Research stay

Nov. 2016 - Feb. 2017

Konstanz, Germany

Data Analysis and Visualization Group. University of Konstanz

b
UNIVERSITÄT
BERN

On the Impact of the Medium in Visualizations for Software Comprehension

Leonel Merino[1], Johannes Fuchs[2], Michael Hund[2], Mohammad Ghafari[1], Oscar Nierstrasz[1], Craig Anslow[3], Michael Behrisch[2], Daniel Keim[2]

[2]Data Analysis and Visualization Group
University of Konstanz

[1]Software Composition Group
University of Bern

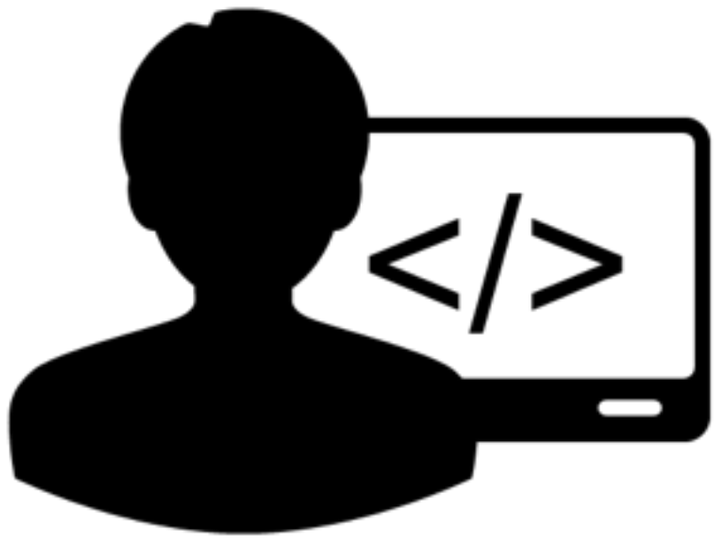
[3]School of Engineering and Computer Science
Victoria University of Wellington

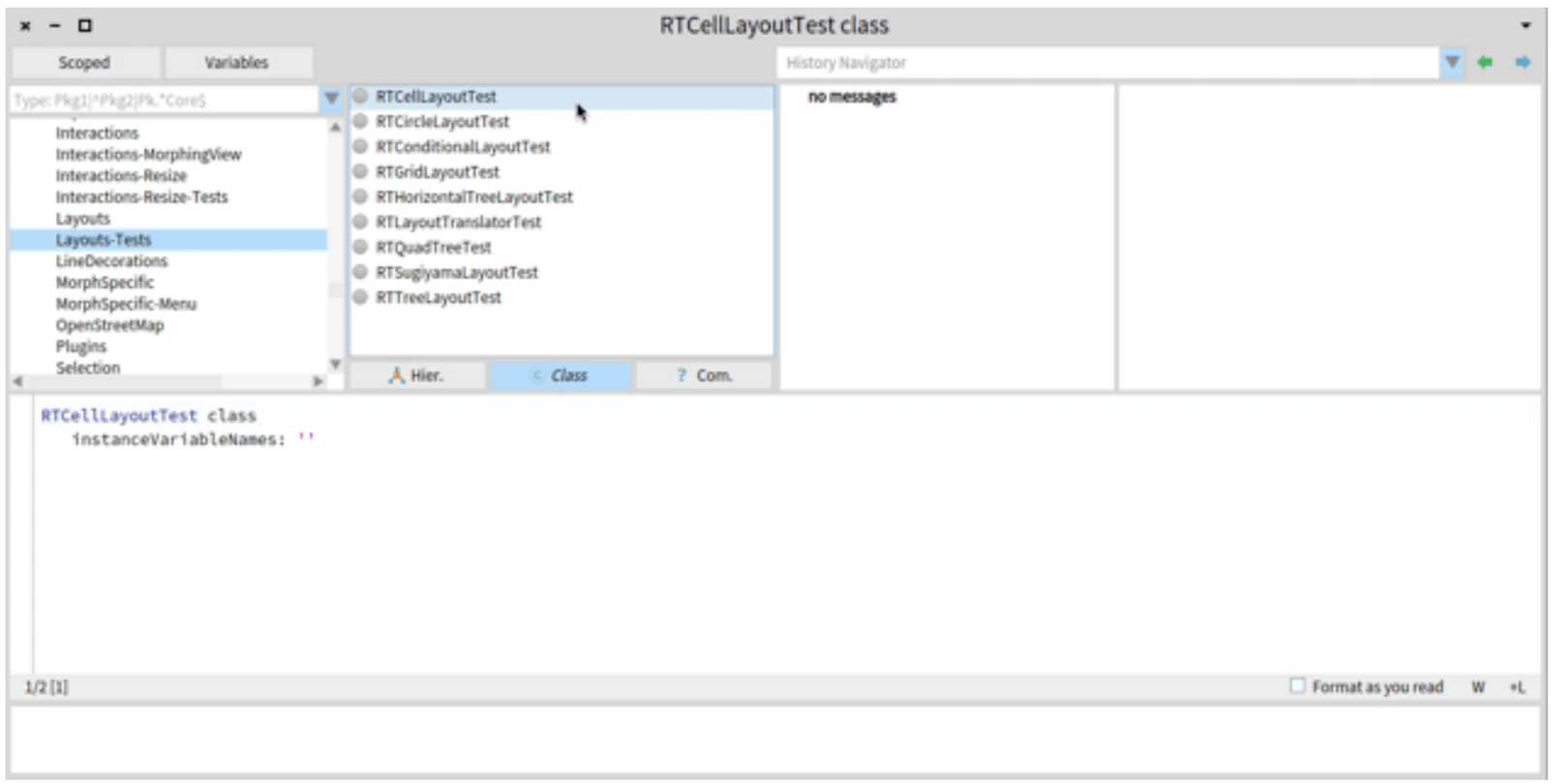
merino@inf.unibe.ch

@leonel_merino

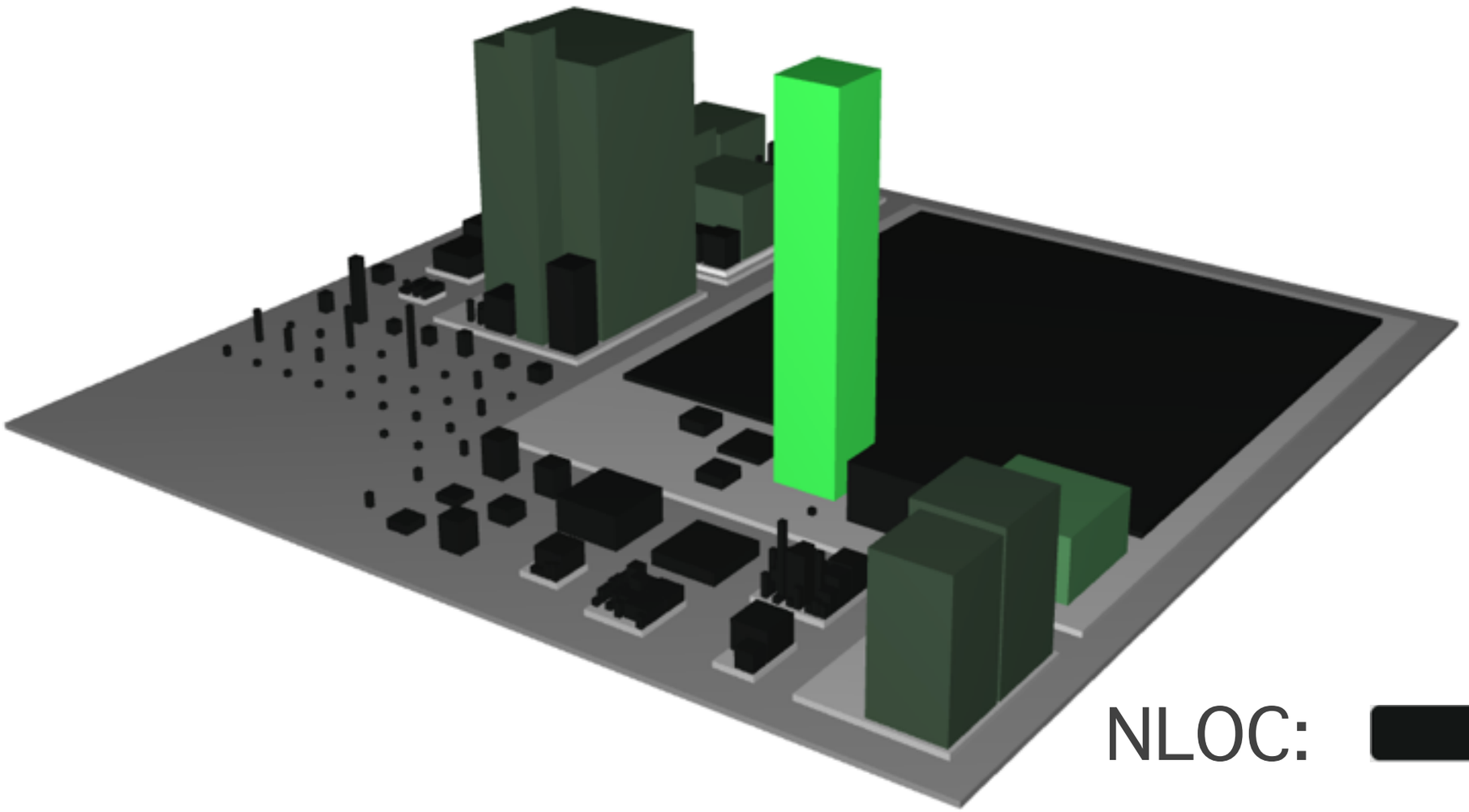
Software Comprehension

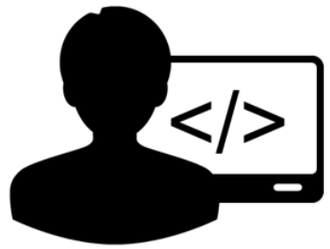
Developers spend most of their time understanding software systems





