Integrative Energy, Water, and Waste Community Design

. . . From Vision and Concept to Practical Implementation

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Army Net-Zero Installations Conference: 19 January 2012

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What is Integrative Design?

. . . the intelligent integration of technology with nature

. . . but for what purpose?

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Why Integrative Design?

What are the primary environmental imperatives we currently face?

- Potable Water
- Climate Change
- Resource Destruction
- Habitat Health
- Pollution/Toxins

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Why Integrative Design? . . . begin with definitions

Integrate:
to make into a whole by bringing all parts together; unify

Whole:
containing all components;
complete; not injured

Heal:
to make whole*

Are we healing?

Are we wholing?

* from the Proto-Germanic *khailaz*, meaning "to make whole," which is the source of the Old English *haelan,* meaning "make whole, sound, and well."

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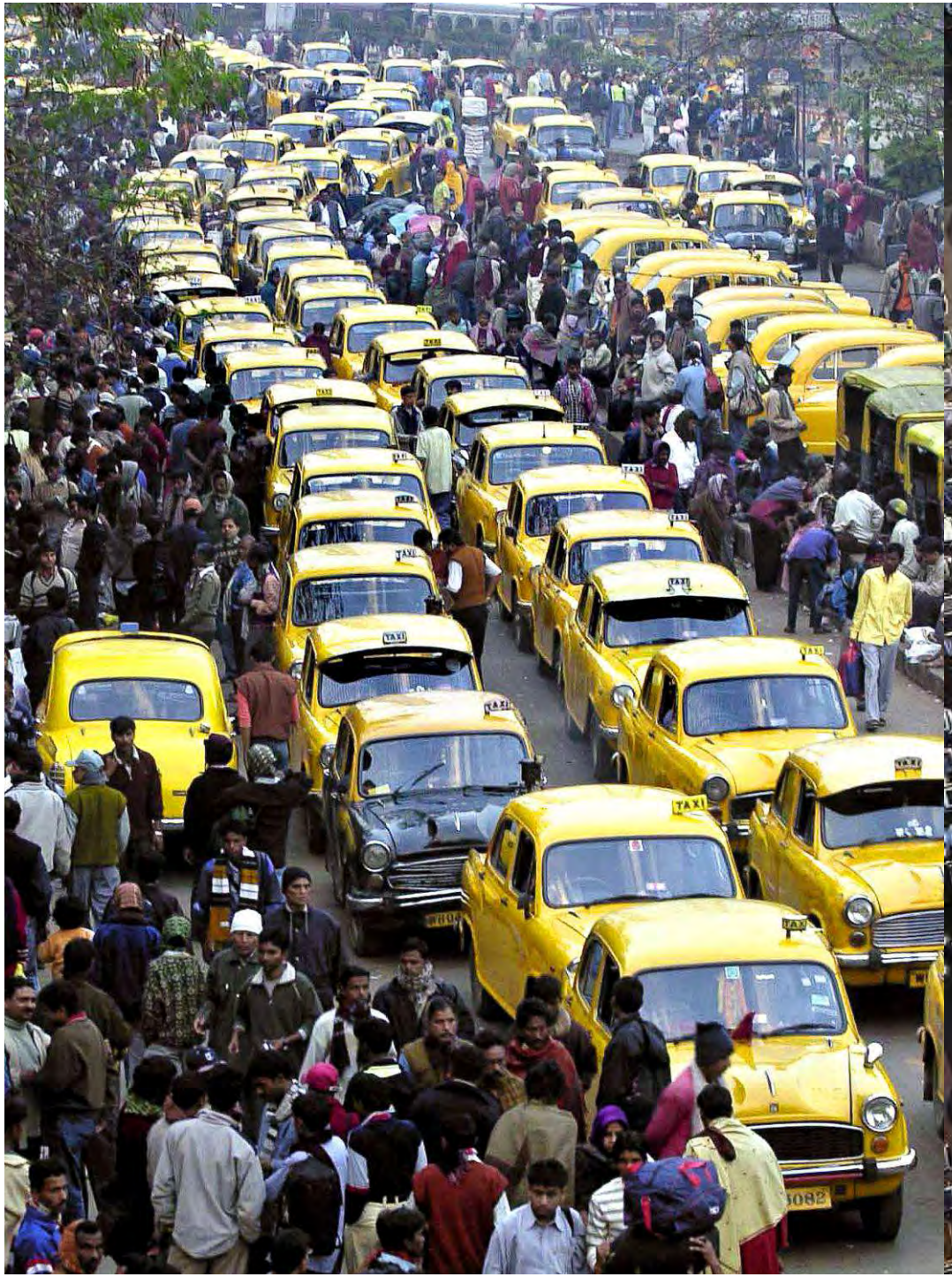
First American Title
Holiday Inn SELECT
DoubleTree Hotel
The Pavilions NORTH
Sam Ash
Chick-fil-A
Friday's
BEST BUY
SPORTS AUTHORITY
San Pedro Crossing
CIRCUIT CITY
LINENS'N THINGS
Barnes & Noble Booksellers
Time Warner
Airport Blvd
Wetmore Rd


TAXI

What is Integrative Design? . . . revisited

Addresses interrelationships between: . . . the four key subsystems

Earth	Habitat
Wind	Water
Fire	Energy
Water	Materials

Outcome:
the health of all systems

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What is Integrative Design?

A process for discovering the mutually beneficial interrelationships between:

- Habitat
- Water
- Energy
- Materials

. . . for the purpose of participating in the health of the place

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Natural Systems as Our Model for Interrelationships

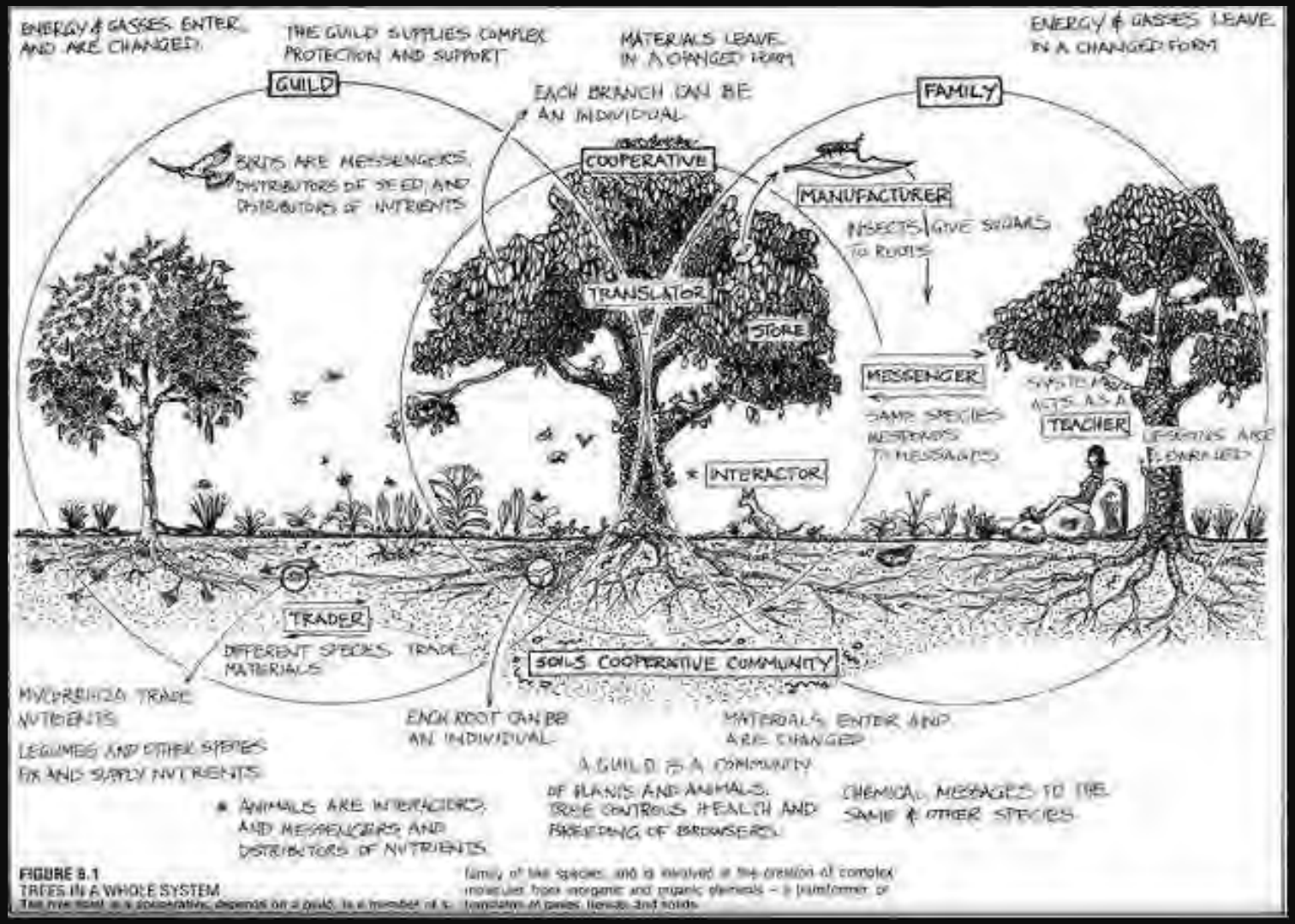

FIGURE 8.1
TREES IN A WHOLE SYSTEM

From Permaculture Designers Manual, Bill Mollison

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Natural Systems as Our Model

Image from Biohabitats, Inc.

