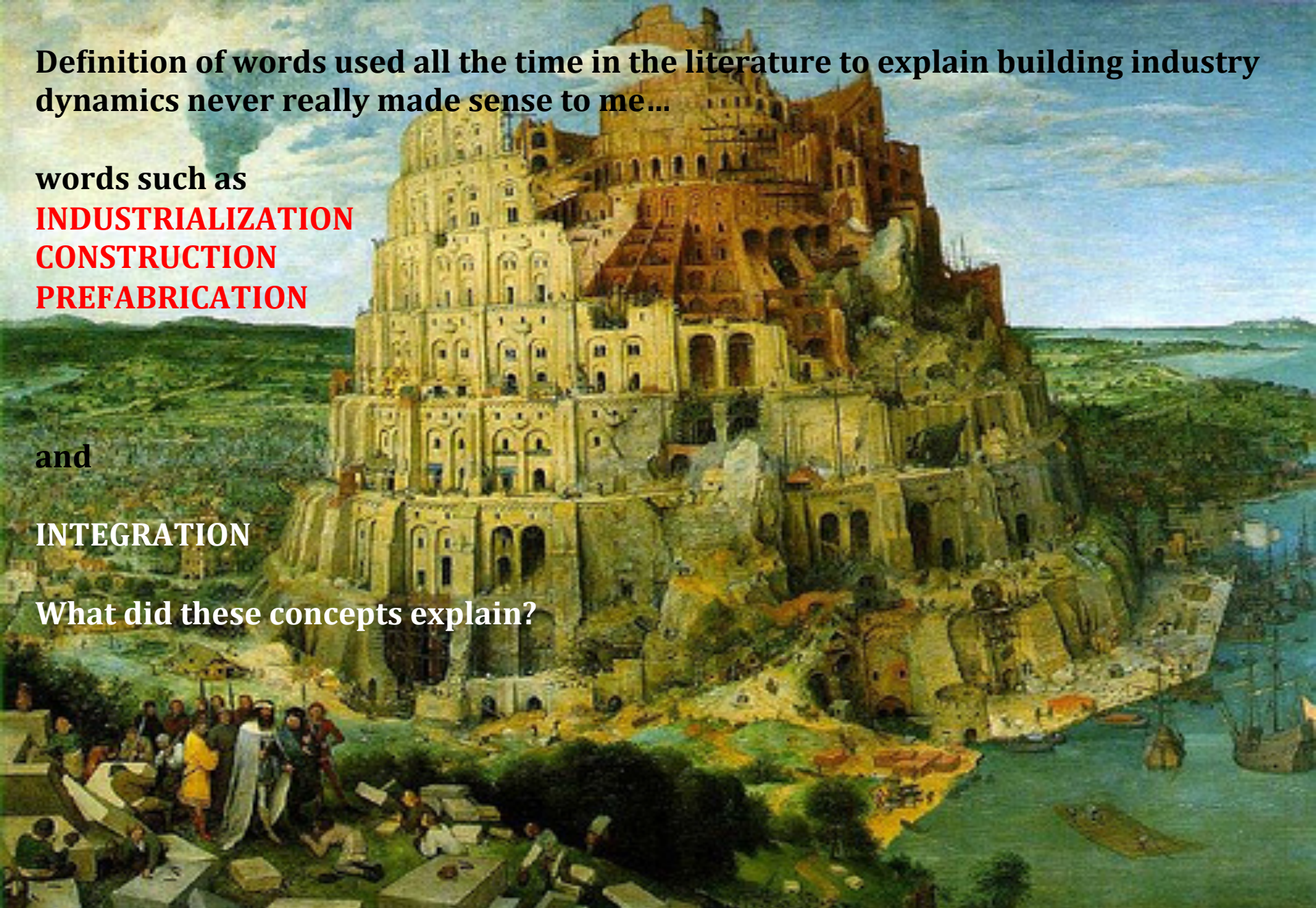
words such as

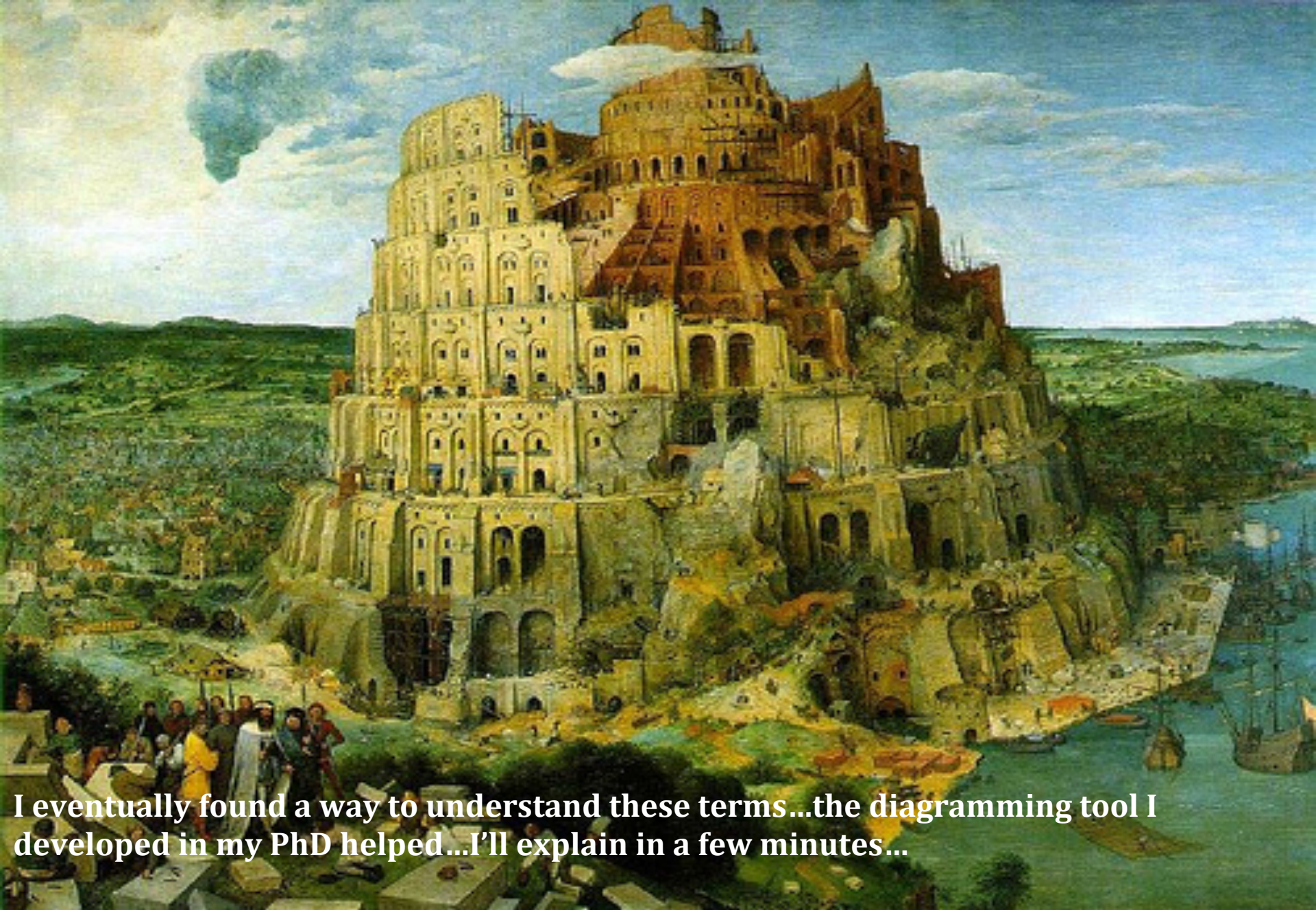
**INDUSTRIALIZATION**  
**CONSTRUCTION**  
**PREFABRICATION**

and

**INTEGRATION**

What did these concepts explain?





**I eventually found a way to understand these terms...the diagramming tool I developed in my PhD helped...I'll explain in a few minutes...**

**A business - not a technical view...**

A basket of parts...

**Industrialization**  
(the producer takes the initiative)



**Construction**  
(the user takes the initiative)



**Prefabrication**  
(another form of construction)



An aerial photograph of a city grid is overlaid with a green circuit board pattern. The circuit board traces follow the streets and building footprints, illustrating the concept of integrating physical infrastructure with digital technology. The text is centered over the lower half of the image.

And then...what could **INTEGRATION** mean for designers and makers of the built environment?

In the Oxford Dictionary, “integration” has several meanings, but the most common one is perhaps the idea that many things become one...UNITED..