Software Visualization

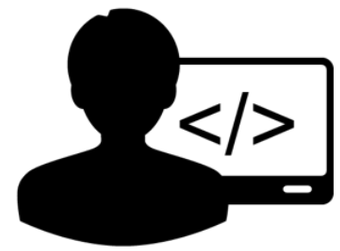


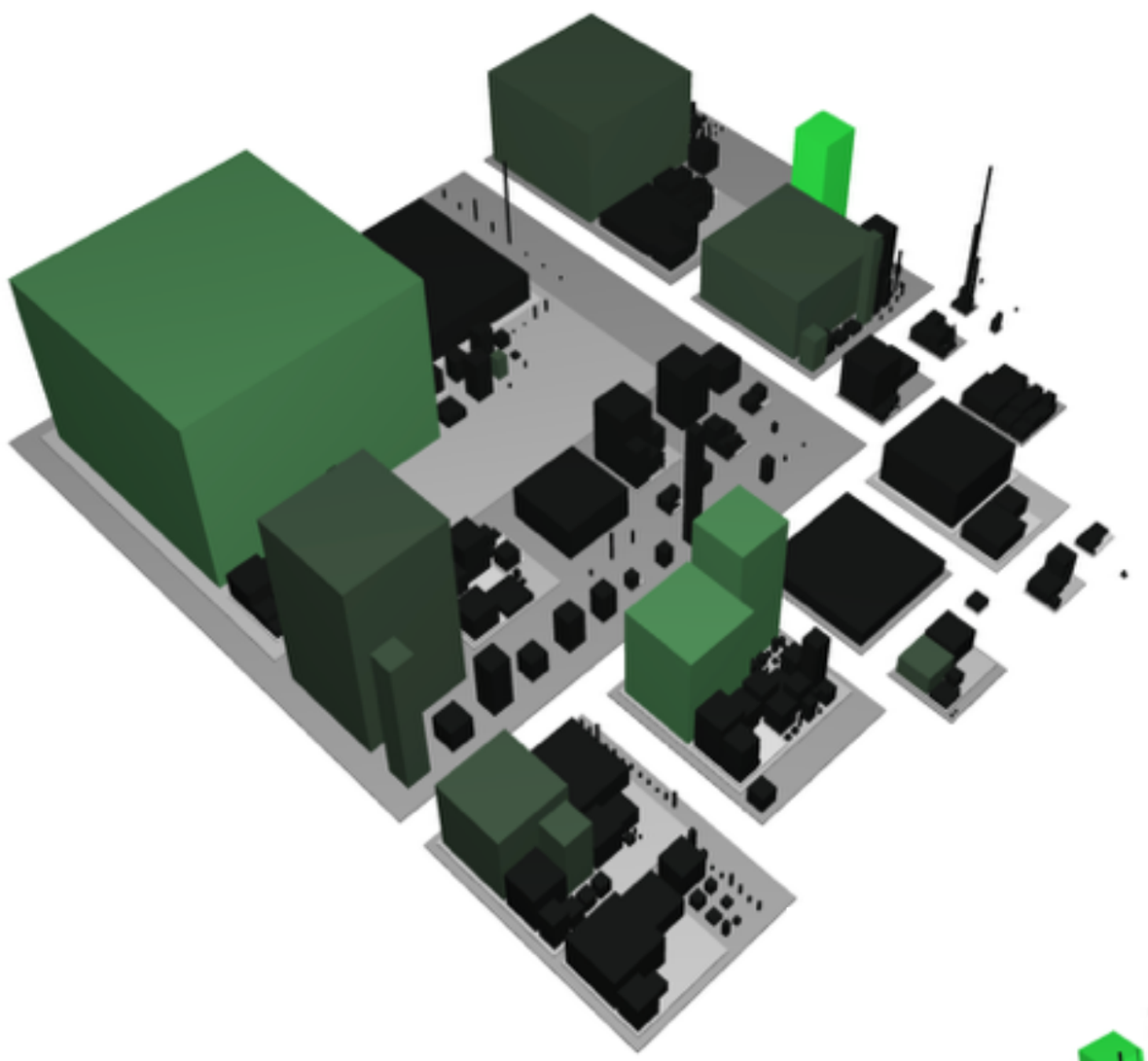


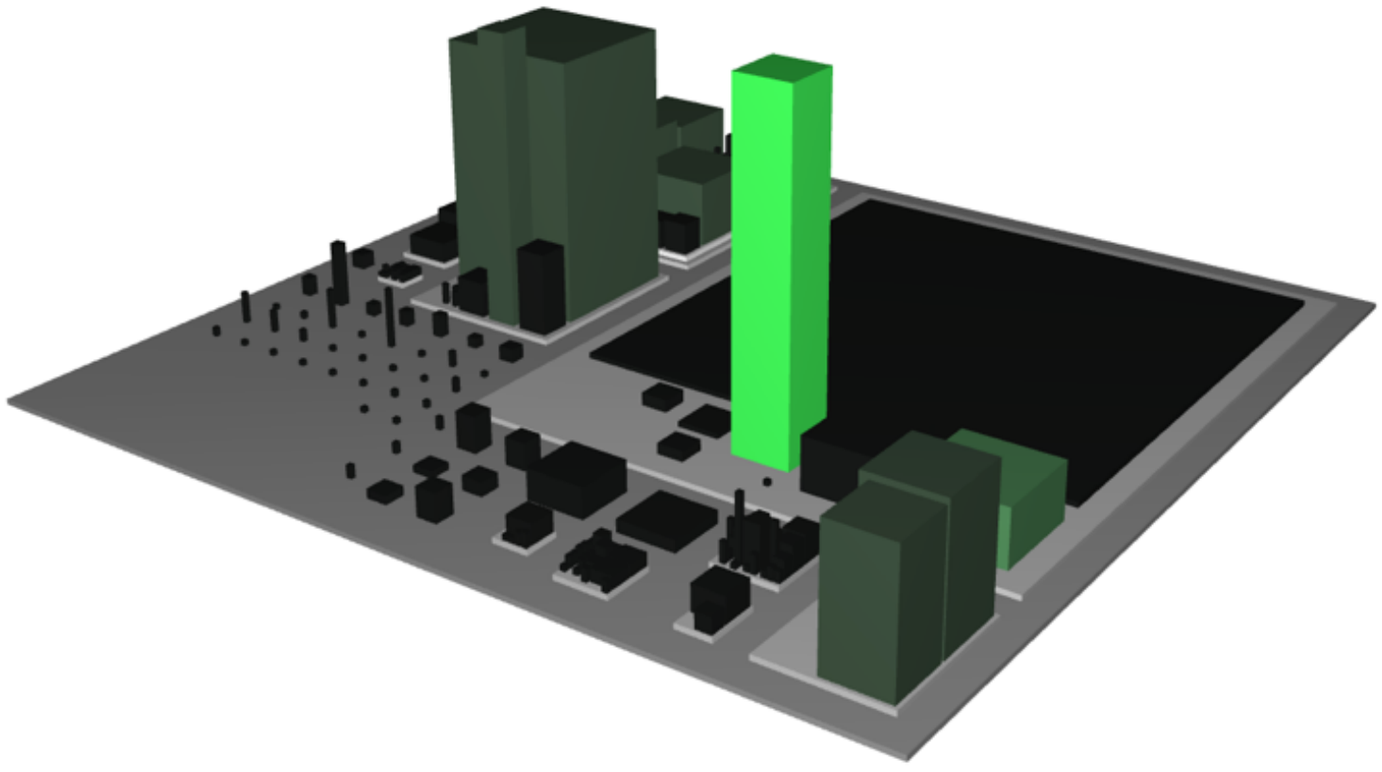
NLOC:

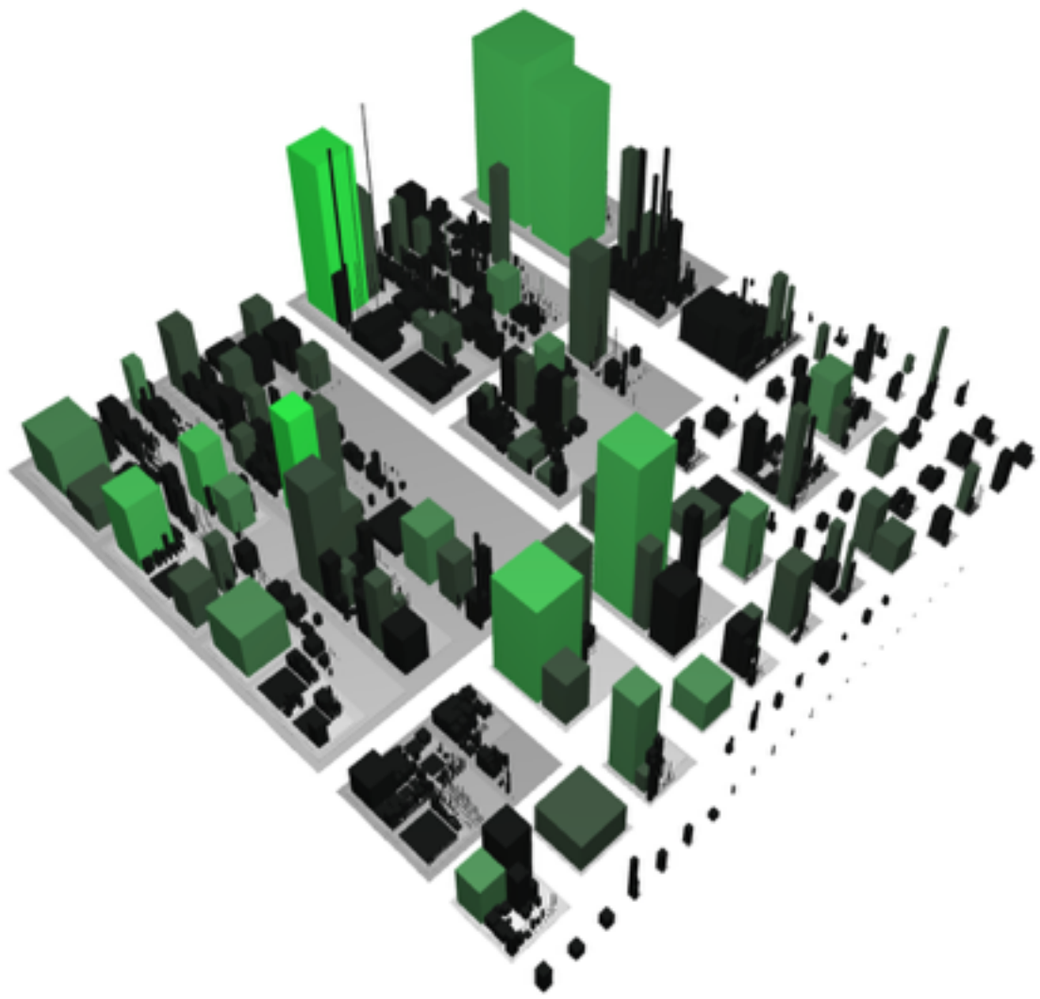
NOM: Height

NOA: Width/Depth

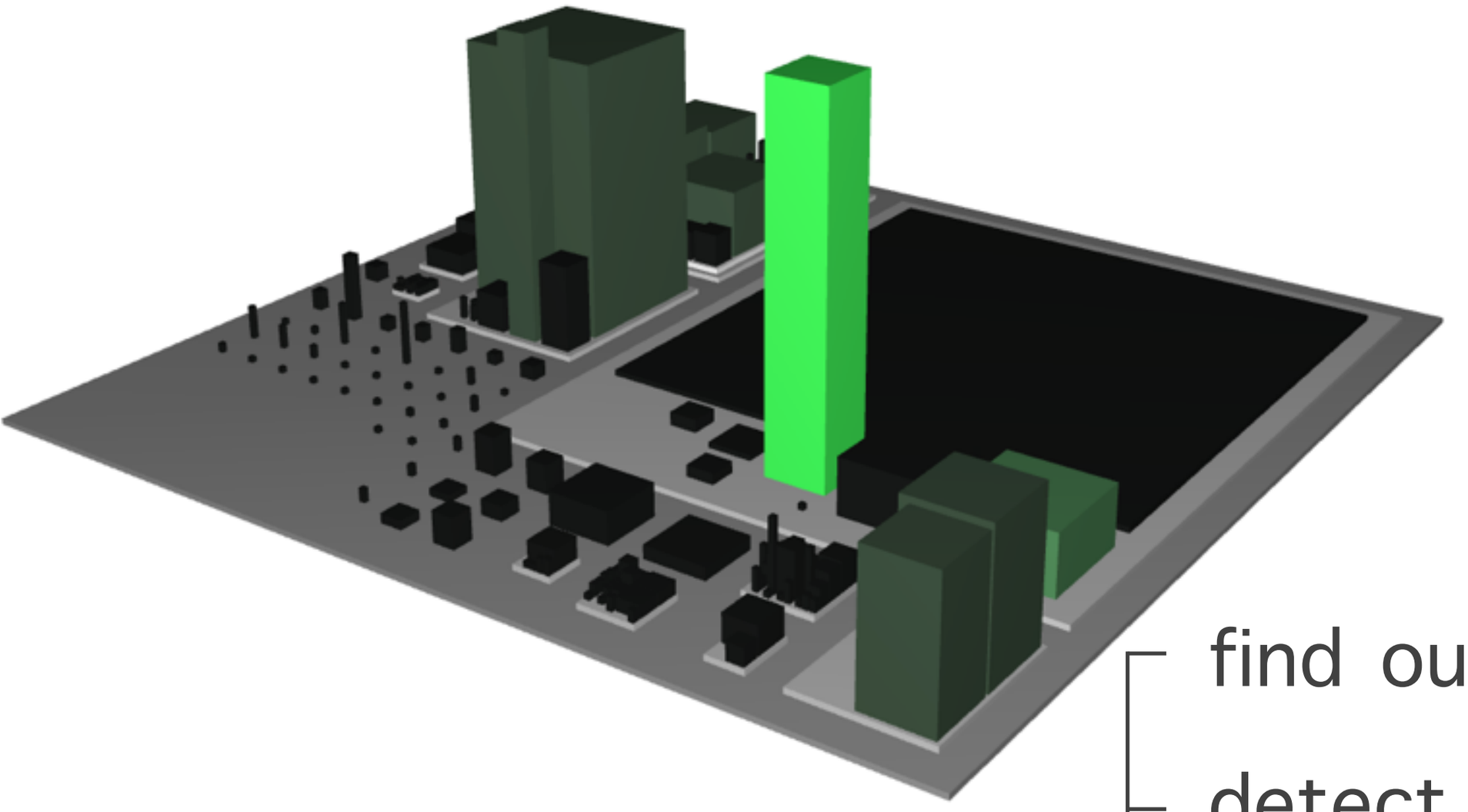


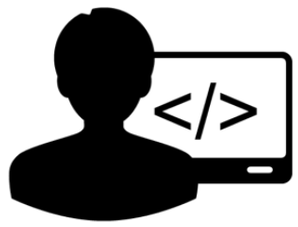






Overview



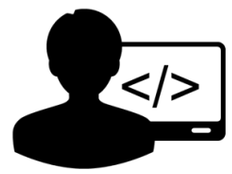


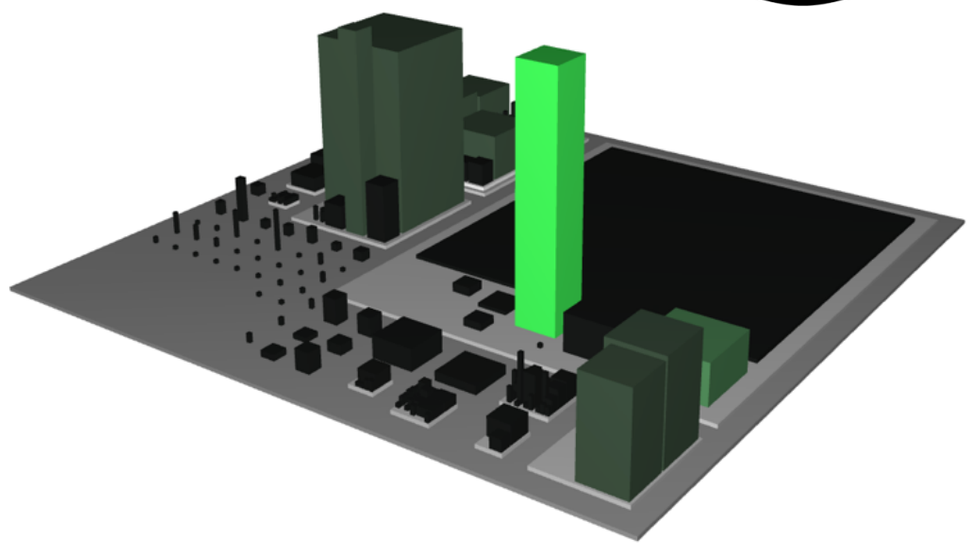
- find outliers
- detect patterns
- quantify elements