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Environmental Imperatives . . . One System

- Potable Water
- Climate Change
- Resource Destruction
- Habitat Health
- Pollution/Toxins

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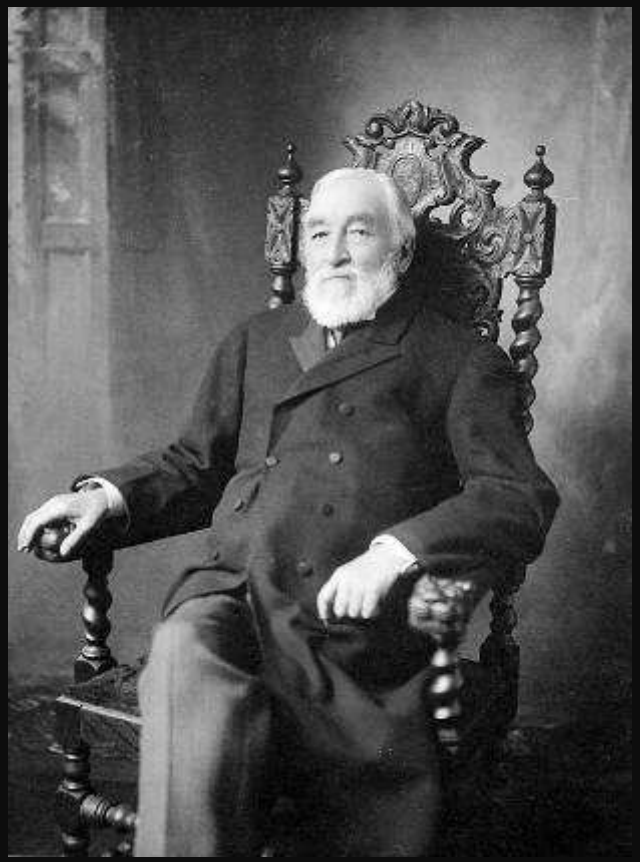
Whole Systems Thinking: The First Airplane 1900 - 1903

. . . Images and story from *A Dream of Wings* by Tom D. Crouch

The Wright Brothers



Samuel Pierpoint Langley

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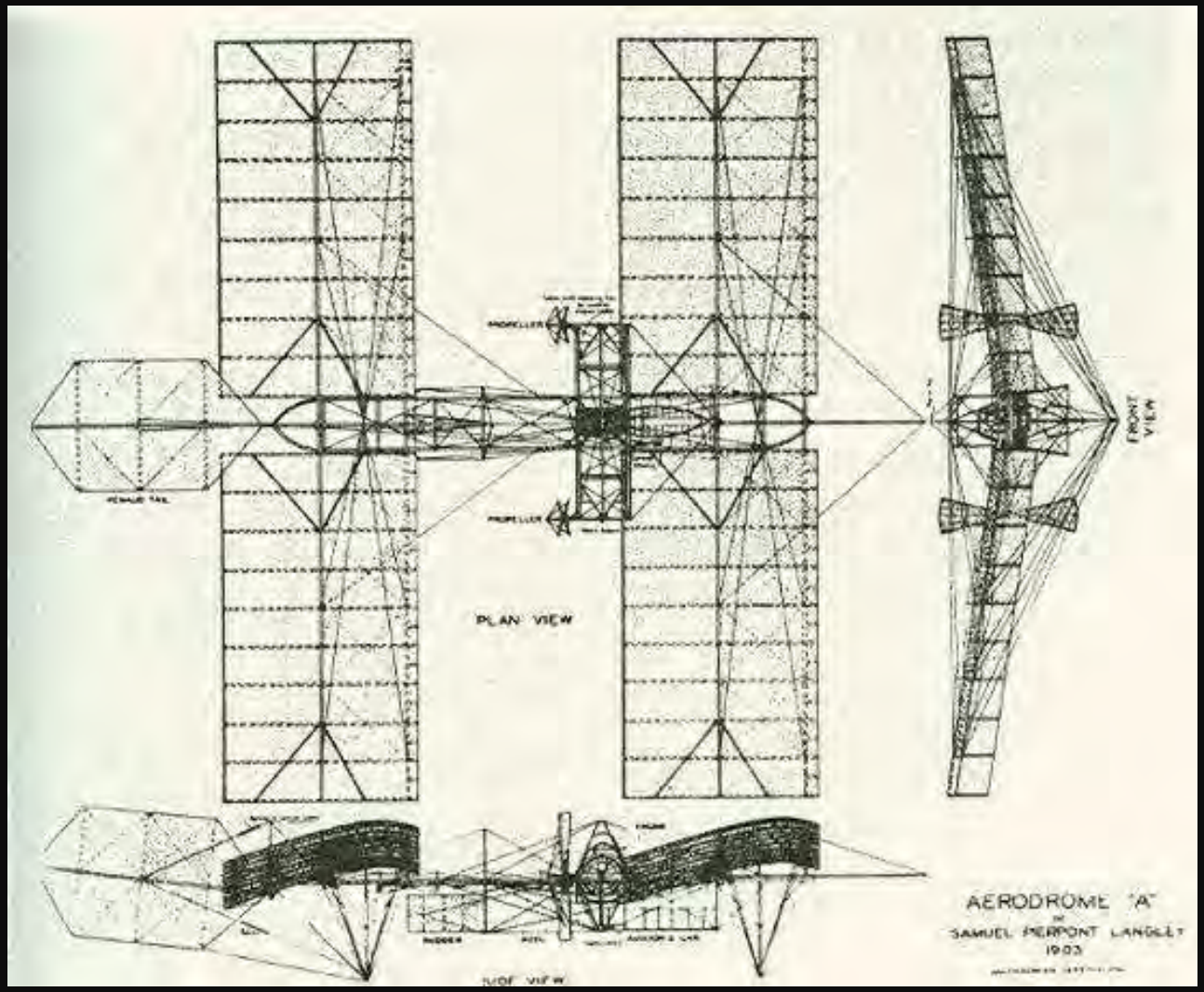
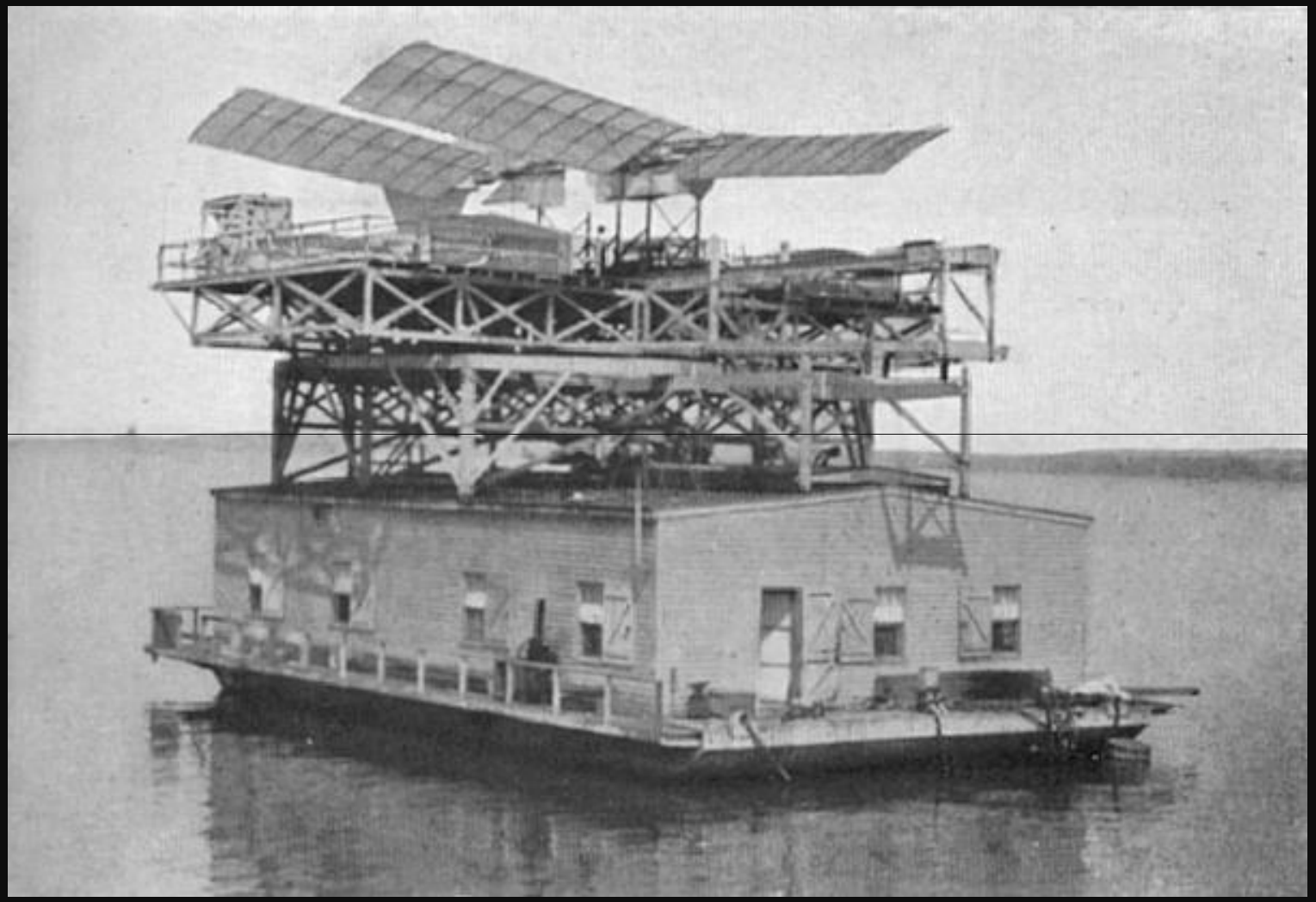
Langley's Solution