In the building industry literature, the use of the word “integration” has been set in opposition to another word found in the building industry literature:

Fragmentation

which always has a negative connotation...

The other consistent theme in the building industry literature on innovation is the reference to other “more mature” or “more integrated” industries, such as the automotive industry.

Much effort is spent comparing the building industry to them, because they are thought to be “integrated” and not fragmented.

Integrated is good.  
Fragmented is bad.



I suggest use of the term **“disaggregated”** instead of **“fragmented”** when describing the constellation of agents involved in designing and building.

This means that a number of **independent parties** are involved - consultants from all kinds of disciplines, even geographically distributed.

The relations between these many parties is key....  
my PhD focused on this...

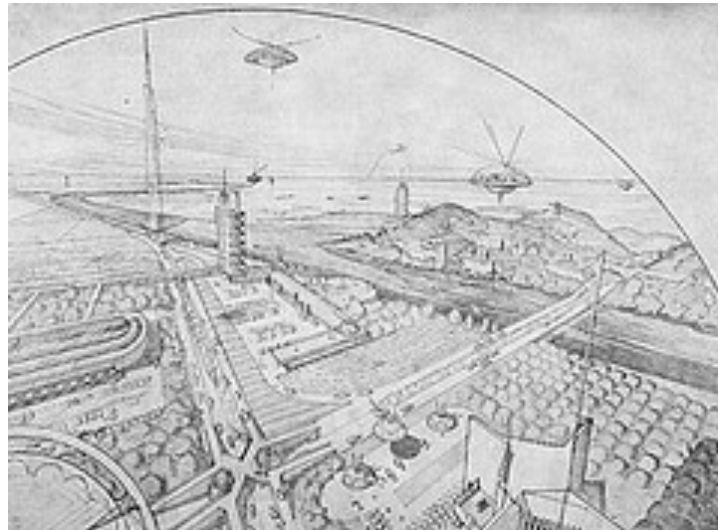
**There is really no question that projects of any size today need many disciplines and thus many parties to get the work done.**

**What are the relations between these parties?**

**There are many patterns of relations.....**

**...teams, partnerships, collaborations, virtual corporations, vertically or horizontally organized networks....**

**... we would find it very strange today if one party (an individual or a company) claimed to be able to do everything – like FLLW!**



**For a long time we have known the fact that the environment is not a solo act...we experience more specialization as the world becomes more complex and fast paced.**

**Back to the term “fragmented” and the reference to “integrated” industries like the automotive sector....**

**It would be amazing and probably a terrible idea if the building industry would model integration in that sense.**

**Do we really want three companies controlling all the building activities... with tight, top-down supply chains and so on.... in the US ..... or in China?!**

**I think few would argue in favor of that, or in favor of abandoning the range of small, medium and large organizations that give the building industry tremendous agility and strength (but also problems!!)**



**In the management literature - I refer particularly to Eric von Hippel's work at MIT - the term **task partitioning** is used to describe the question of how to understand a task (a design task, for example) and get it done effectively.**

**Von Hippel helps us to understand how the work on a complex undertaking must be partitioned in a sensible way.**

I learned that in the building industry, using “integration” inevitably means more than “technical” matters....

that issues of **CONTROL** must be resolved - what party (an individual or group) makes things happen...a decidedly business view...or a view about the exercise of power.

**CONTROL is...taking action... (of course under multiple constraints)**

My PhD thesis question was:

**Could a diagramming tool help describe the ECOLOGY of PRODUCTION...distributed (vs. integrated) control in chains of production... and thus supplement and clarify the verbal and terminological references that we depend on?**

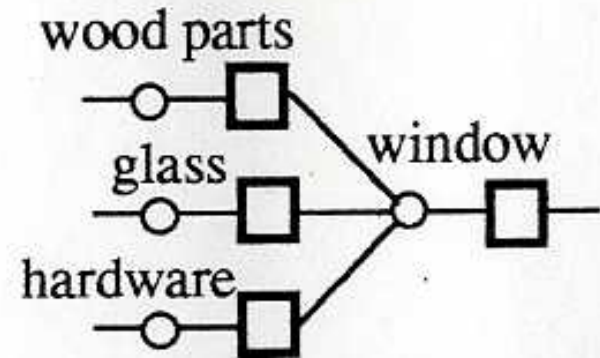
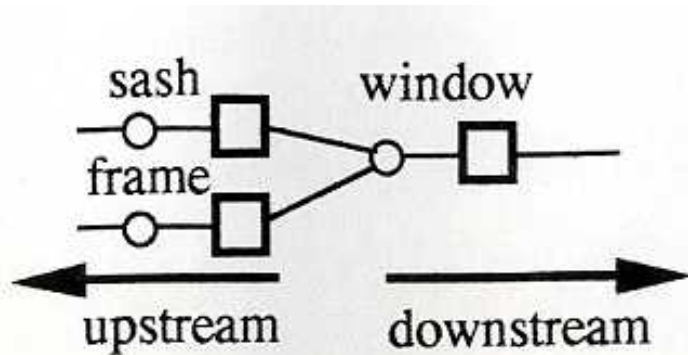