Software Visualization

Performance

- find outliers
- detect patterns
- quantify elements

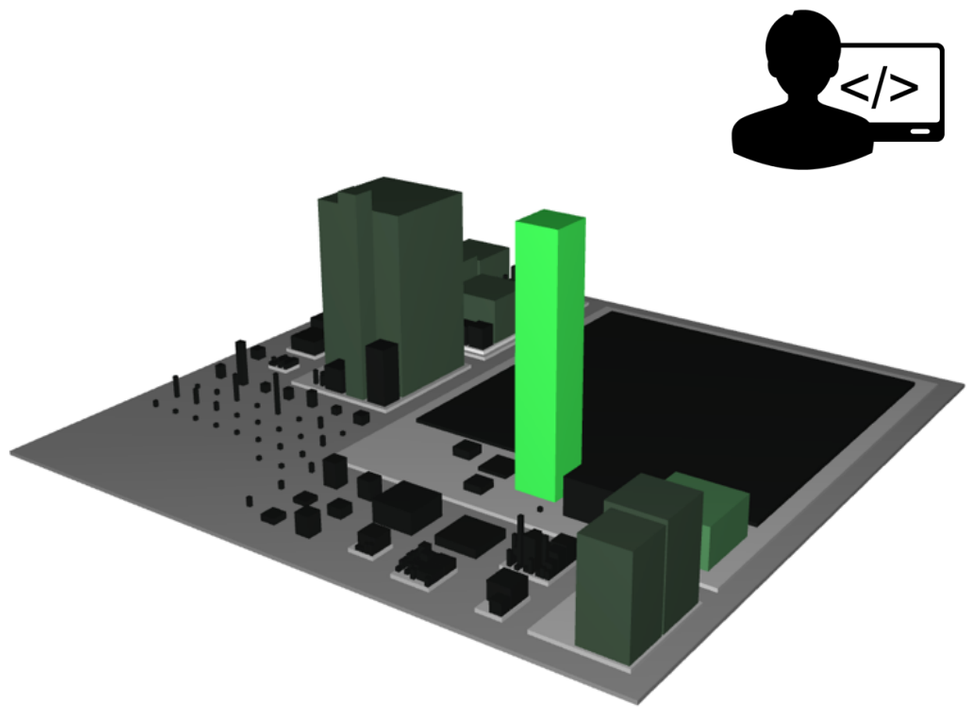




Software Visualization

Performance
- find outliers
- detect patterns
- quantify elements

Memorability

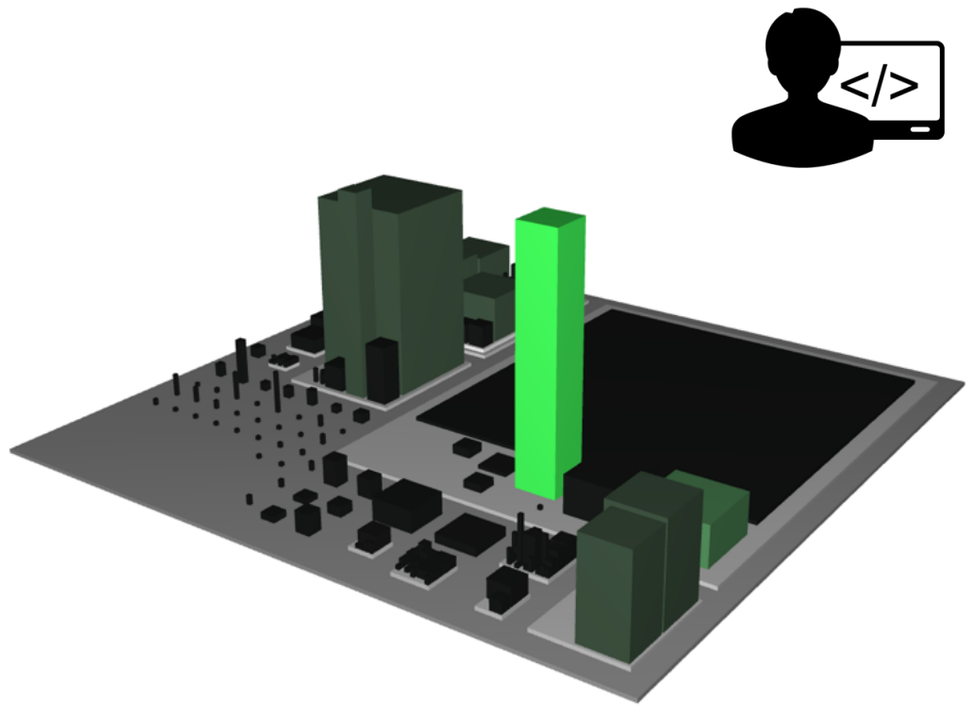


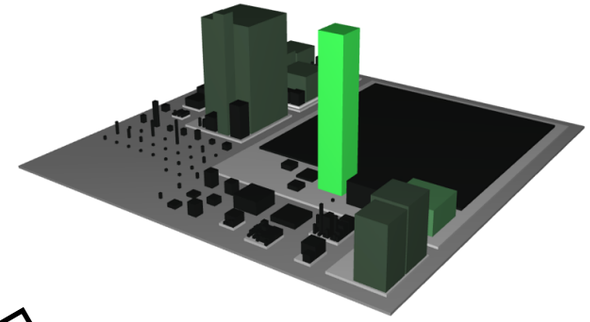
Software Visualization

Performance
- find outliers
- detect patterns
- quantify elements

Memorability

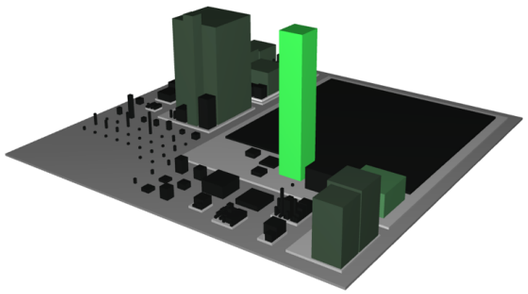
Experience






htc
VIVE

The Impact of the Medium

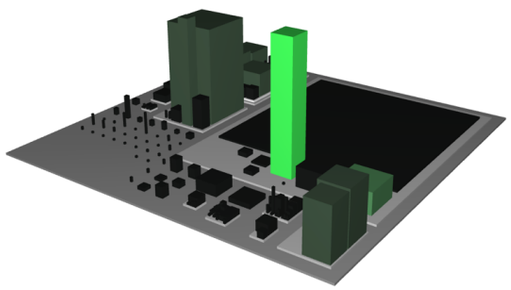


Performance

Memorability

User Experience

Controlled Experiment



Performance

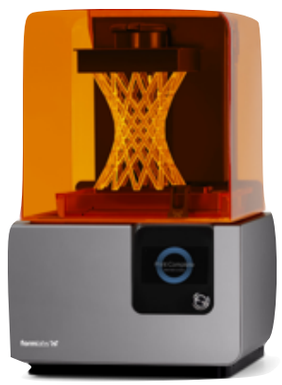
Memorability

Experience

x3

PostDoc/PhD/BA/MA
28/8 years

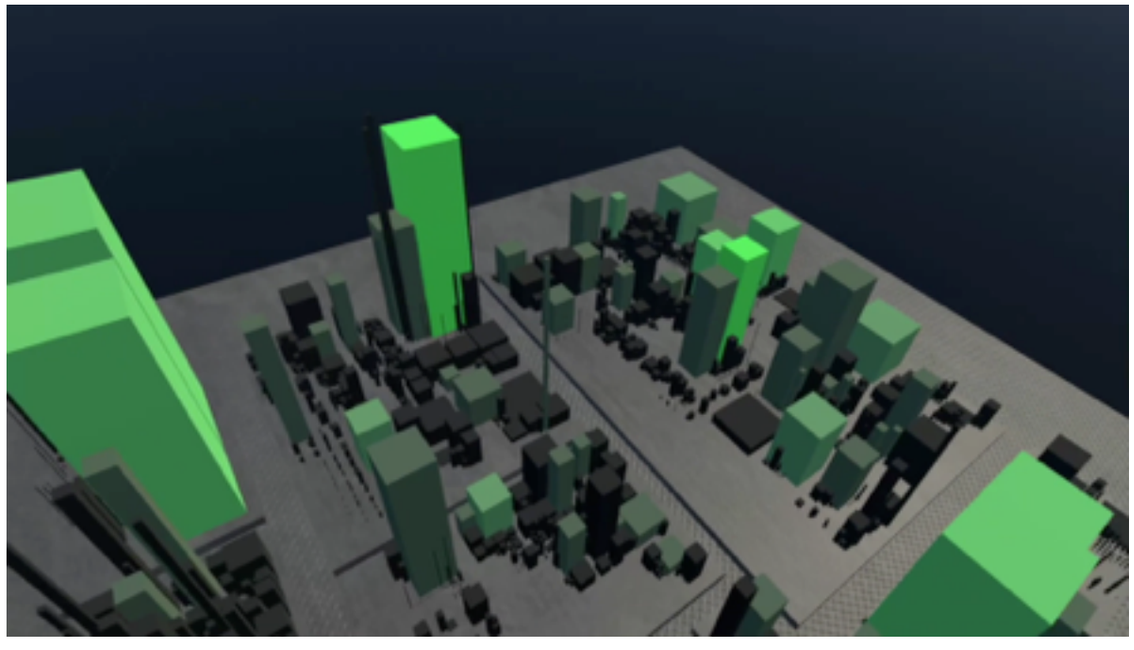
Axion Freemind Azureus



Deployment: SCS

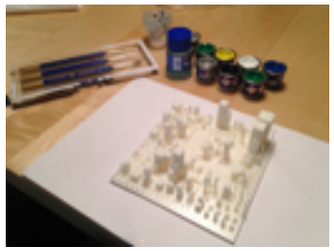
Visualization	CodeCity in Moose 5
Apparatus	Apple MacBook Pro with a resolution of 1440 x 900 pixels
Location	Konstanz (4) + Bern (5)
Participants	1 PostDoc, 3 BA/MA, 5 PhD
Subject	Axion, Freemind, Azureus

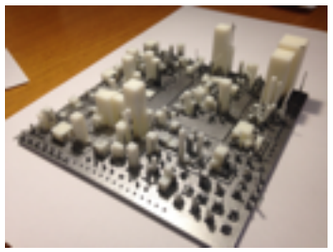
Deployment: I3D

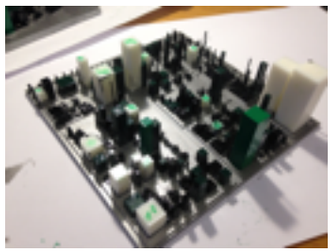


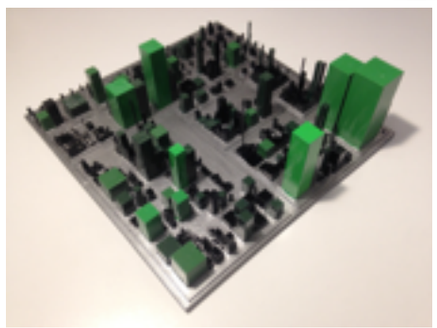
Visualization	Custom development in Unity 5.5
Apparatus	HTC Vive VR Headset with a 2160 x 1200 combined resolution, 90 Hz refresh rate and 110° field of view
Location	Konstanz (9)
Participants	1 PostDoc, 3 BA/MA, 5 PhD
Subject	Axion, Freemind, Azureus