First Test Flight



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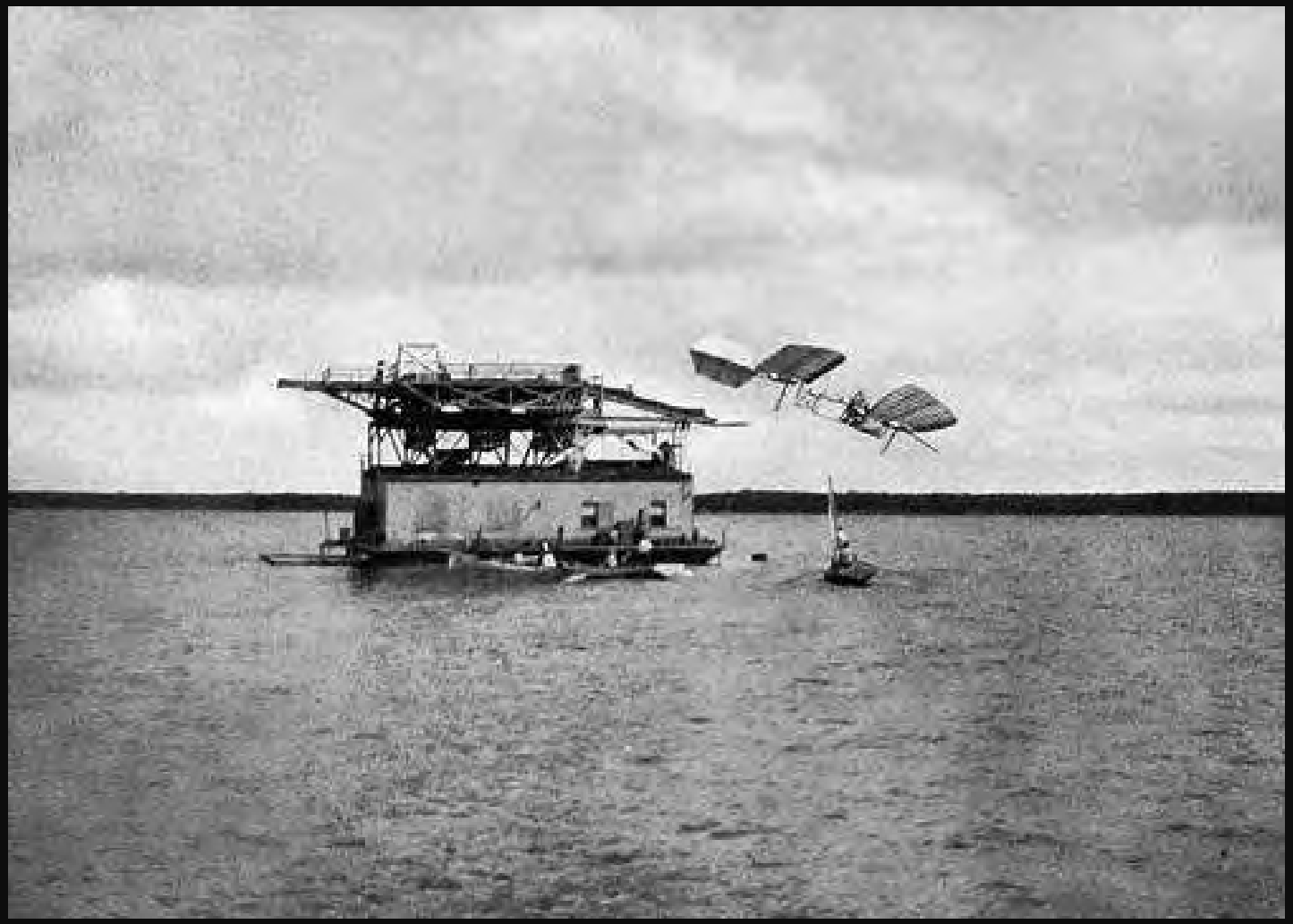
“Like a handful of mortar”



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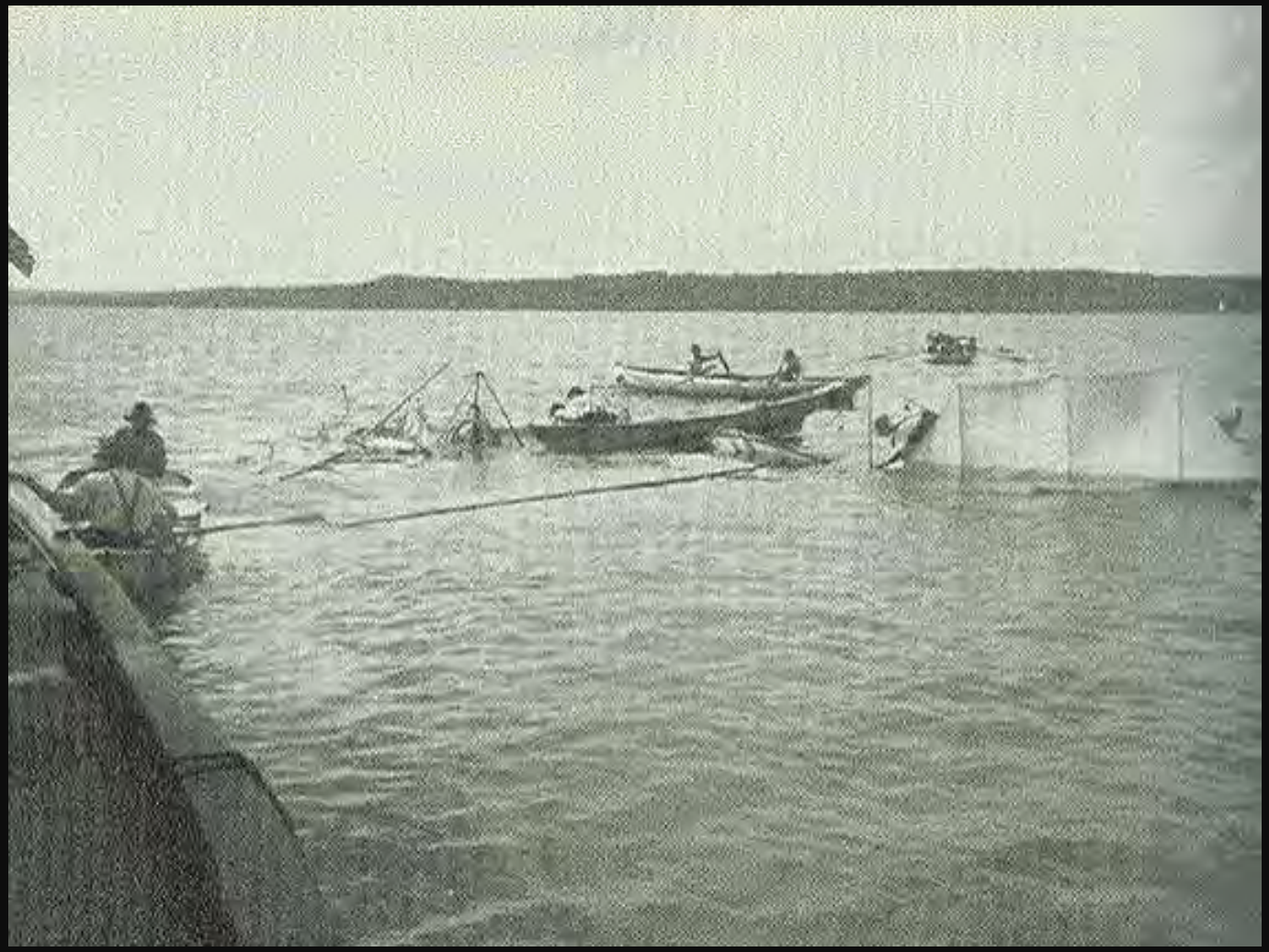
Langley’s Second Attempt