...instead of considering just products, or just organizational patterns, the **CONTROL** of PARTS was the key...seeing parts and people together...

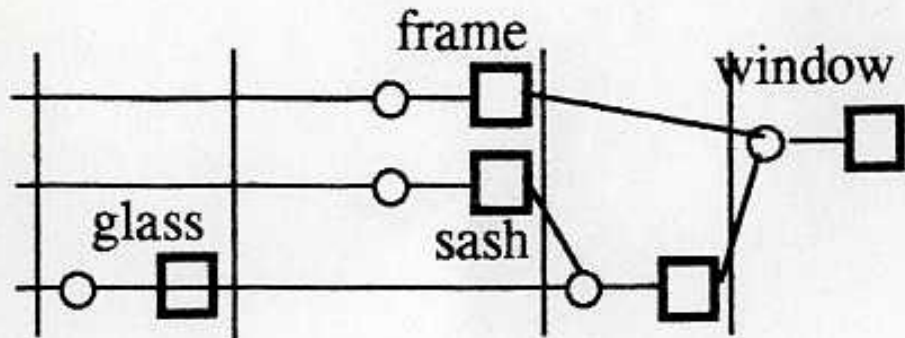
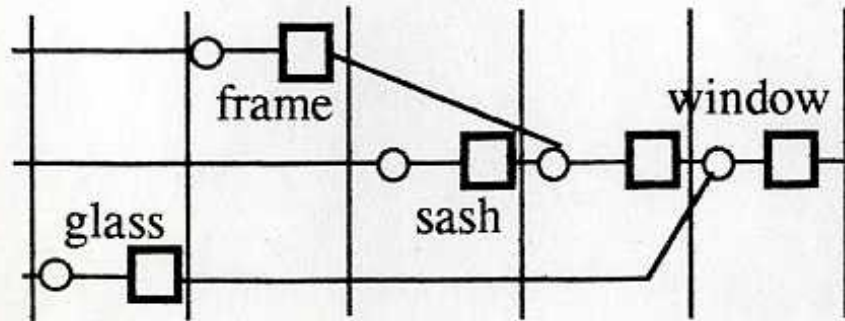


# A diagramming tool to explain patterns of control

## Parts and Operations

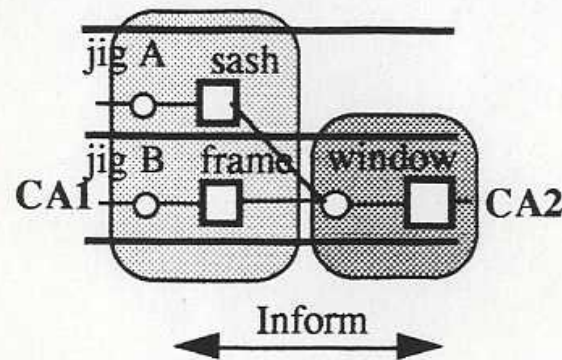
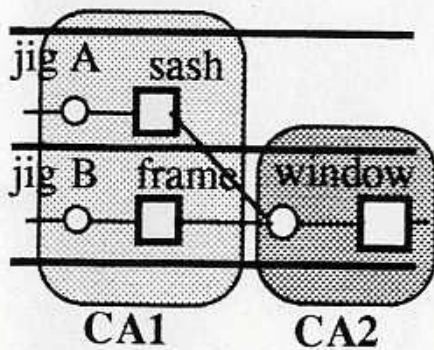
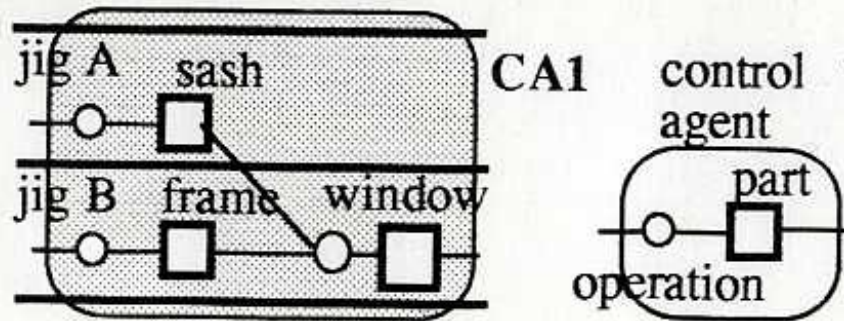