Deployment: P3D



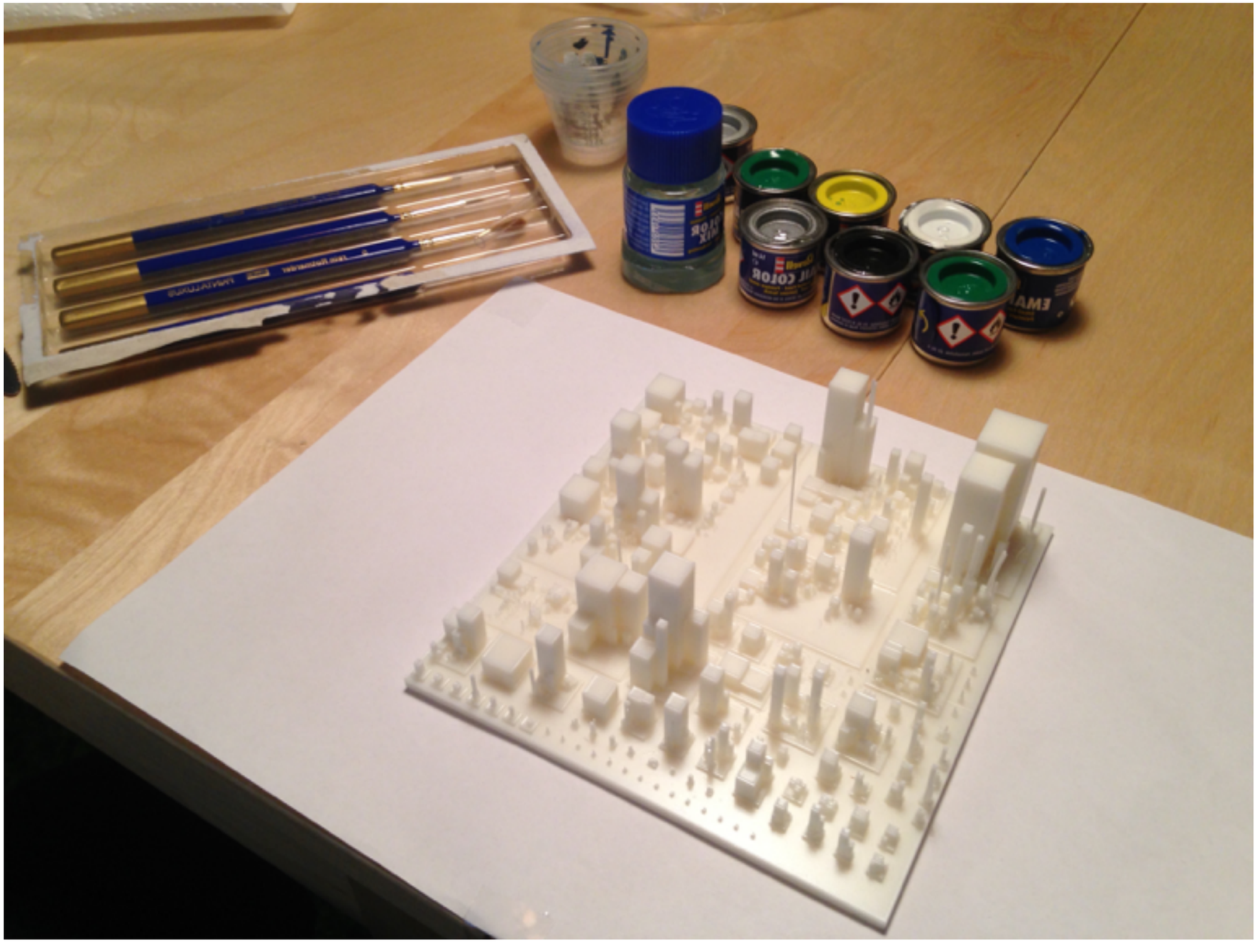




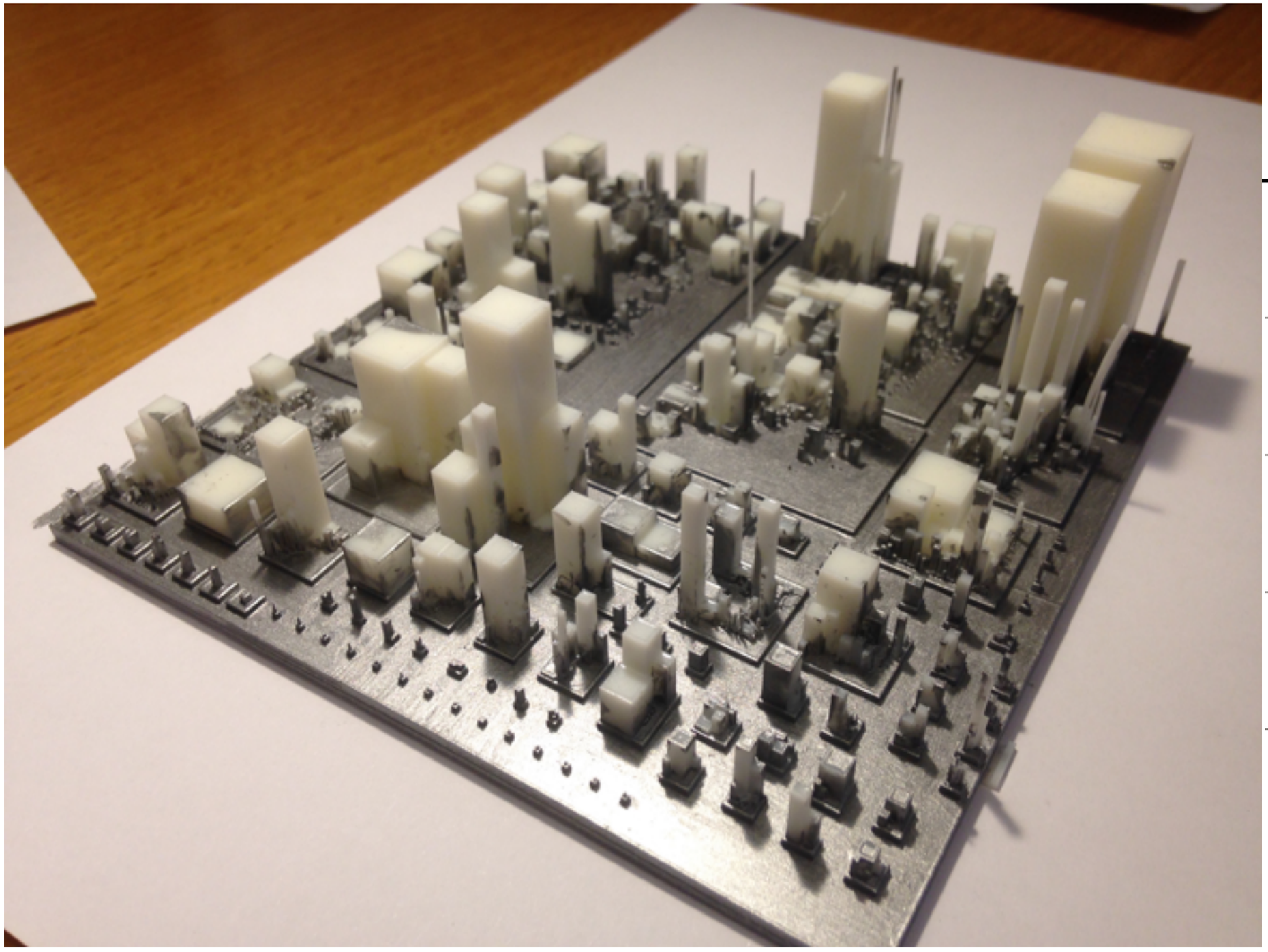


Visualization	Model exported to the Stereo Lithography (STL) format from the I3D implementation (in Unity)
Apparatus	Form 2 3D printer by form- labs based on stereolithography (SLA) technology
Location	Konstanz (0) + Bern (9)
Participants	1 PostDoc, 3 BA/MA, 5 PhD
Subject	Axion, Freemind, Azureus