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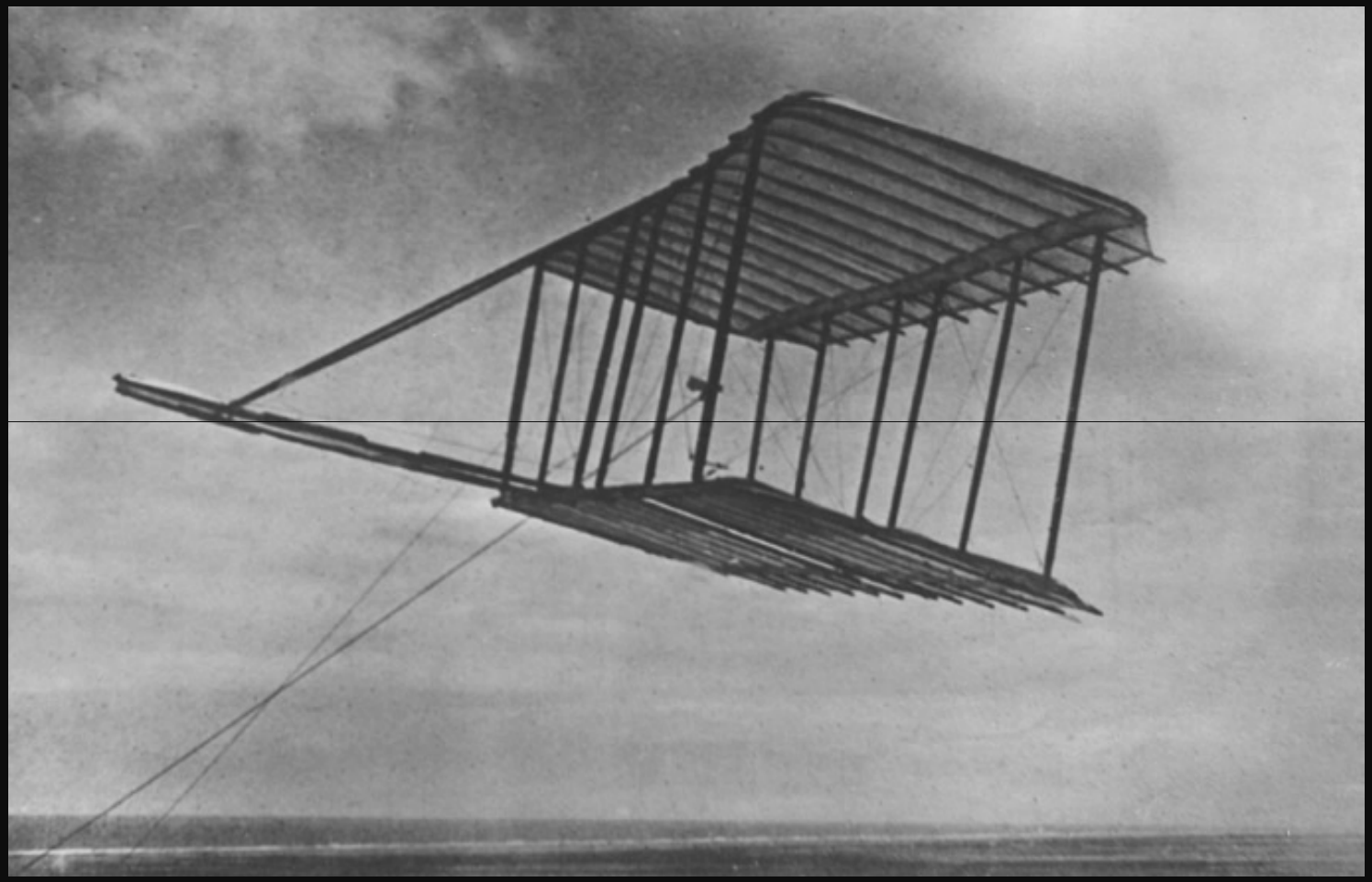
The Wright Brothers Started with Kites…



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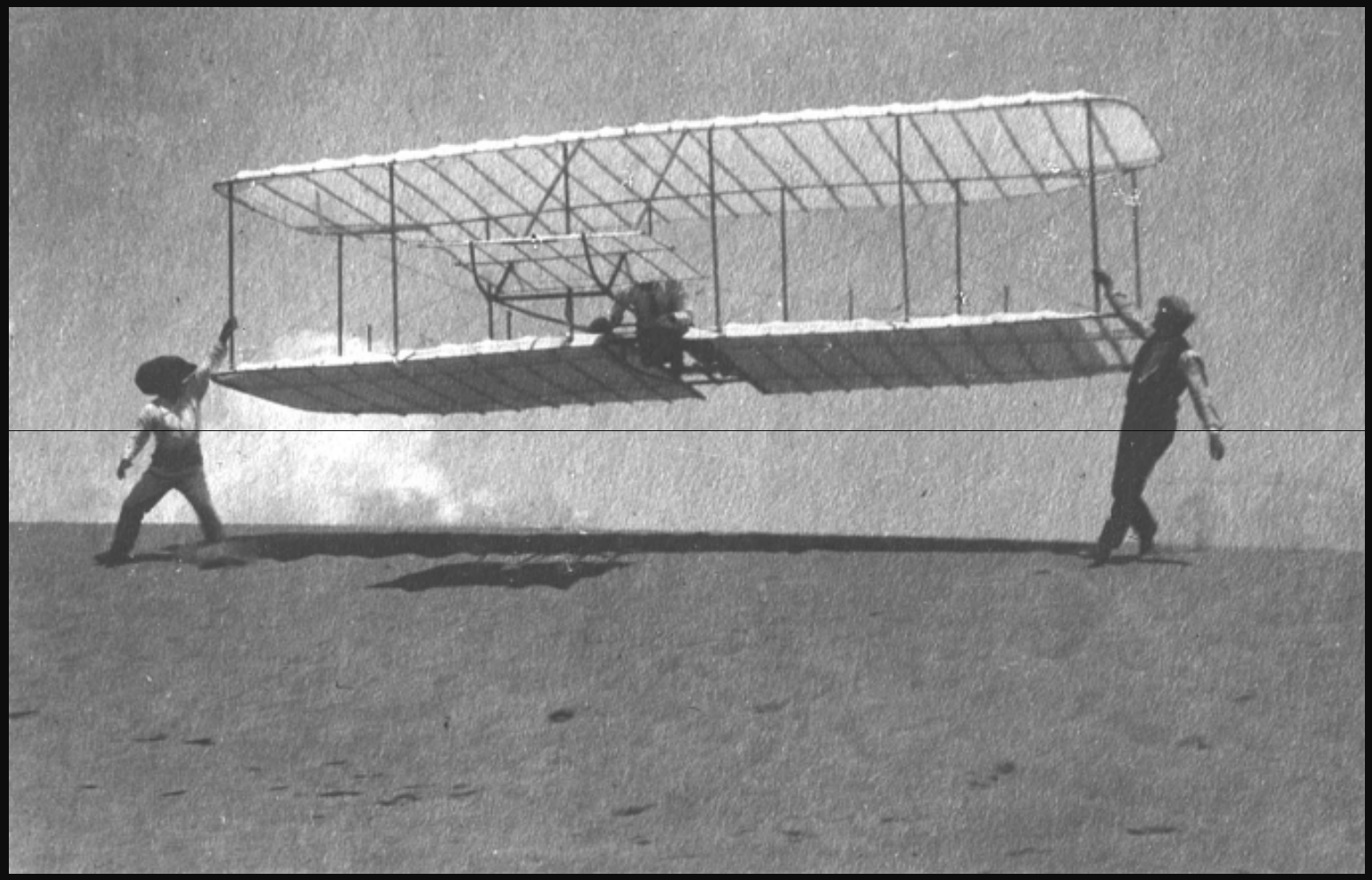
Then Gliders