## Operation Sequences



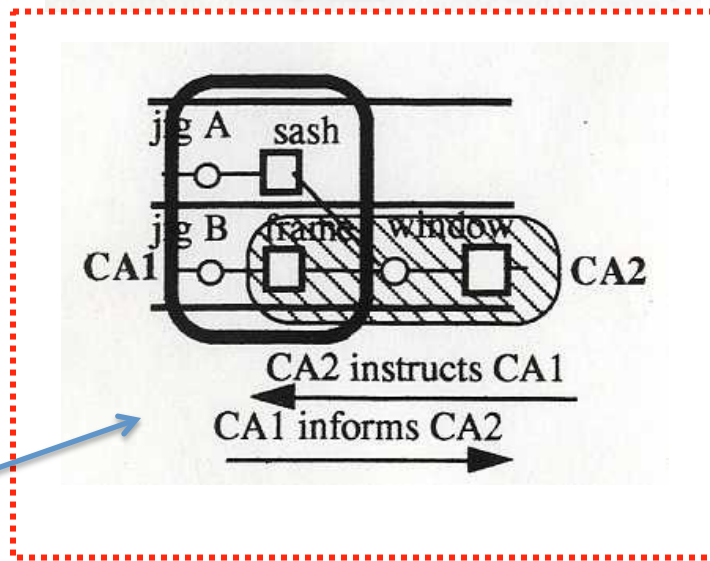
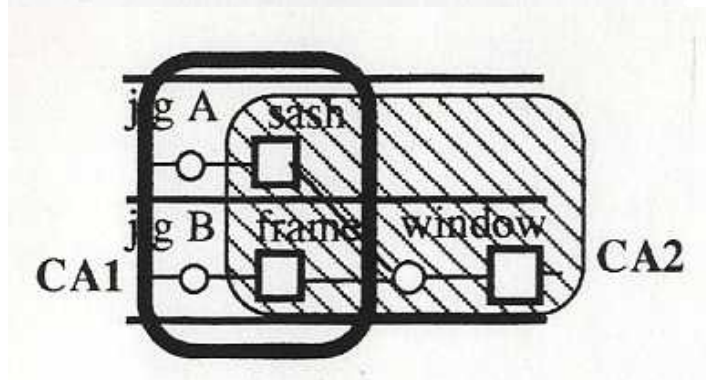
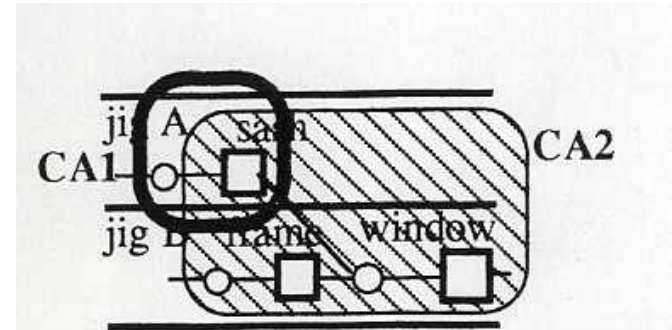
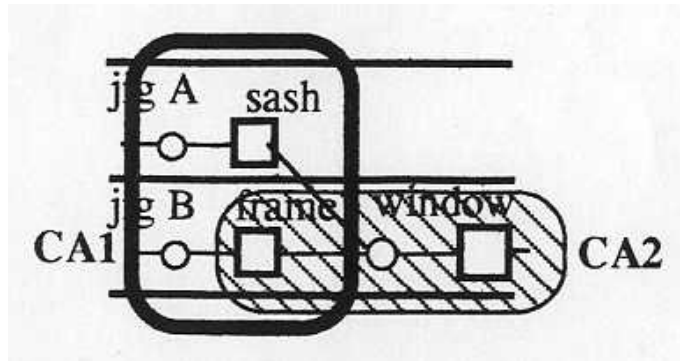
## Interaction of control agents