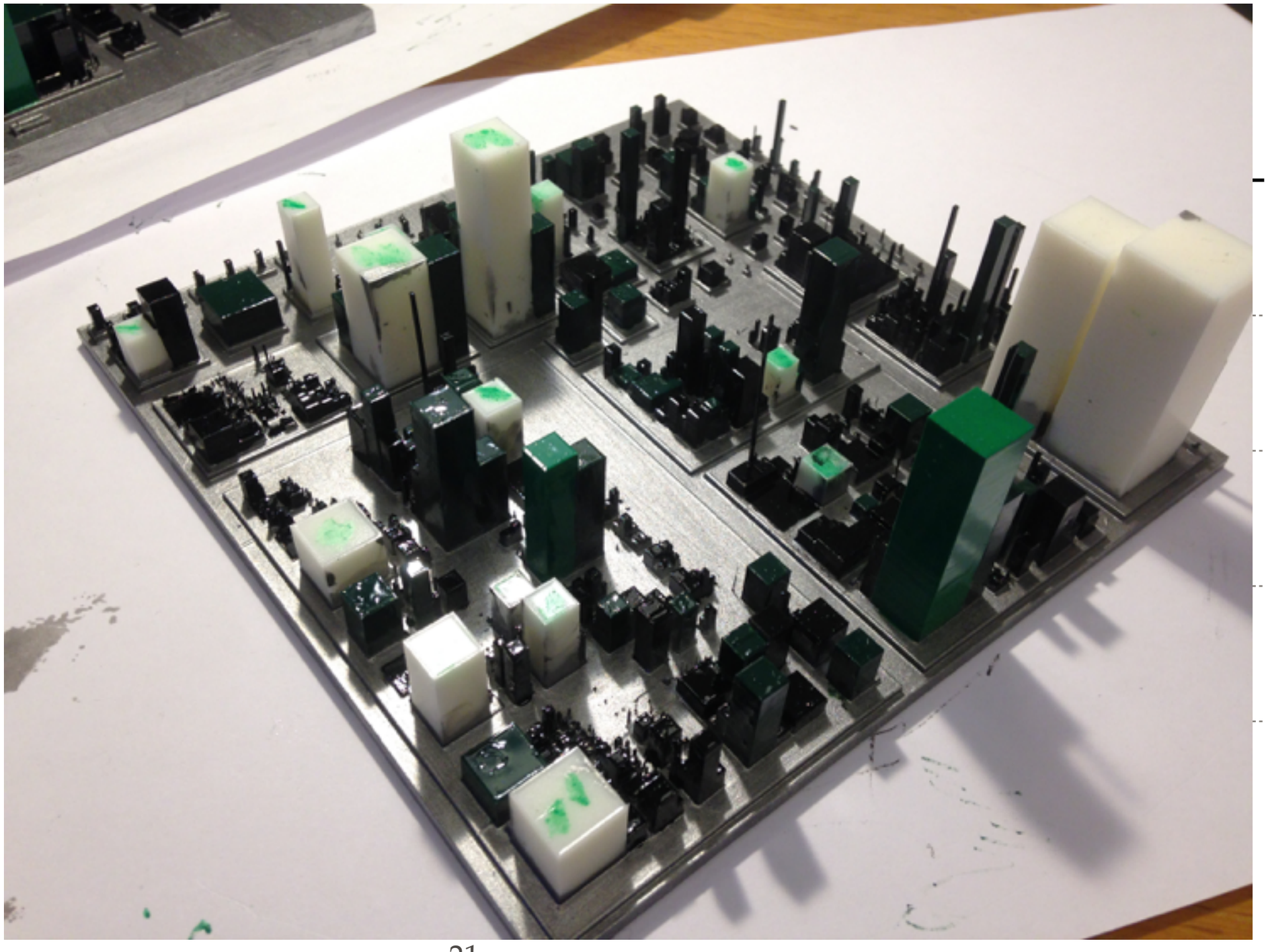
Deployment: P3D



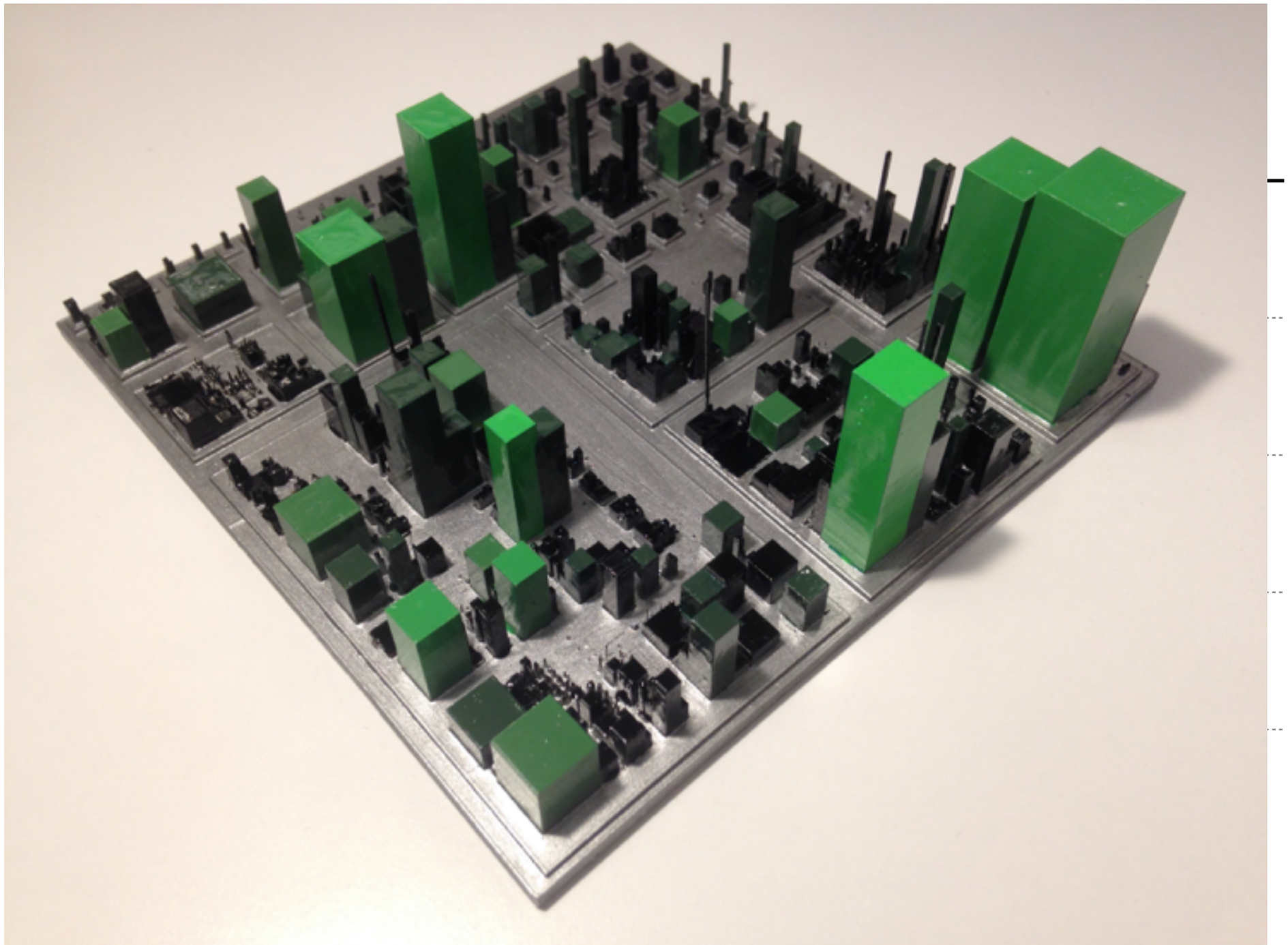
Deployment: P3D



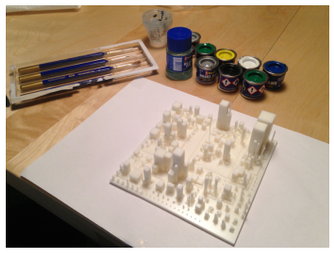
Deployment: P3D

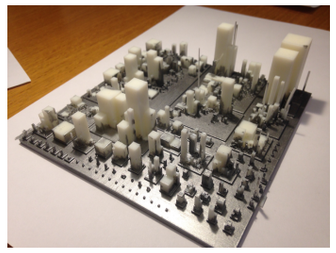


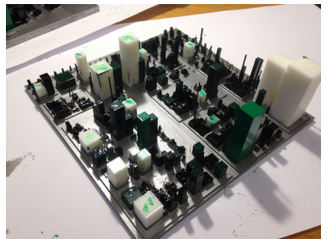
Deployment: P3D

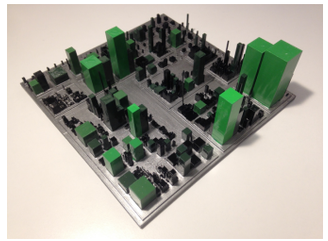


Deployment: P3D









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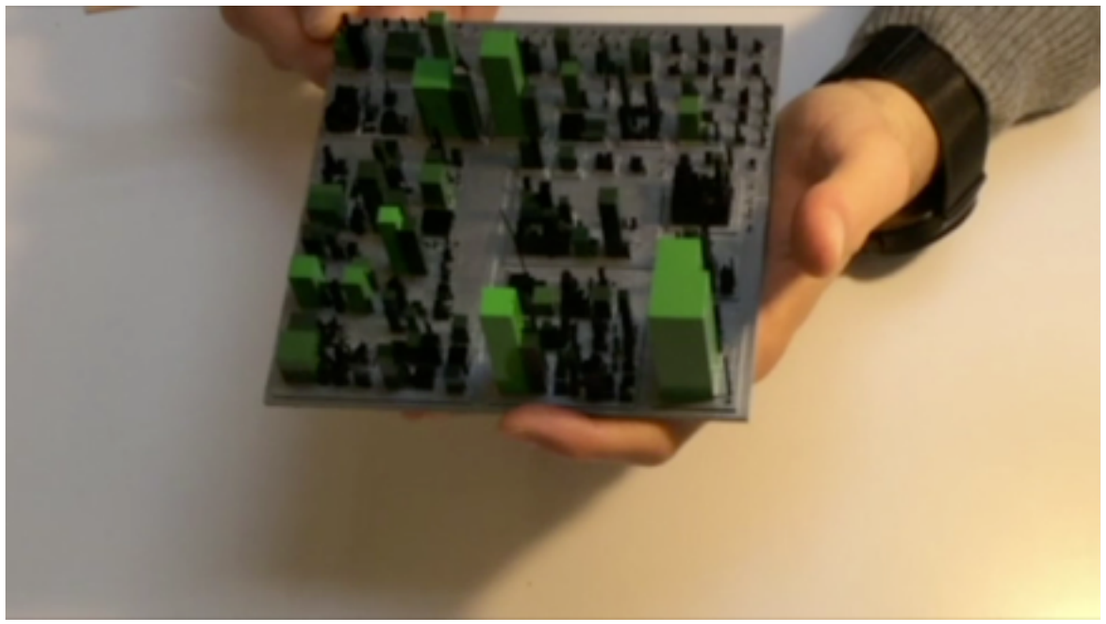
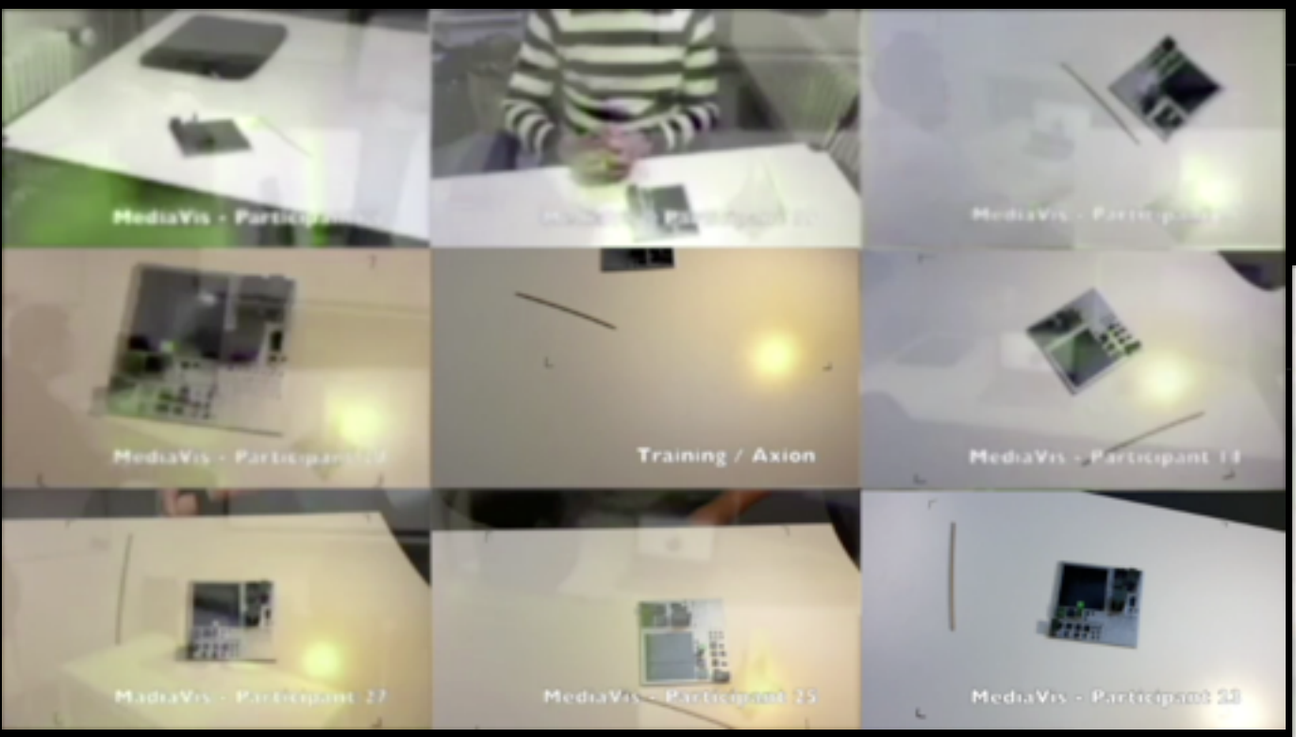
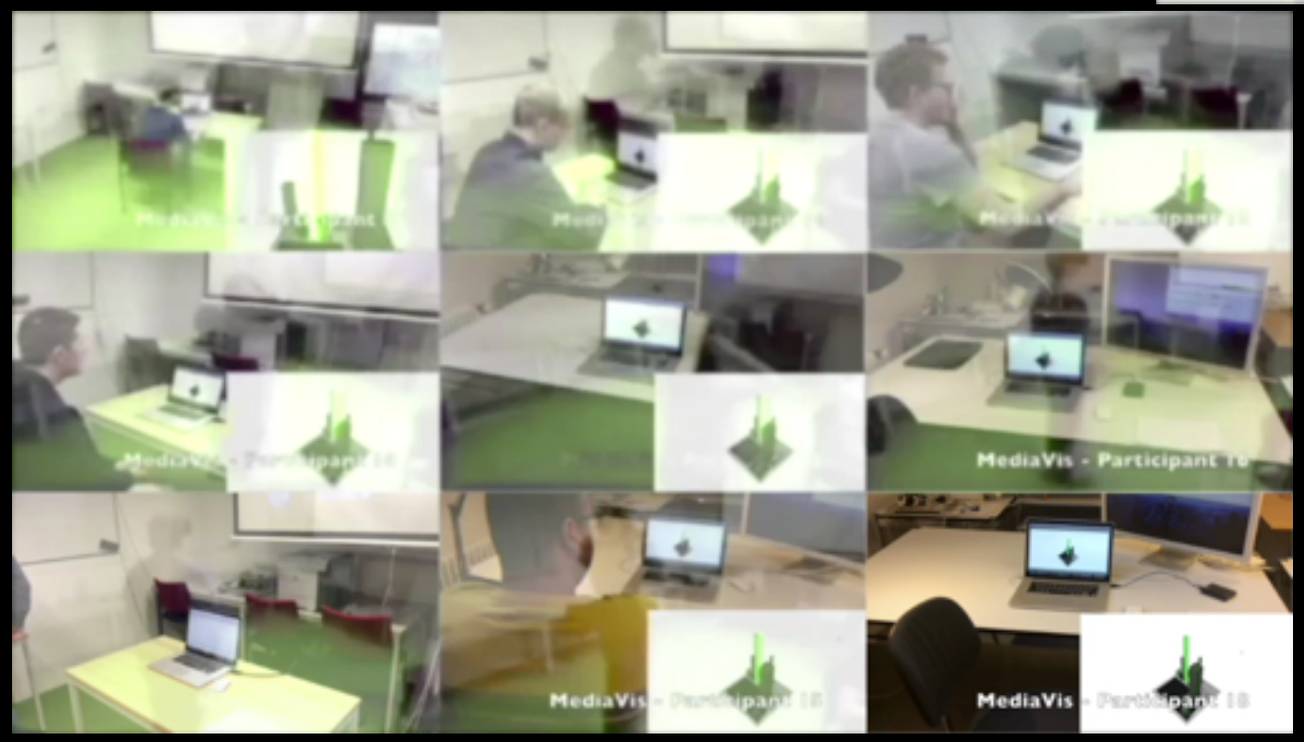