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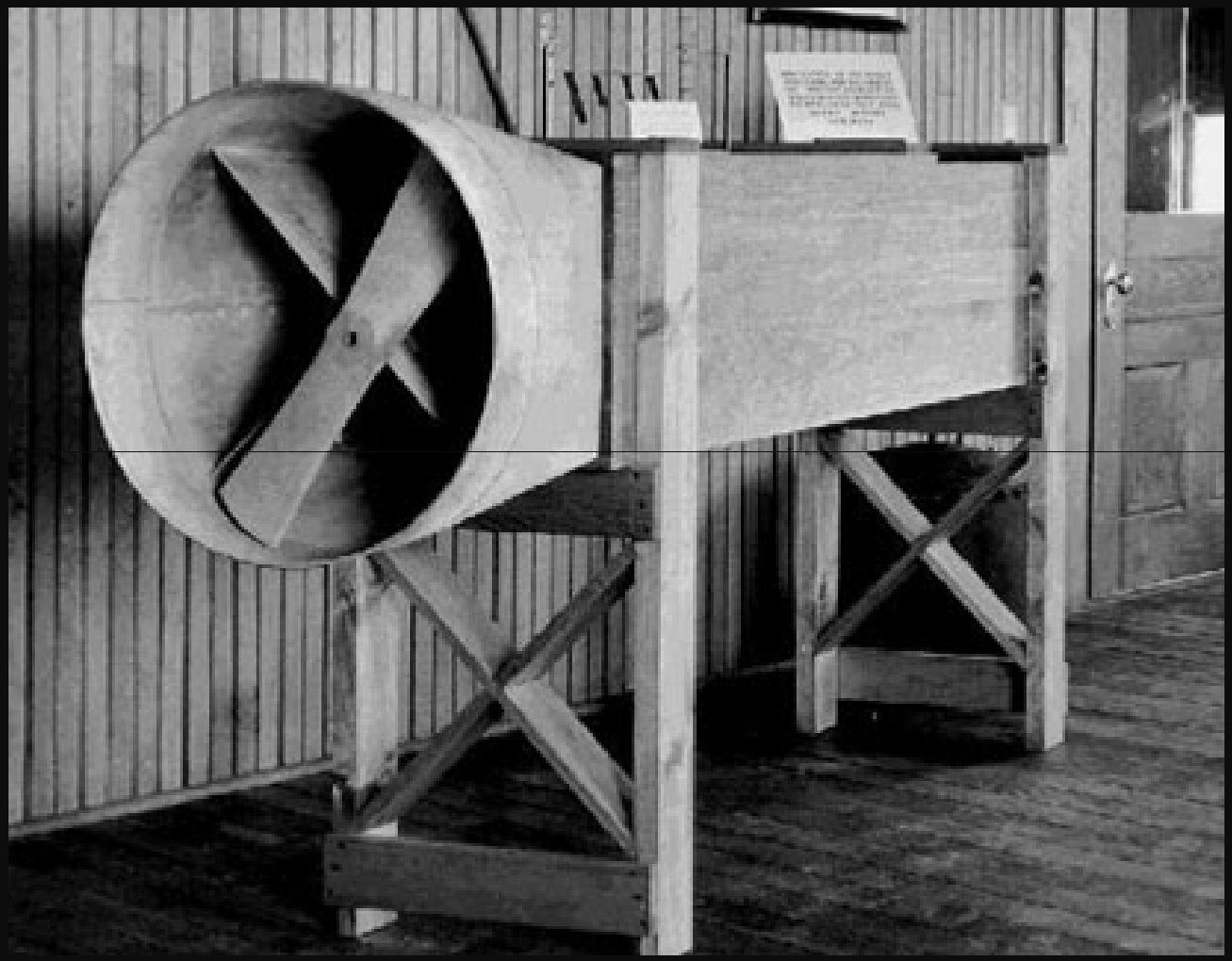
A Breakthrough



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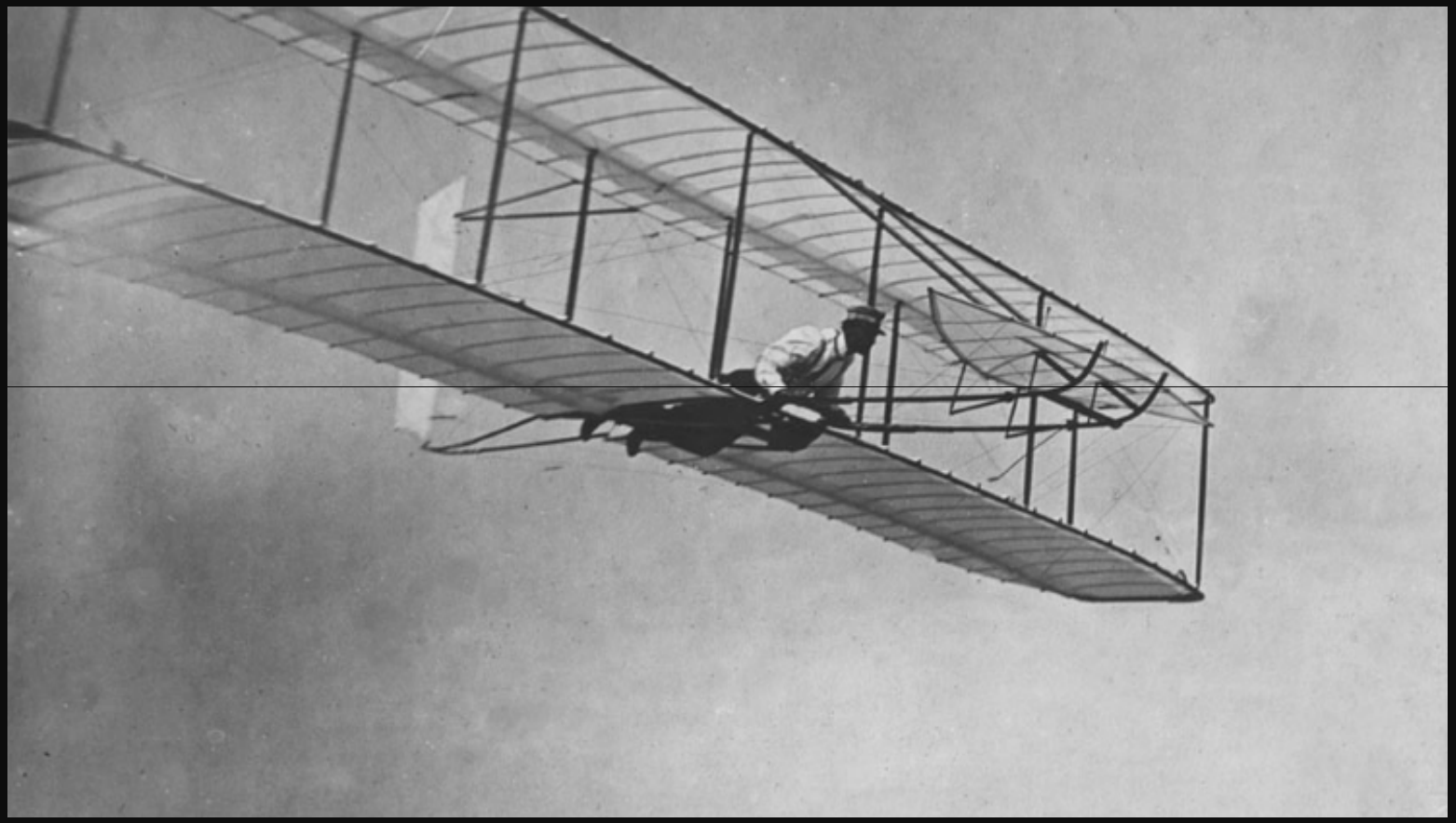
Nearly the Final Design



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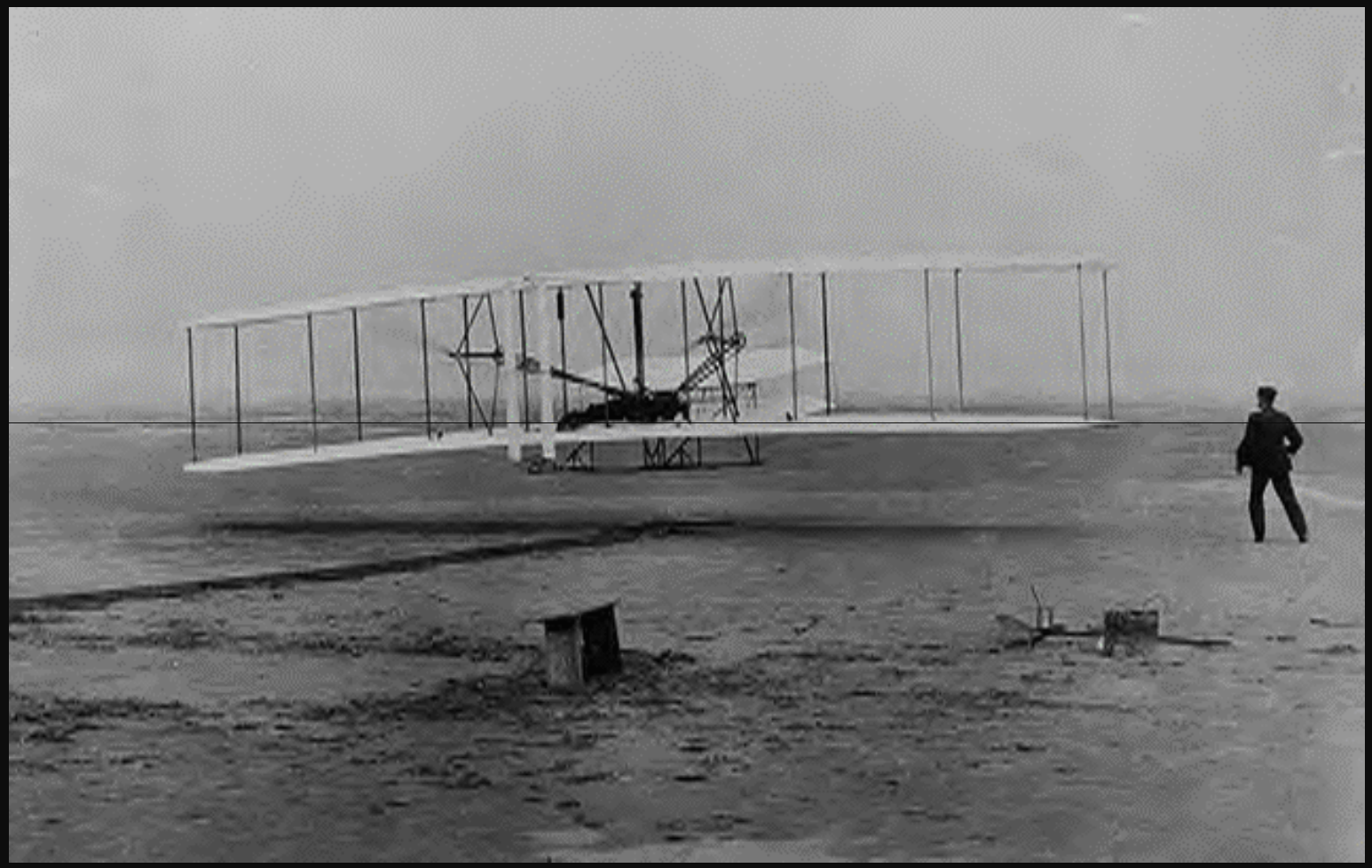
The First Flight