*Dispersed control pattern...not one, but several agents can appear...each acts independently, and only communicate via the “market... This signifies a kind of “decoupling” of maker and user.*



## OVERLAPPING CONTROL PATTERN

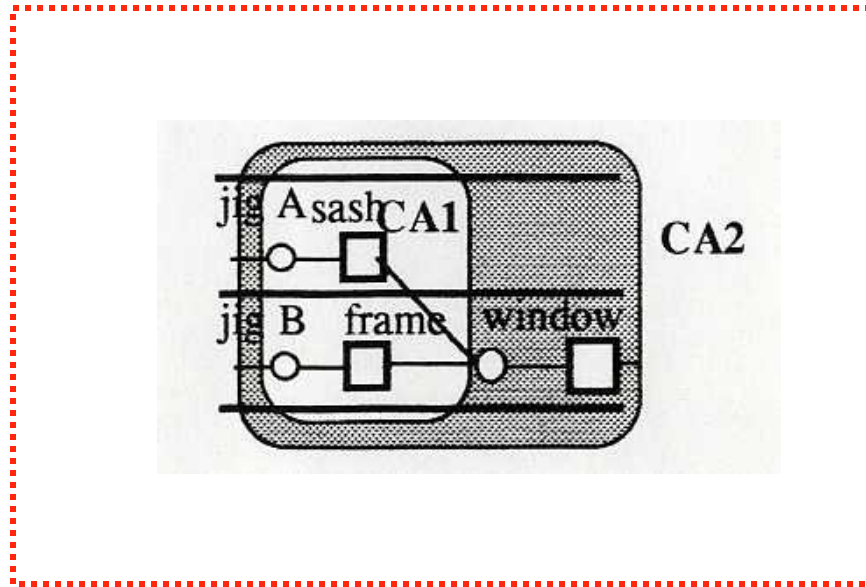
This introduces **INDIRECT CONTROL**... CA2 controls (makes) the window AND has indirect control of the frame, which it needs but doesn't want to make it. Both CA1 and CA2 share the frame but have different relations to it. WHAT I WANT THIS TO SIGNIFY IS THAT CA2 INSTRUCTS CA1 TO MAKE THE FRAME. This is one way for a downstream agent to relate to an upstream agent.



The upstream agent (CA1) makes the Frame but only after getting an order From the downstream agent (CA2).

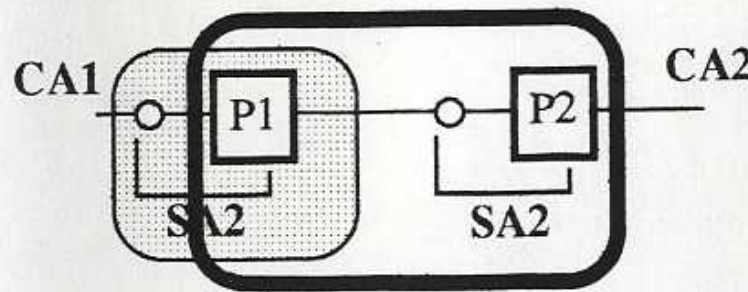
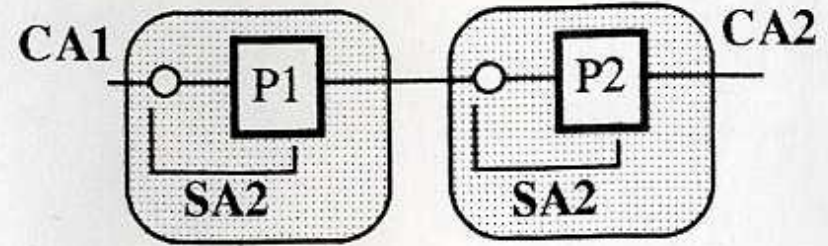
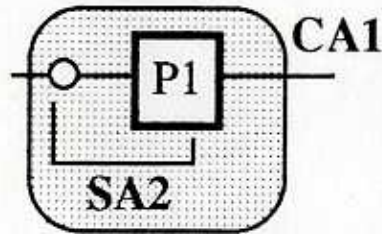
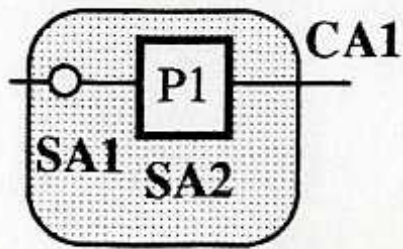
## ***PATTERN OF INCLUSION***