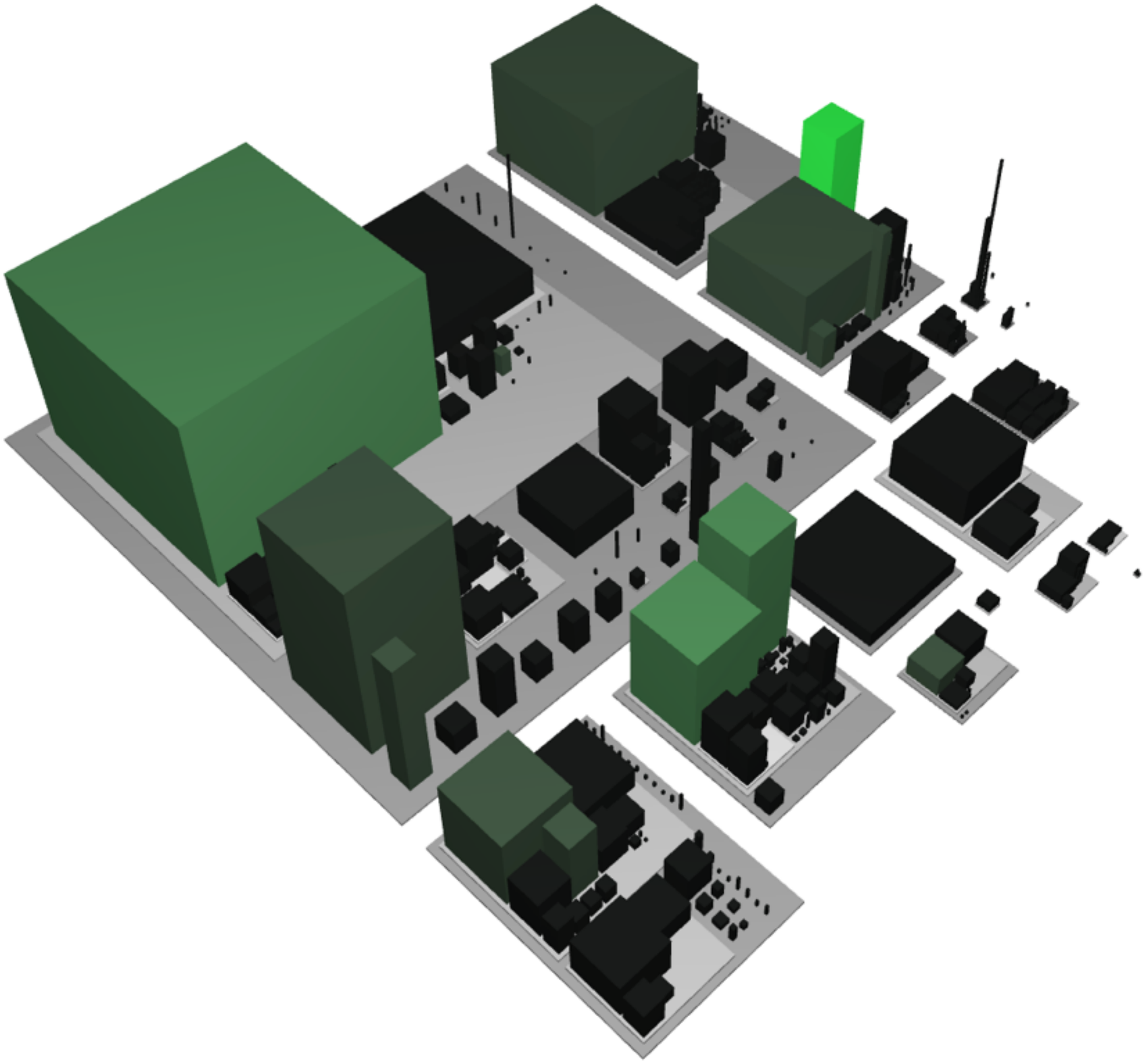


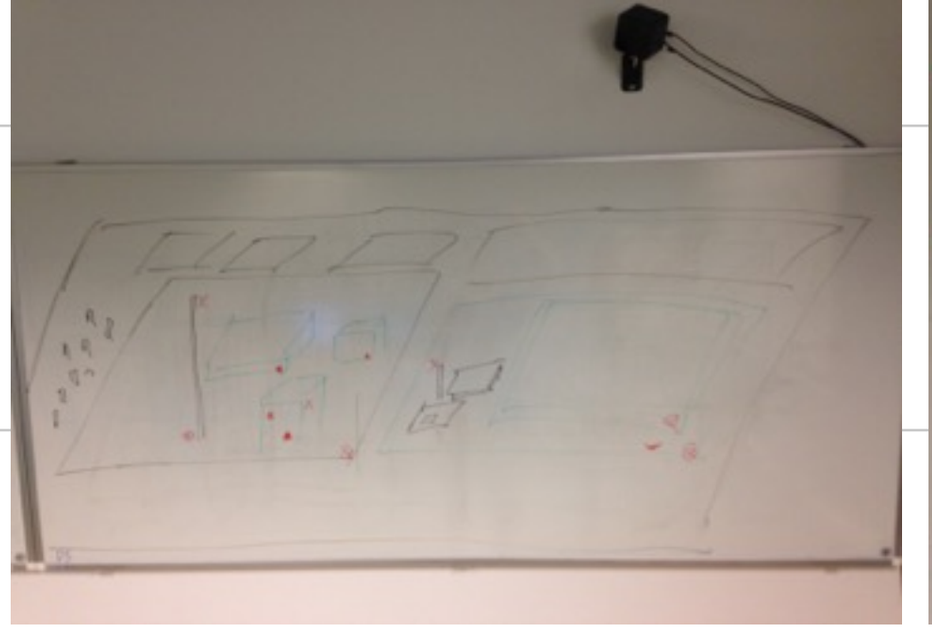
00’ Axion

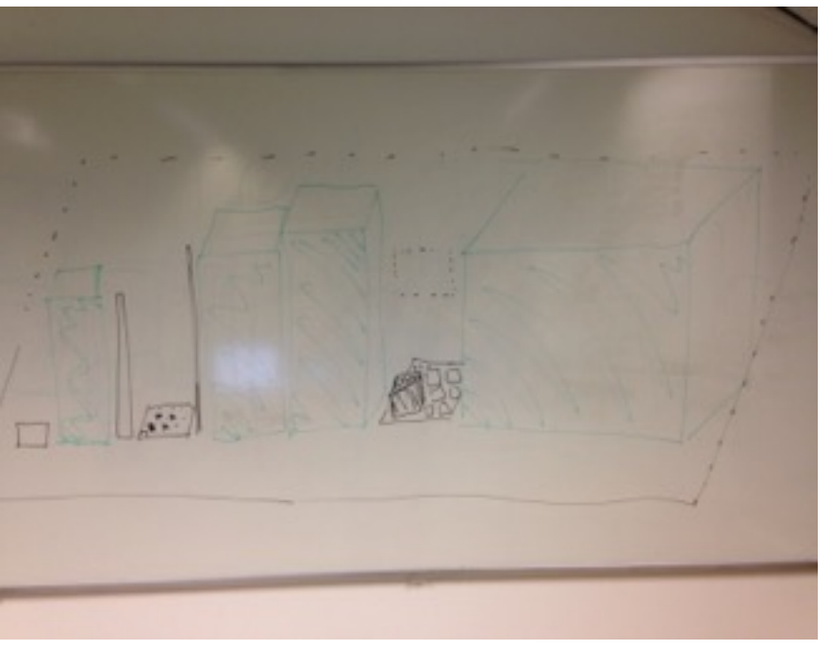
30’ Freemind

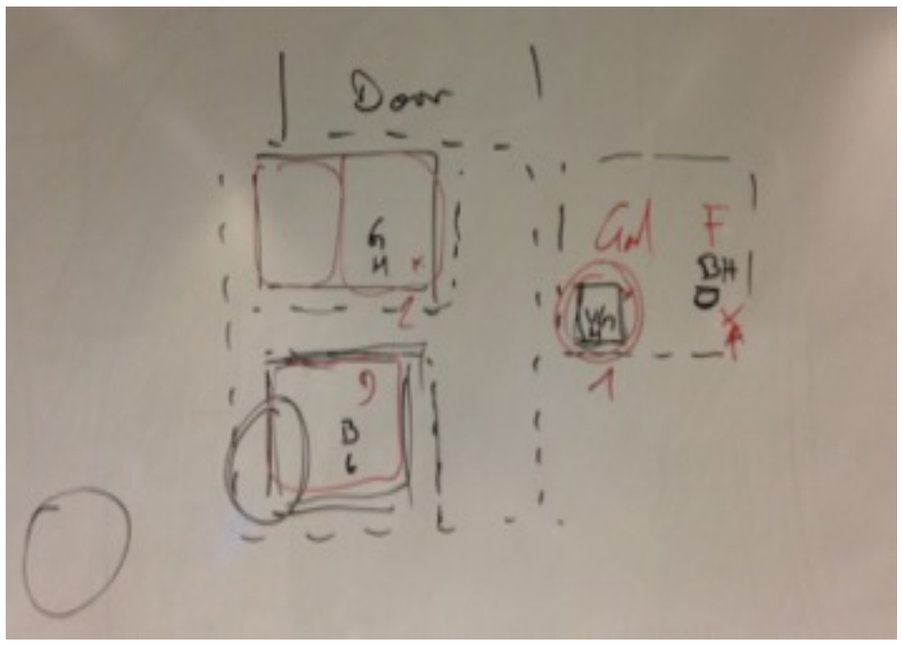
60’ Azureus

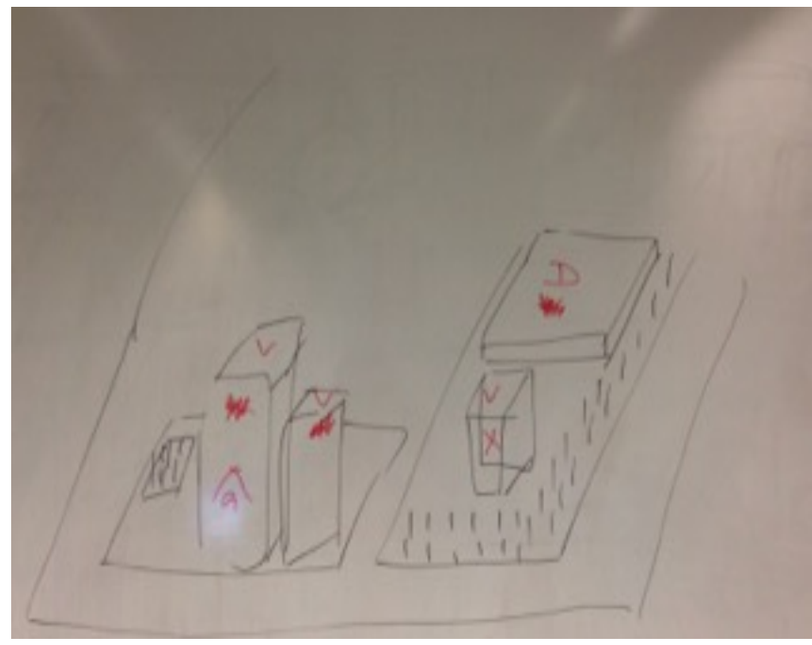

EXPO

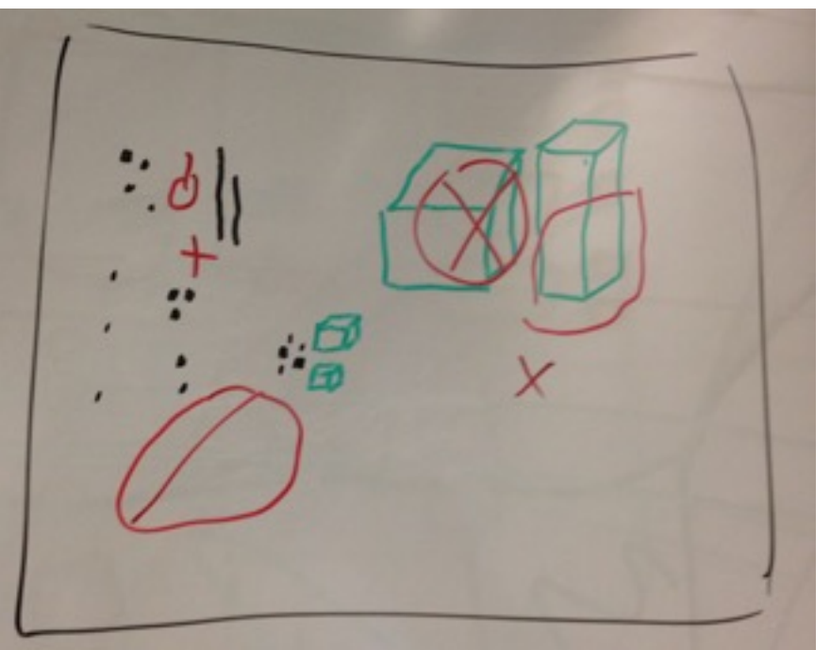


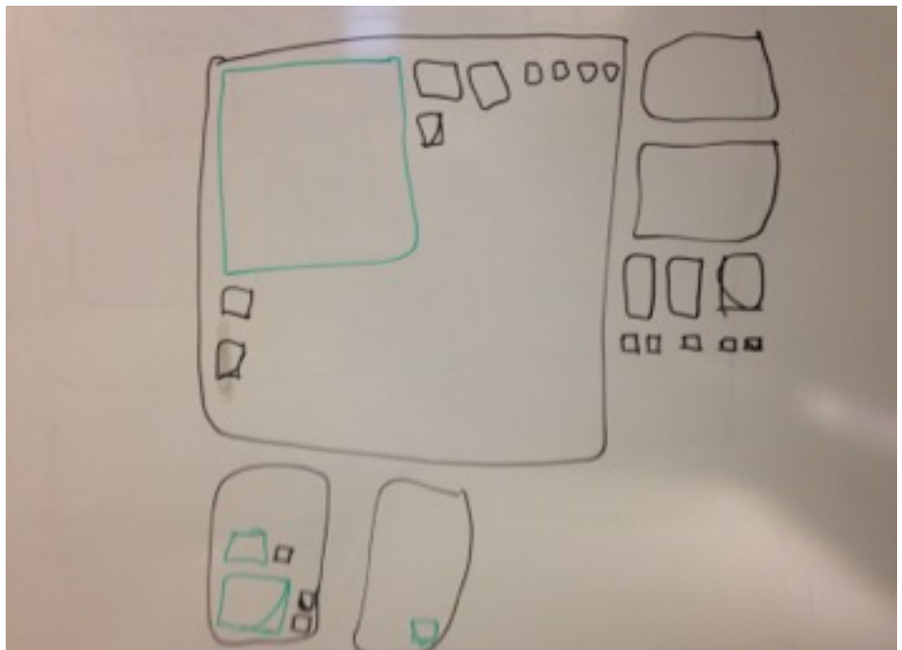


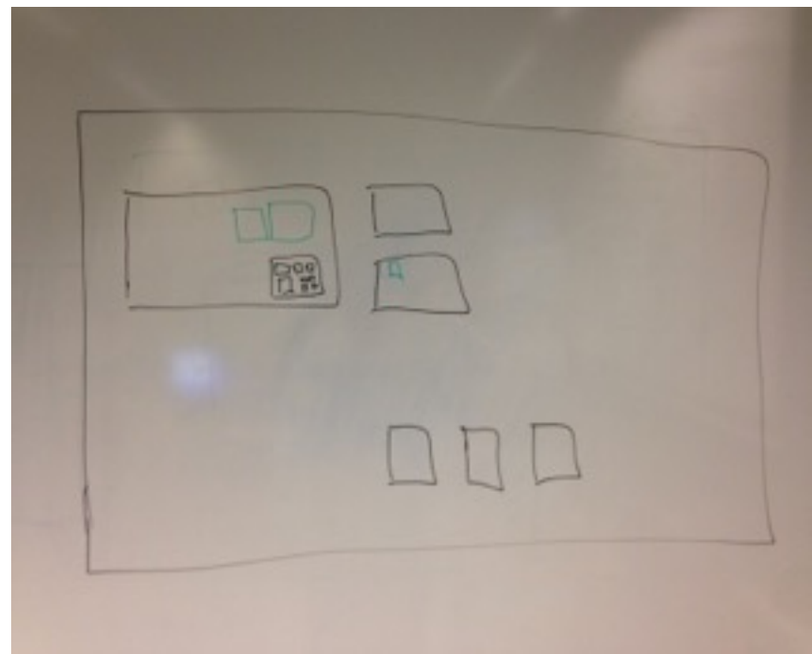


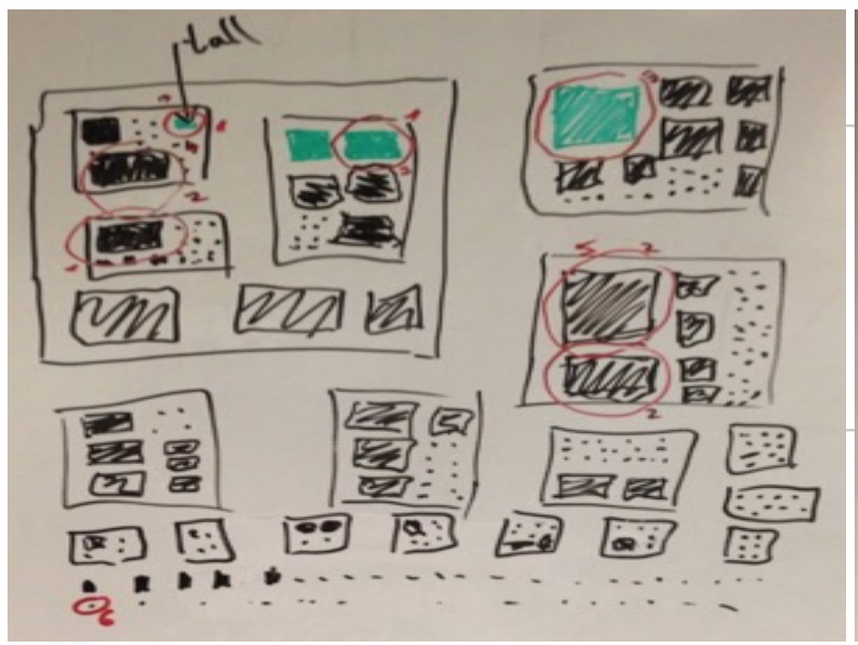