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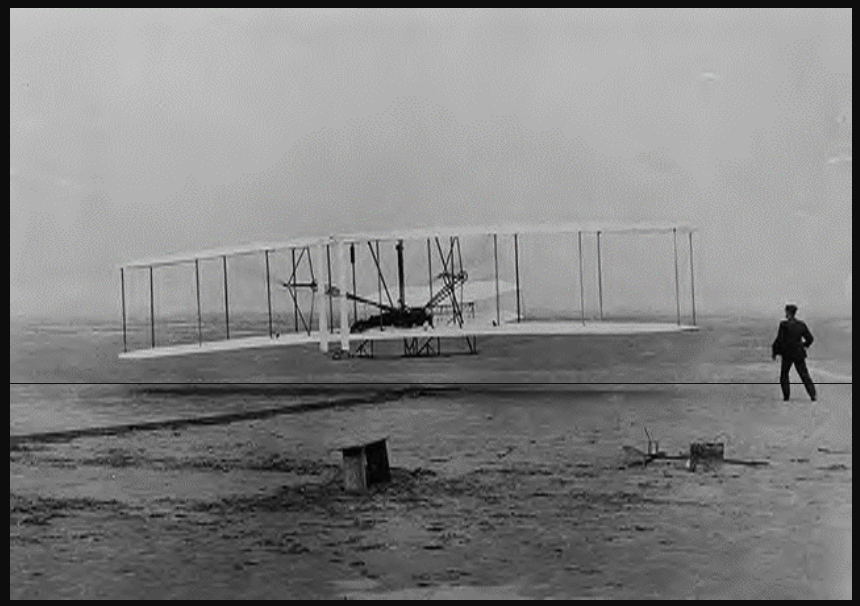
Will your building…

fly?



Wright Bros. - an integrated system

. . . or flop?

Langley - each piece optimized in isolation

How many of our buildings are an un-integrated Aerodrome into which we put a huge HVAC system to make up for design flaws?

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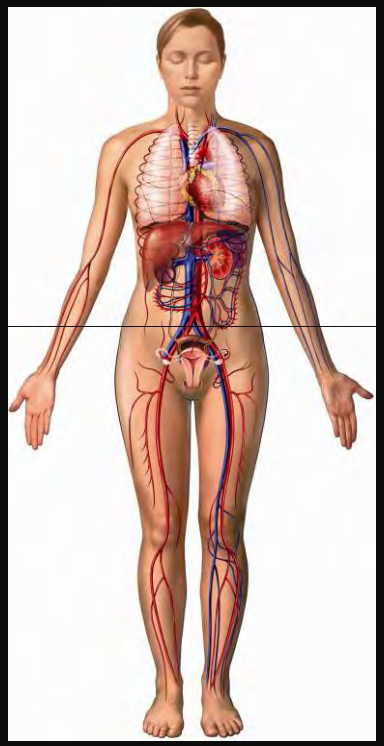
Integrative Design: Building as an Organism

Systems Integration:

- Understanding relationships between systems
- Not a set of component parts
- Holistic, non-linear process
- Downsize or eliminate systems
- Analysis Tools

  Energy modeling – as a DESIGN tool
  Daylighting modeling
  Materials analysis and impacts



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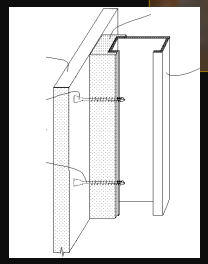
Case Study Example: HVAC System Sizing

Combining systems impacts to reduce cooling capacity

Air Conditioning	ft2/ton
• Standard office building	250 - 400
• PA DEP Spec	600
• PA DEP Cambria Case Study	663



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Case Study Example: Systems Impacts on Other Systems

How does your interior paint color affect HVAC system costs?

<u>Connections</u>:
Paint
Lighting
HVAC Sizing for cooling

Coefficients of Utilization PRU-9-A-04-2T8-SC-YMW-S-120
Floor effective floor cavity reflectance = .20

Ceiling	80				70				50		
Wall	70	50	30	10	70	50	30	10	50	30	10
RCR 0	.72	.72	.72	.72	.62	.62	.62	.62	.43	.43	.43
1	.66	.62	.60	.57	.56	.54	.52	.50	.37	.36	.35
2	.60	.54	.50	.47	.51	.47	.43	.41	.33	.31	.29
3	.54	.48	.43	.39	.46	.41	.37	.34	.29	.26	.24
4	.49	.42	.37	.32	.42	.36	.32	.28	.25	.22	.20
5	.45	.37	.32	.27	.39	.32	.28	.24	.23	.20	.17
6	.41	.33	.28	.24	.35	.29	.24	.21	.20	.17	.15
7	.38	.30	.24	.20	.33	.26	.21	.18	.18	.15	.13
8	.35	.27	.21	.18	.30	.23	.19	.16	.16	.13	.11
9	.33	.24	.19	.15	.28	.21	.17	.14	.15	.12	.10
10	.30	.22	.17	.14	.26	.19	.15	.12	.13	.11	.09

$$\#\text{ of light fixtures} = \frac{\text{footcandles x area}}{\text{lumens x LLF x CU}}$$ = 25% Reduction

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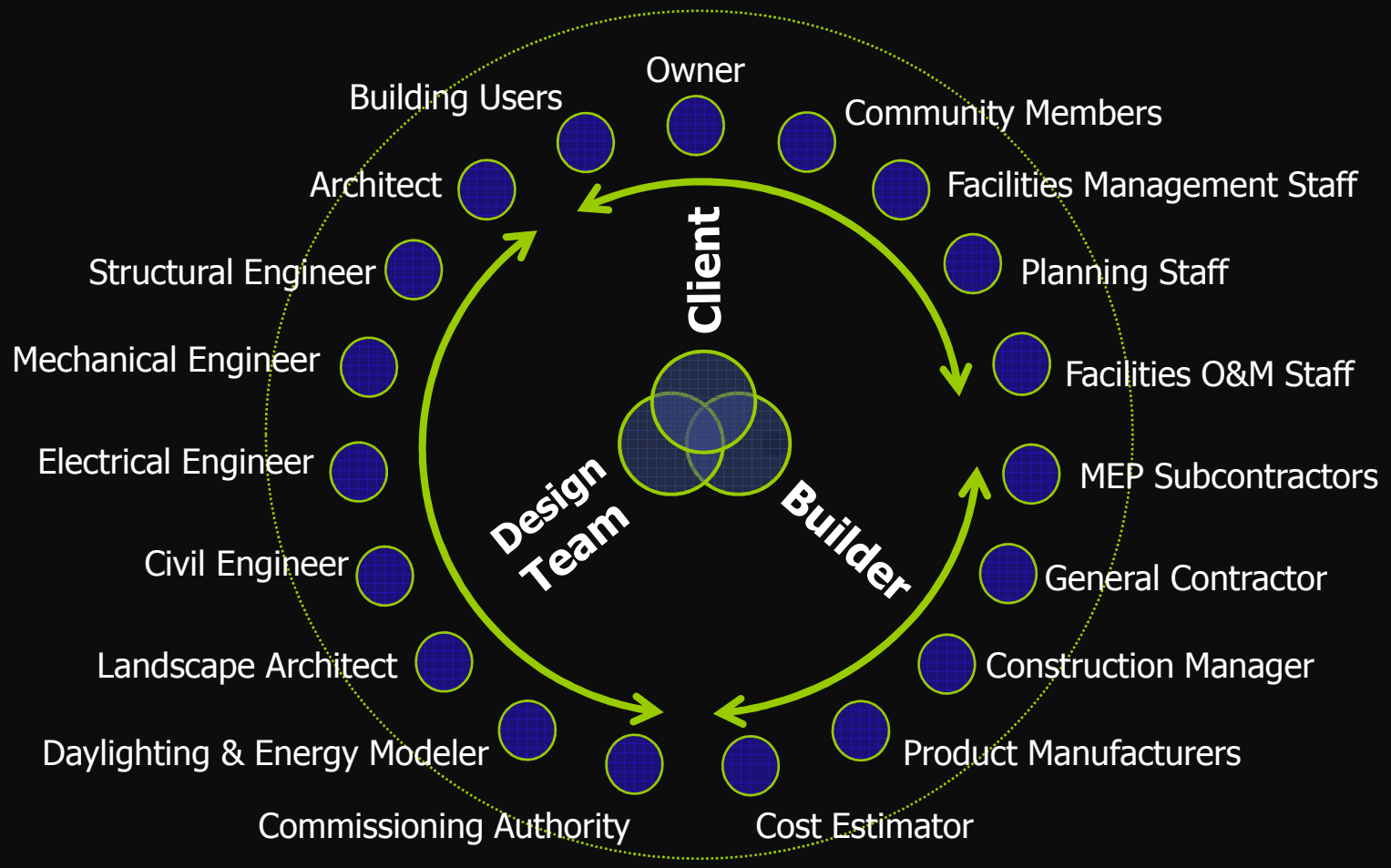
Integrative Design Team