***CA1 controls (makes) Sash and Frame, both of which are ordered (INDIRECTLY CONTROLLED) by CA2. CA1 has no independence in this diagram. It is completely responsive to CA2. (maybe a division of company owned by CA2, which cannot make the results of its control available to anyone other than CA2)***

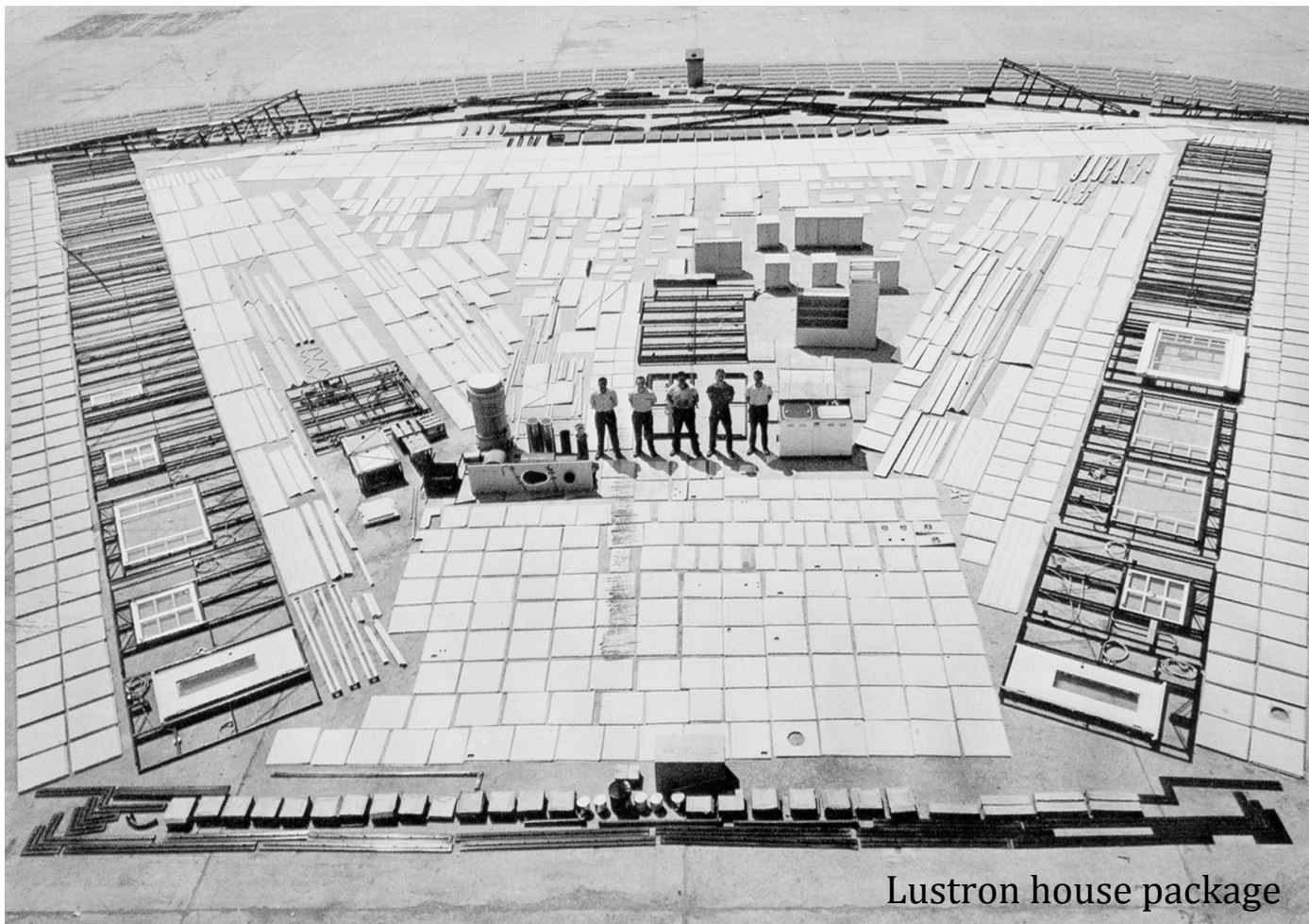


## Specification Agents and Control Agents Interacting...

Specialization appears between those who **specify** and those who **make**



*Do any of these diagrams represent “integration”?*



Lustron house package

**ONE OF MY OBJECTIVES WAS TO UNDERSTAND** why building systems that are perfectly rational and efficient on paper sometimes fail when applied in practice.....is it because they require **apparently unacceptable adjustments** of interrelations in the worlds of design, manufacturing and construction?