Door







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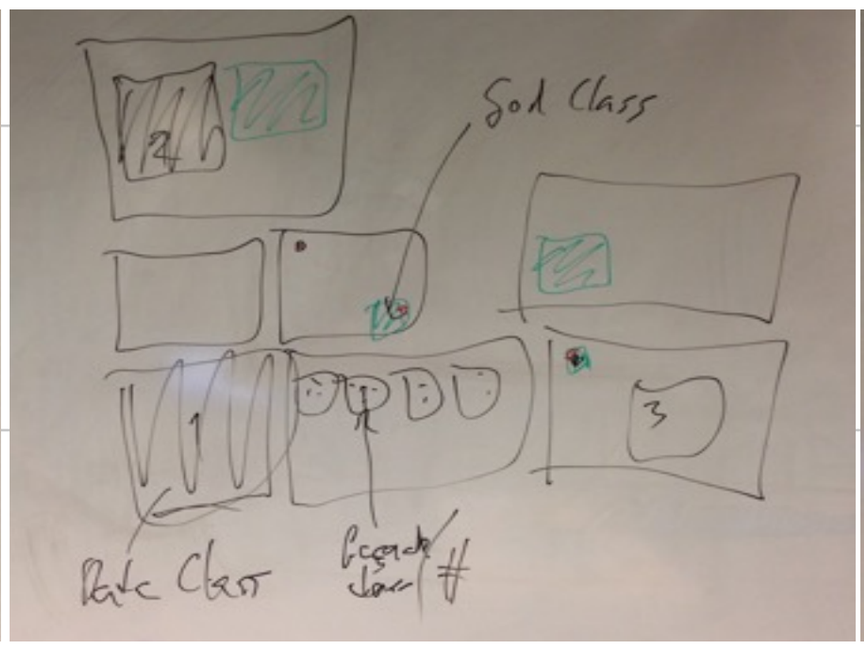
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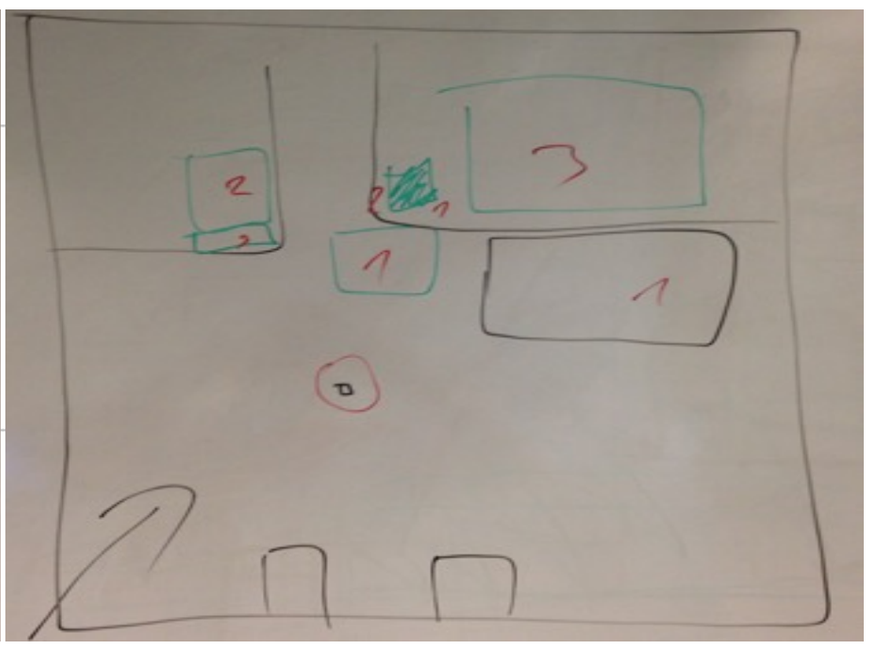
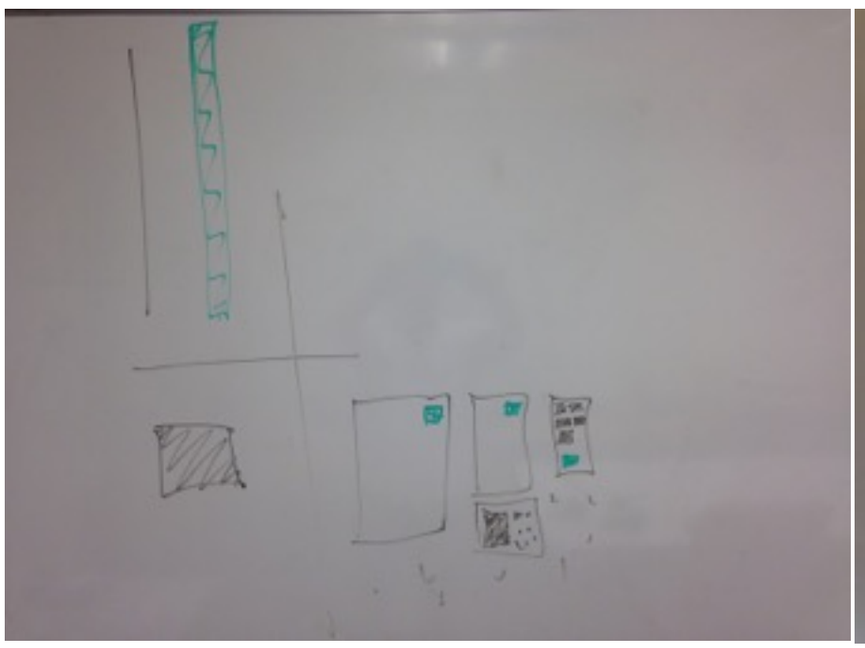
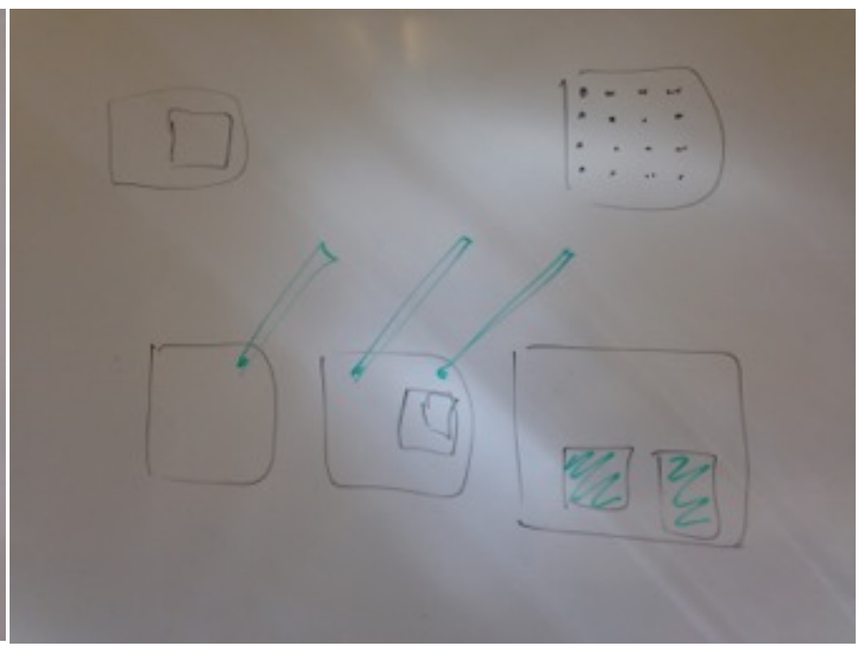
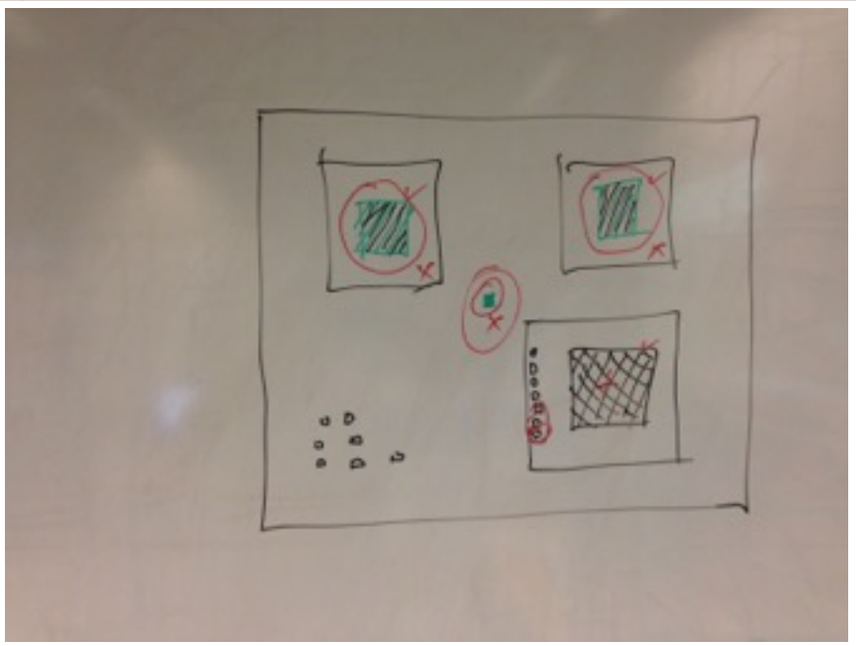
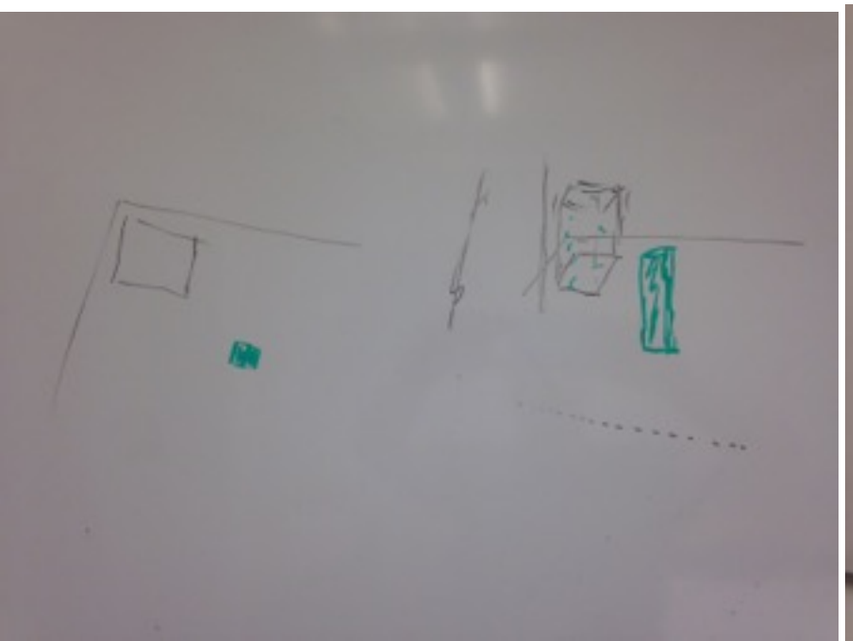
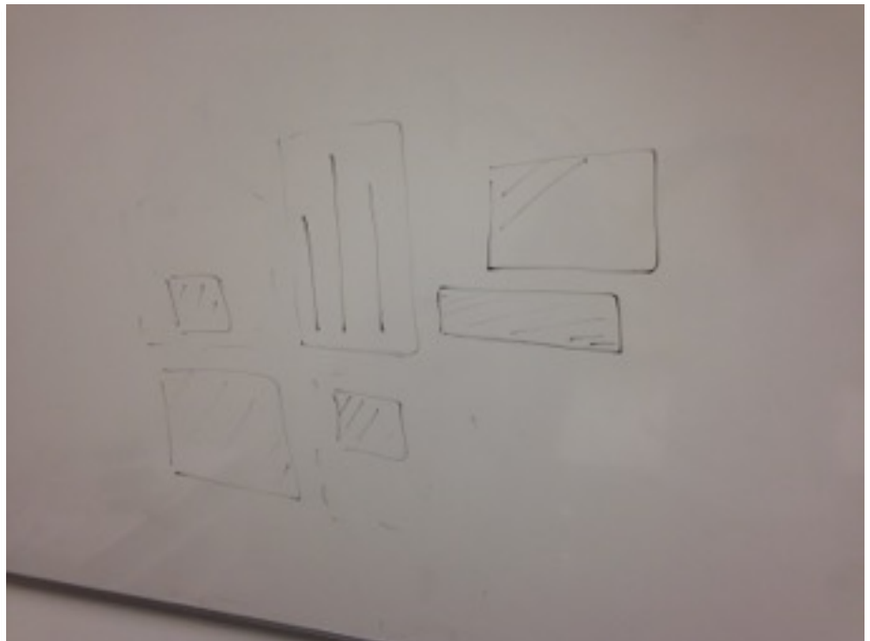