The Composite Master Builder



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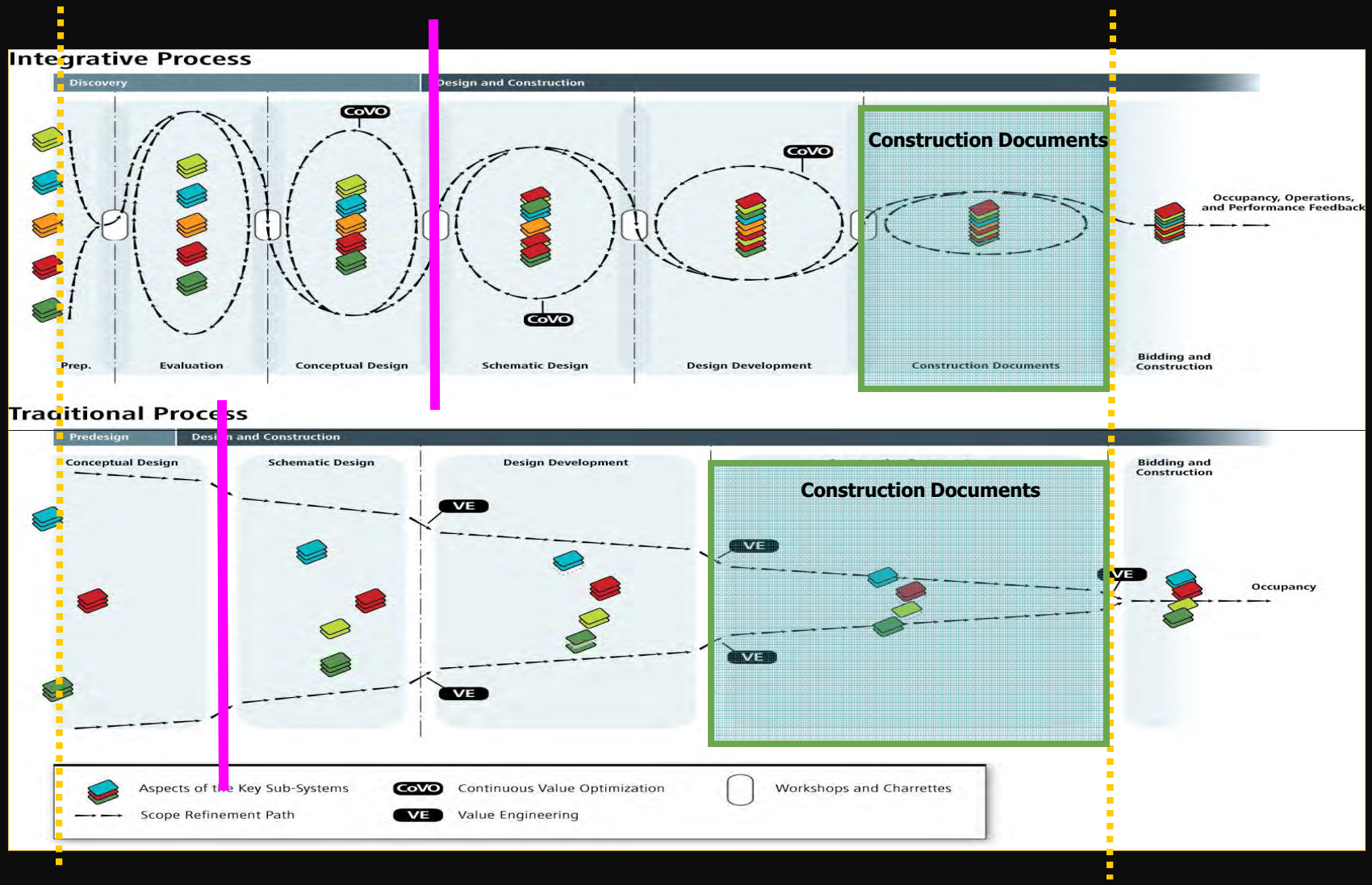
Integrative Design Process: Impacts on Design Schedule



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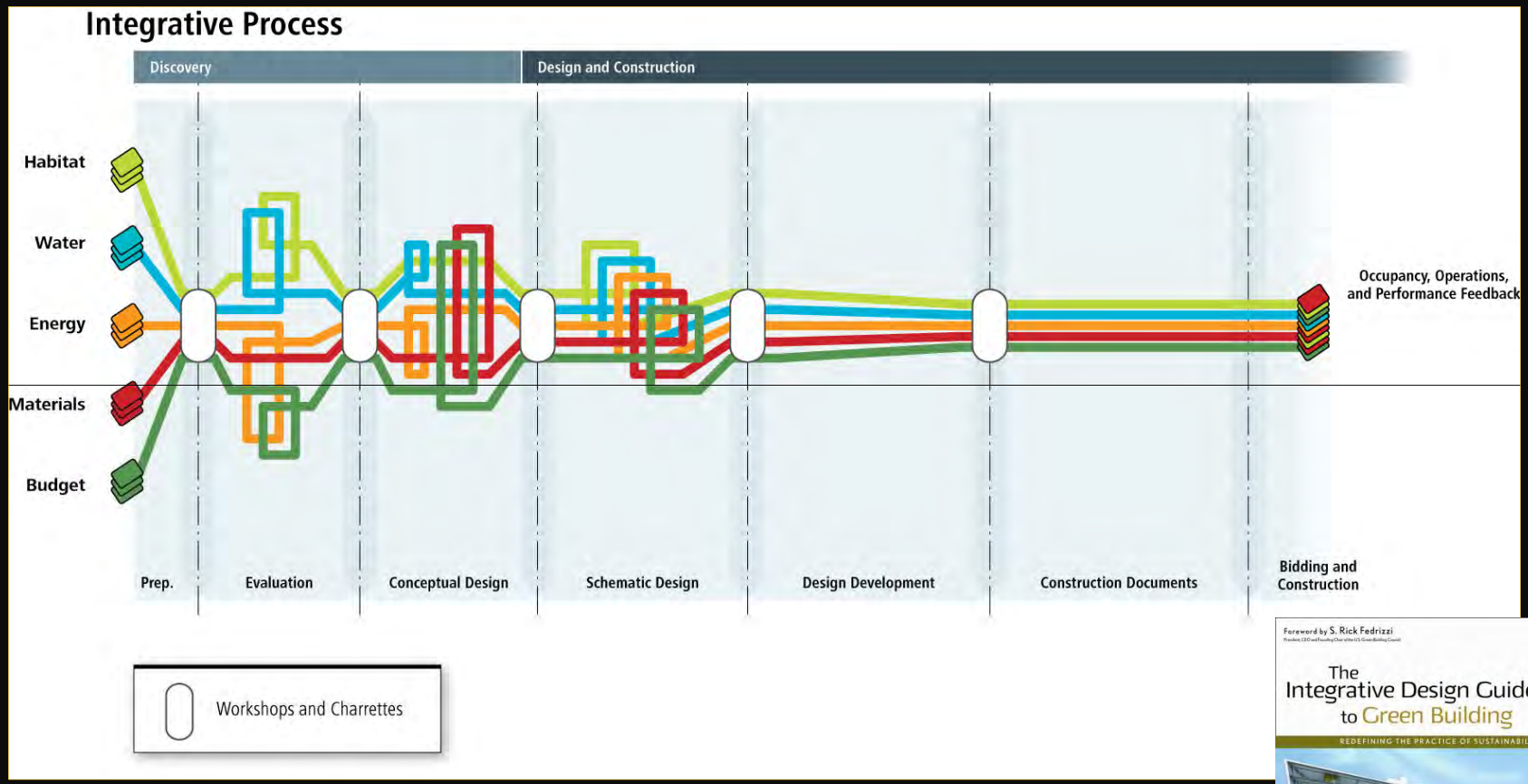
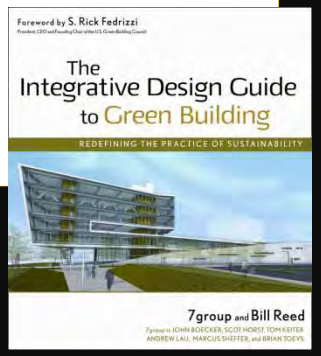
Integrative Design Process Overview





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Integrative Design Case Study

Big Savings

cost ***less*** than

Small Savings

Less first cost is needed to save 50% energy than to save 20% energy.