## **SOME CONCLUSIONS...**

- **Industrialization, construction, prefabrication and integration can only be understood in relation to patterns of control**
- **Control is not a technical question, but technical questions always reside in patterns of control**



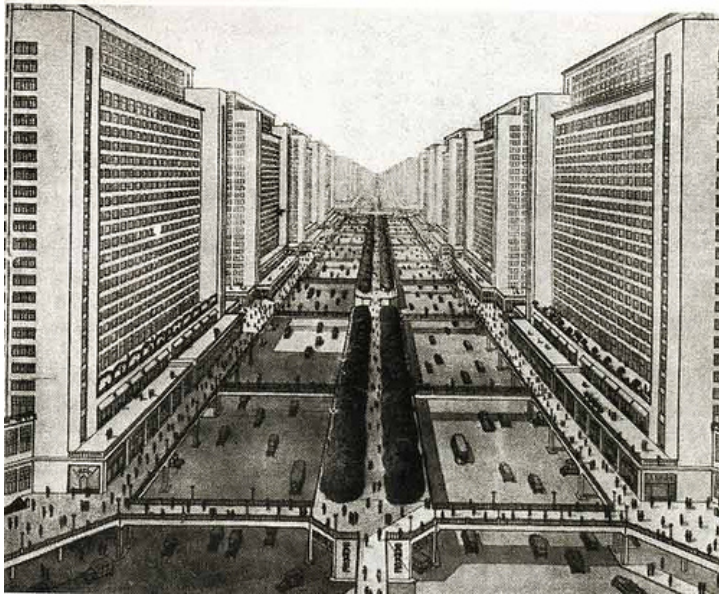




**The point of these notes is to suggest a reexamination of the terms of reference we employ, and also suggests use of non-verbal means to support discussion about them....**

**Can we accept ....with good methods ..... the central feature of the built environment's existence and transformation....**

**that is.....PARTITIONED or DISTRIBUTED CONTROL?**



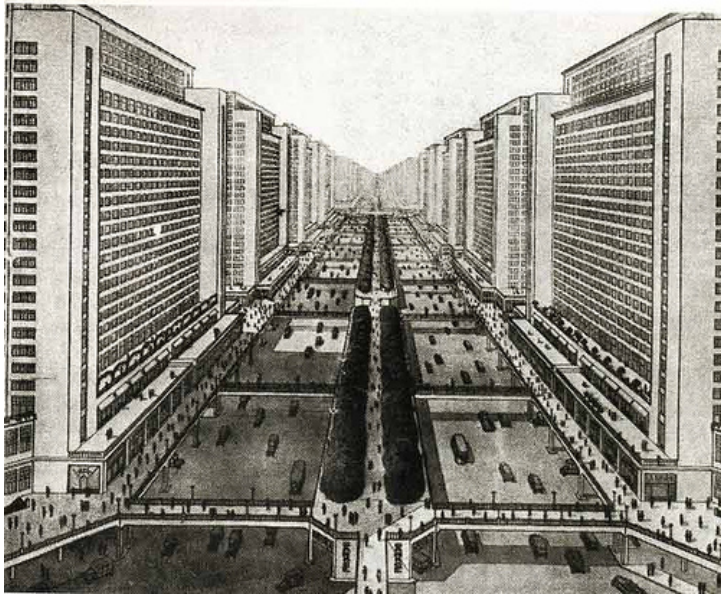
For a very long time, the implicit theory of good environment has been **UNITARY** control...

.....the idea that if only one party could make all the decisions, everything would be better...not realizing that this might tend toward a dictatorship of the environmental design game... and in any case, that is not the way the world works!



Which of these is an example of an **INTEGRATED DESIGN SOLUTION?**





**Now for a little test!**

**What two or three things do these notes make you think about? Does what I present relate to your own thesis question? If so, how?**