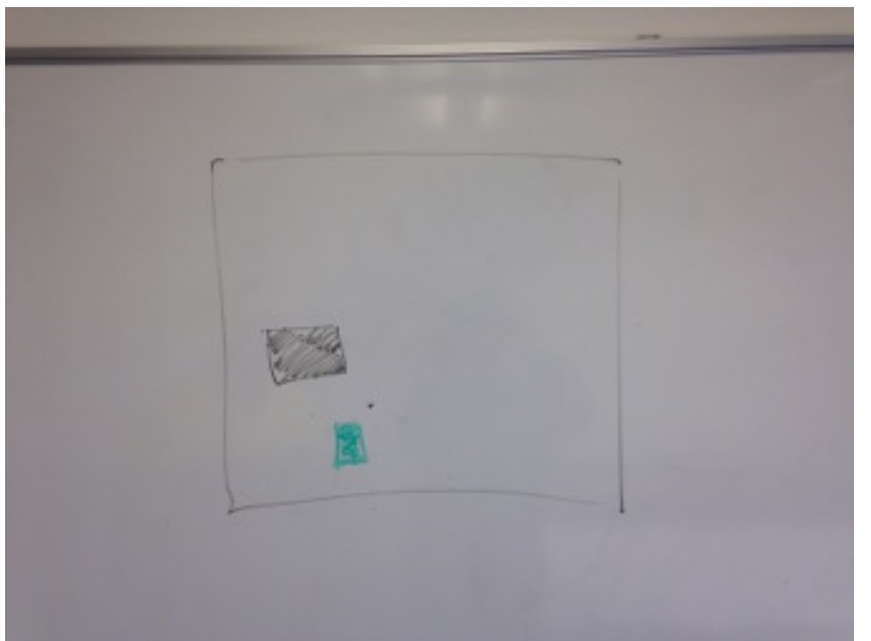


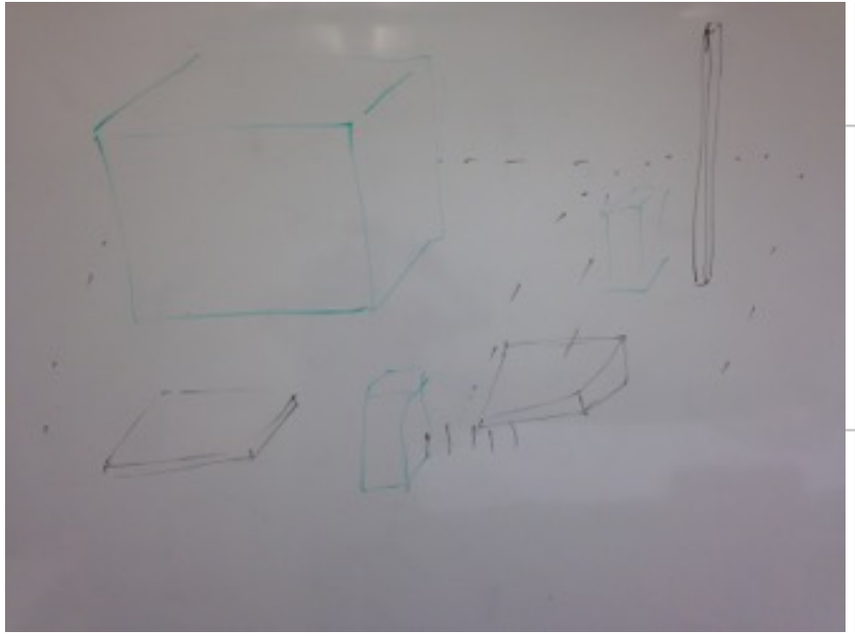


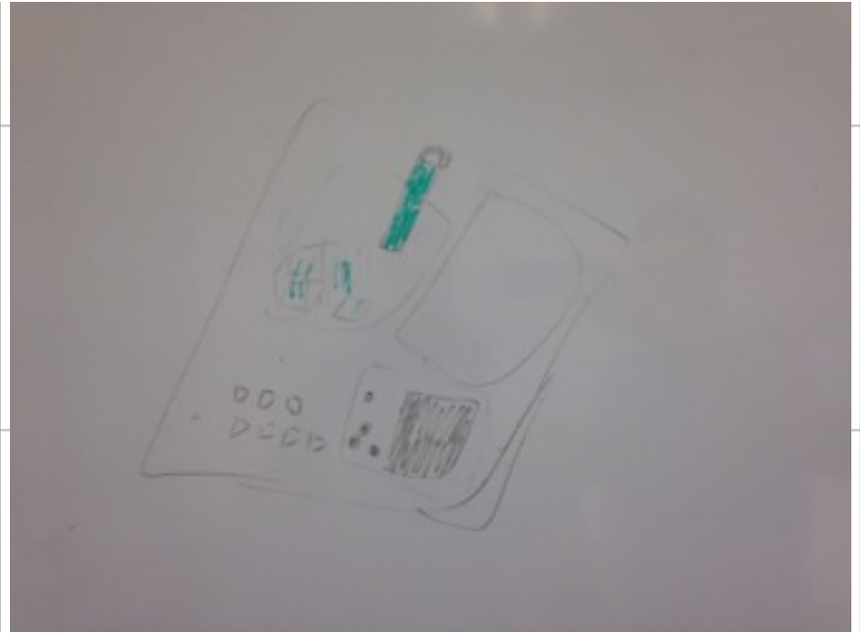




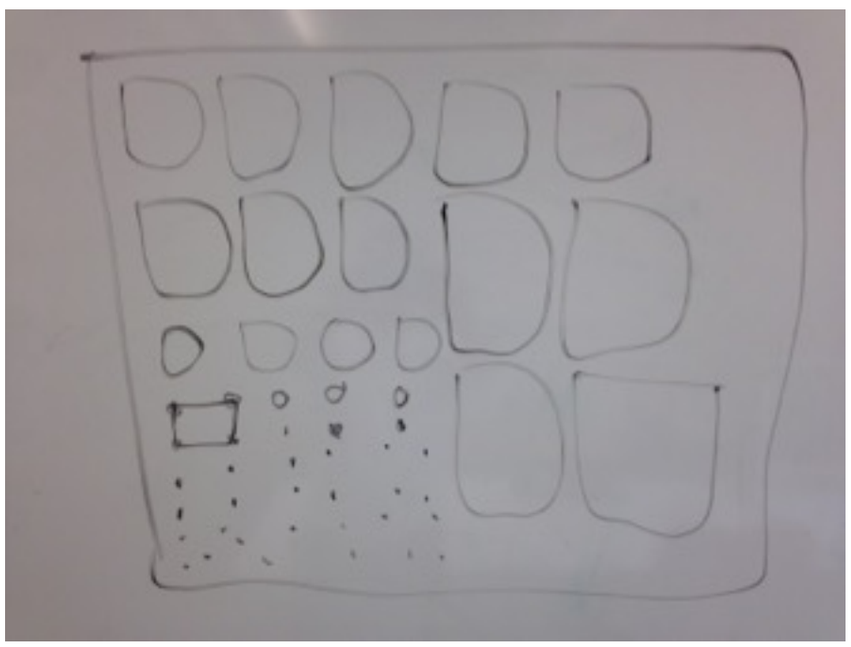


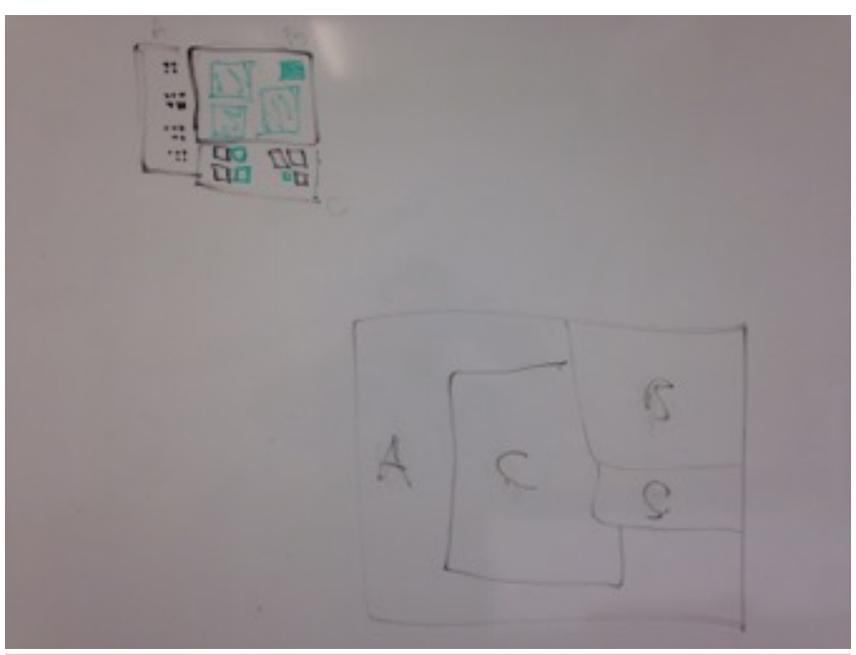







Tall
Tall
Tall



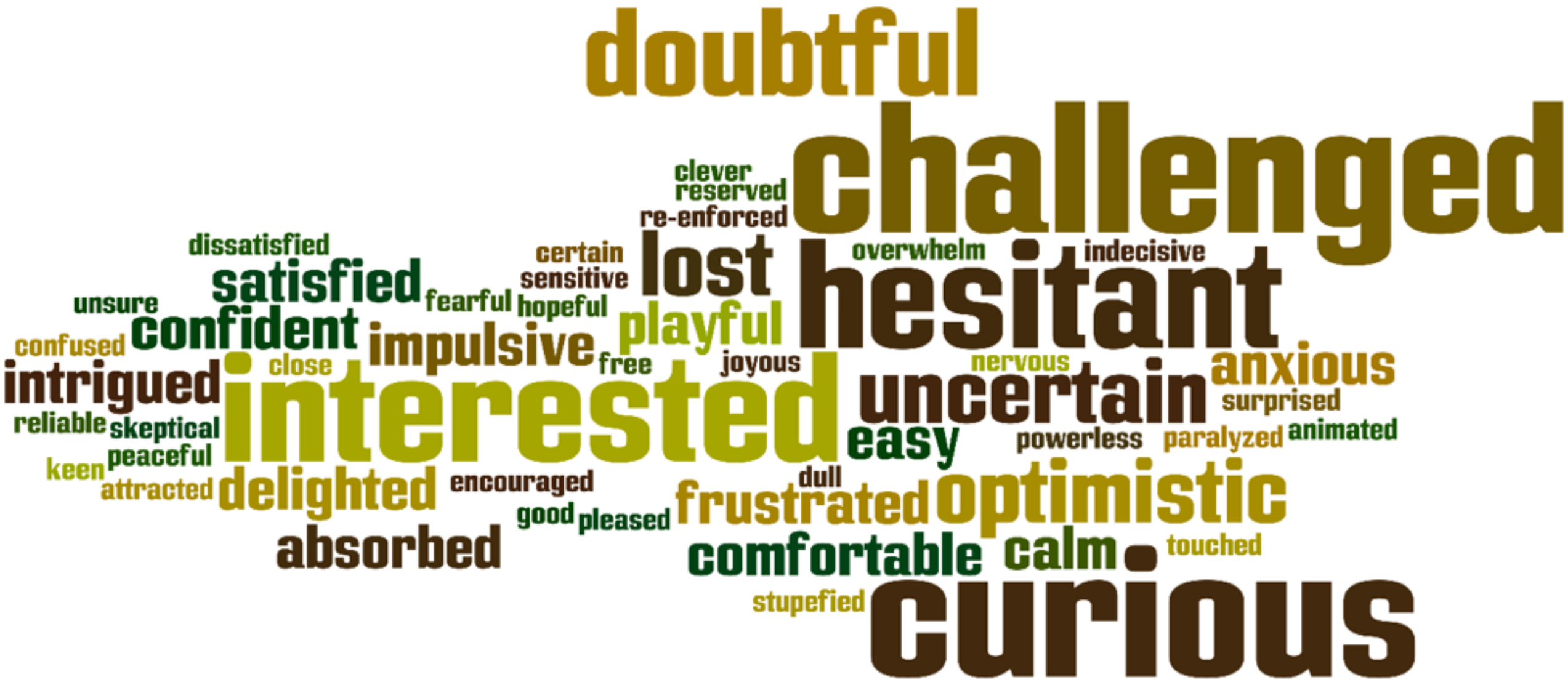

A
C
S
C


HIGH AND GREEN
OUT OF MODULE
BIG FAT


CURIOUS
understanding
interested
intrigued
wonder
amazed
surprised
CONFUSED
unsure
uncertain
disgruntled
flustered
embarrassed
pessimistic
hesitant
shy
CONFIDENT
assertive
strong
determined
proud
optimistic
hopeful
CONFIDENT
discouraged
lost
defeated
dismayed
guilty
disappointed
distressed
dispirited
miserable
a sense of loss
miserable
lonely
terrible
regretful
in despair
desperate
powerless
disappointed
DULL
lifeless
revived
energised
bored
interested
exhausted
indifferent
sluggish
ENGAGED
intrigued
curious
focused
absorbed
stimulated
motivated
ENERGISED
energetic
passionate
thrilled
inspiring
alive
playful
courageous
wonderful
spirited
free
ENGAGED
intrigued
curious
dynamic
secure
lively
rebellious
free
inquisitive
smart
ANGRY
infuriated
hostile
resentful
enraged
indignant
insulting
boiling
irritated
bitter
hateful
open
annoyed
aggressive
fuming
sore
increased
cross
offensive
unpleasant
provoked
worked up
infuriated
HURT
victimised
heartbroken
aching
rejected
afflicted
wronged
humiliated
dejected
alienated
injured
betrayed
offended
deprived
appalled
tormented
agonised
crushed
pained
INTIMIDATED
curious
concerned
intrigued
fascinated
uneasy
nosy
inquisitive
engrossed
animated
affected
absorbed
LOVE
sensitive
close
drawn toward
captivated
devoted
affectionate
sympathetic
loving
admiration
warm
touched
tender
consolidate
bond
attracted
passionate
HELPLESS
paralysed
in a daze
despair
distressed
useless
bored
dominated
inferior
incapable
frustrated
alone
fatigued
vulnerable
overwhelm
perturbed
empty
hesitant
tragic
wistful
SAD
sorrowful
mournful
grief
tearful
pained
desperate
pessimistic
grieved
unhappy
lonely
desolate
dismayed
anguish


satisfied
excited
hesitant
confused
cheerful
animated
inspired
curious
fatigued
confident
shy
quiet
alone
playful
easy
absorbed
skeptical
dynamic
intrigued
interested
optimistic
doubtful
determined
suspicious
eager
lonely
uncertain
unsure
overwhelm
inquisitive
amazed
brave
accepting
enthusiastic
bold
encouraged
fascinated
free
clever
indecisive
calm
challenged
attracted
nervous
unique

excited
interested
frustrated
hesitant
optimistic
calm
confused
draw
lousy
challenged
satisfied
certain
dull
attracted
clever
concerned
comforted
relaxed
positive
confident
re-enforced
free
easy
lost
unsure
playful
toward
perplexed
overwhelm
content
keen
indecisive
sure
comfortable
determined
reliable
understanding
delighted
neutral
uncertain
curious
joyous
pleased
annoyed
encouraged
enthusiastic
cheerful
inspired


doubtful
challenged
clever
reserved
re-enforced
dissatisfied
certain
lost
overwhelm
indecisive
satisfied
sensitive
hesitant
unsure
fearful
hopeful
confident
playful
impulsive
confused
free
joyous
nervous
anxious
close
intrigued
interested
uncertain
surprised
reliable
skeptical
easy
powerless
paralyzed
animated
peaceful
keen
attracted
delighted
encouraged
dull
frustrated
optimistic
good
pleased
absorbed
comfortable
calm
touched
stupefied
curious

Results

			Freemind (600 classes)			Azureus (6600 classes)		
			Best	Medium	Worst	Best	Medium	Worst
Performance	Finding outliers	Time to completion	P3D	SCS	I3D			
		Accuracy	P3D=SCS=I3D					
	Finding patterns	Time to completion	SCS	I3D	P3D			
		Accuracy	SCS	P3D=I3D				
	Location and Quantification	Time to completion	I3D	P3D	SCS			
		Accuracy	SCS	I3D	P3D			
Memorability								
User Experience								

Results

			Freemind (600 classes)			Azureus (6600 classes)		
			Best	Medium	Worst	Best	Medium	Worst
Performance	Finding outliers	Time to completion	P3D	SCS	I3D	P3D	SCS	I3D
		Accuracy	P3D=SCS=I3D			P3D=SCS=I3D		
	Finding patterns	Time to completion	SCS	I3D	P3D	P3D	I3D	SCS
		Accuracy	SCS	P3D=I3D		P3D=SCS=I3D		
	Location and Quantification	Time to completion	I3D	P3D	SCS	I3D	SCS	P3D
		Accuracy	SCS	I3D	P3D	I3D	P3D	SCS
Memorability								
User Experience								

Results

			Freemind (600 classes)			Azureus (6600 classes)		
			Best	Medium	Worst	Best	Medium	Worst
Performance	Finding outliers	Time to completion	P3D	SCS	I3D	P3D	SCS	I3D
		Accuracy	P3D=SCS=I3D			P3D=SCS=I3D		
	Finding patterns	Time to completion	SCS	I3D	P3D	P3D	I3D	SCS
		Accuracy	SCS	P3D=I3D		P3D=SCS=I3D		
	Location and Quantification	Time to completion	I3D	P3D	SCS	I3D	SCS	P3D
		Accuracy	SCS	I3D	P3D	I3D	P3D	SCS
Memorability			I3D	SCS	P3D			
User Experience								

Results

			Freemind (600 classes)			Azureus (6600 classes)		
			Best	Medium	Worst	Best	Medium	Worst
Performance	Finding outliers	Time to completion	P3D	SCS	I3D	P3D	SCS	I3D
		Accuracy	P3D=SCS=I3D			P3D=SCS=I3D		
	Finding patterns	Time to completion	SCS	I3D	P3D	P3D	I3D	SCS
		Accuracy	SCS	P3D=I3D		P3D=SCS=I3D		
	Location and Quantification	Time to completion	I3D	P3D	SCS	I3D	SCS	P3D
		Accuracy	SCS	I3D	P3D	I3D	P3D	SCS
Memorability			I3D	SCS	P3D			
User Experience			I3D	SCS	P3D	SCS	I3D	P3D

Results

			Freemind (600 classes)			Azureus (6600 classes)		
			Best	Medium	Worst	Best	Medium	Worst
Performance	Finding outliers	Time to completion	P3D	SCS	I3D	P3D	SCS	I3D
		Accuracy	P3D=SCS=I3D			P3D=SCS=I3D		
	Finding patterns	Time to completion	SCS	I3D	P3D	P3D	I3D	SCS
		Accuracy	SCS	P3D=I3D		P3D=SCS=I3D		
	Location and Quantification	Time to completion	I3D	P3D	SCS	I3D	SCS	P3D
		Accuracy	SCS	I3D	P3D	I3D	P3D	SCS
Memorability			I3D	SCS	P3D			
User Experience			I3D	SCS	P3D	SCS	I3D	P3D