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Case Study Example:
Neptune Township Community School

NJ Elementary School & Community Center - 145,600 GSF

Image from SSP Architectural Group

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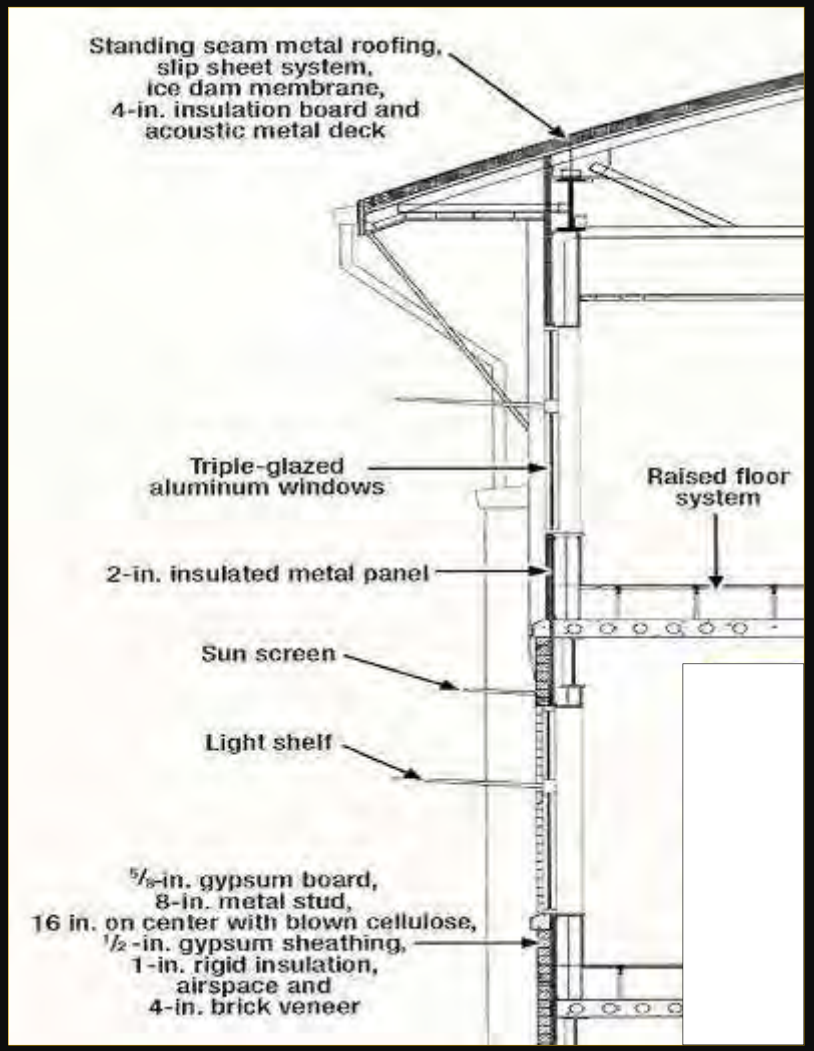
Energy Efficiency Measures (EEMs)



13 EEMs analyzed:

- solar orientation
- R27 wall w/ blown cellulose
- R30 roof insulation
- triple pane windows
- LPD = 0.92 W/sf
- solar shading
- light shelves
- daylight dimming
- ground source heat pumps
- underfloor supply air
- demand controlled ventilation
- energy recovery units

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Energy Modeling Parametric Runs – Individual EEMs

Individual EEM Design Runs	ASHRAEBudget Building	Daylighting (1W/sqft)	Wood Frame Triple Pane	R27 Metal Frame Walls	R30Roof Insulation
		Estimated Operating Costs			
Electric	$124,184	$106,134	$115,969	$116,462	$119,786
Gas	$25,882	$27,350	$24,981	$24,366	$25,095
Total	**$150,067**	**$133,483**	**$140,950**	**$140,827**	**$144,881**
Cost/SqFt	**$1.03**	**$0.92**	**$0.97**	**$0.97**	**$0.99**
		Building Energy Use (Mbtus)			
Electric (MBtu)	3,930.6	3,389.8	3,653.6	3,646.7	3,770.9
Gas (MBtu)	3,451.0	3,464.6	3,330.8	3,248.8	3,346.0
Total (MBtu)	**7,381.5**	**7,036.5**	**6,984.4**	**6,895.5**	**7,116.8**
		HVAC System Size			
Heating (kBtu/h)	1,383.0	1,394.8	1,160.3	1,177.8	1,283.8
Cooling (Tons)	150	130	135	138	143
		EEM Economics			
EEM Savings	NA	**$16,584**	**$9,117**	**$9,240**	**$5,186**
EEM Costs (see note 2)	NA	**$90,350**	**$69,896**	**$46,302**	**$41,789**
Payback	NA	**5.45**	**7.67**	**5.01**	**8.06**

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Energy Modeling Parametric Runs – Combination Runs

EEM Combination Design Runs	ASHRAE Budget Blg	ASHRAE Plus EEMs [1]	ASHRAE EEMs w/ Daylighting	GSHP Plus EEMs[1]	GSHP EEMs w/ Daylighting
		Estimated Operating Costs			
Electric	$124,184	$90,764	$87,624	$72,547	$69,901
Gas	$25,882	$25,347	$25,531	$0	$0
Total	**$150,067**	**$116,111**	**$113,155**	**$72,547**	**$69,901**
Cost/SqFt	**$1.03**	**$0.80**	**$0.78**	**$0.50**	**$0.48**
		Building Energy Use (Mbtus)			
Electric (MBtu)	3,930.6	2,884.2	2,802.7	2,315.9	2,252.9
Gas (MBtu)	3,451.0	3,379.5	3,404.2	0.0	0.0
Total (MBtu)	**7,381.5**	**6,263.7**	**6,206.9**	**2,315.9**	**2,252.9**
		HVAC System Size			
Heating (Btu/h)	1,383.0	911	911	911	911
Cooling (Tons)	150	96	91	96	91
		EEM Economics			
EEM Savings/year	NA	$33,956	**$36,912**	$77,520	**$80,166**
EEM Costs	NA	$34,100	**$124,450**	$365,900	**-$275,550**
Payback	NA	1.00	**3.37 years**	0.00	0.00

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Integrative Design Process Principles

"Optimizing components in isolation tends to *pessimize* the whole system – and hence the bottom line."

"You can actually make a system less efficient, simply by not properly linking up those components."

"If they're not designed to work with one another, they'll tend to work against one another."

Hawken, A. Lovins, H. Lovins, from Natural Capitalism

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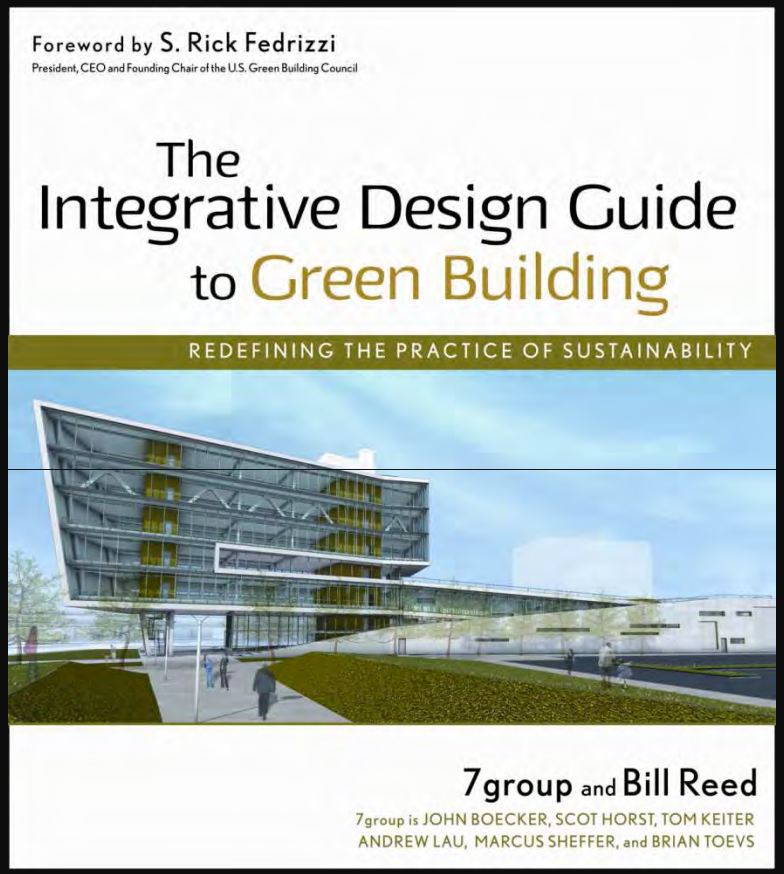
Integrative Design Mantra

Everyone

Engaging

Everything

Early



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Questions

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