

Scout: Rapid Exploration of Interface Layout Alternatives through High-Level Design Constraints

Amanda Swearngin, Chenglong Wang, Alannah Oleson, Amy Ko, James Fogarty

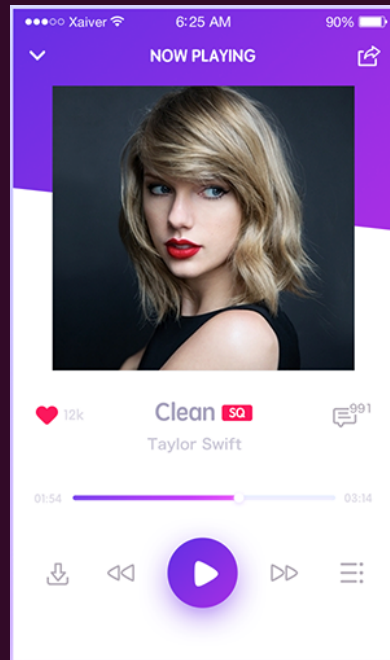
amaswea.github.io

DUB Shorts

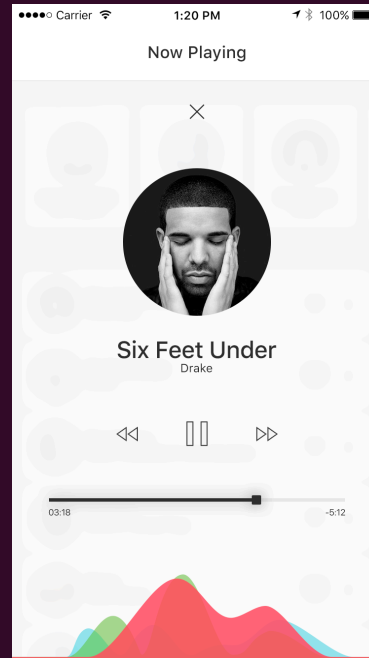
April 15th, 2020



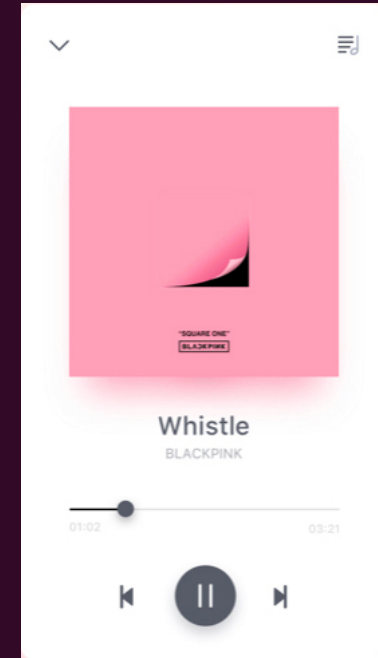
Alternative 1



Alternative 2

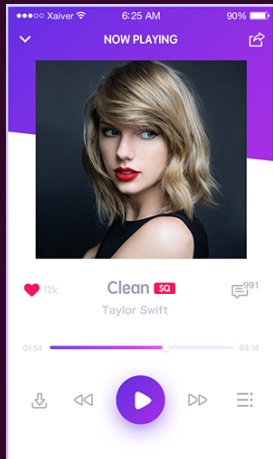


Alternative 3

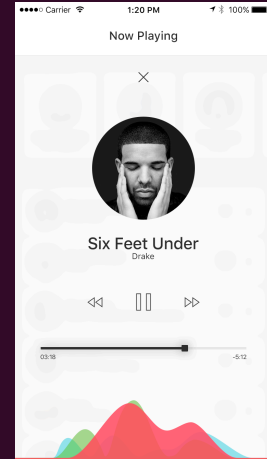


Benefits of Creating Alternatives

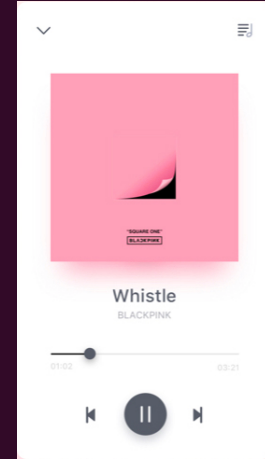
Alternative 1



Alternative 2



Alternative 3



Better designs¹

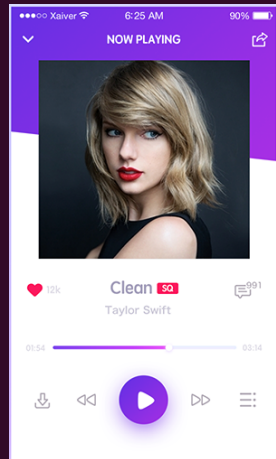
Stronger critiques²

More diverse designs³

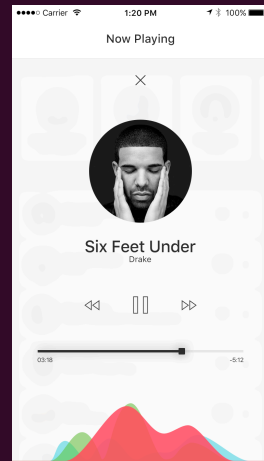
1. Dow, et. al., "Parallel Prototyping Leads to Better Design Results, More Divergence, and Increased Self-efficacy, Design Thinking Research", 2012
2. Tohidi, et. al., "Getting the Right Design and the Design Right", CHI 2006
3. Bill Buxton, "Sketching User Experiences: Getting the Design Right and the Right Design", 2007

Challenges of Creating Alternatives

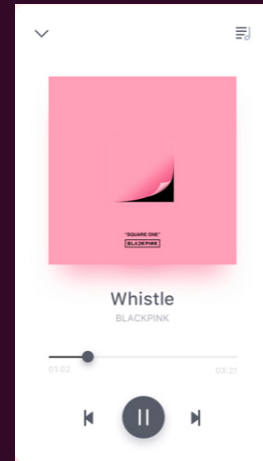
Alternative 1



Alternative 2

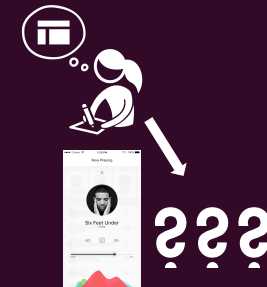


Alternative 3



Designer Fixation¹

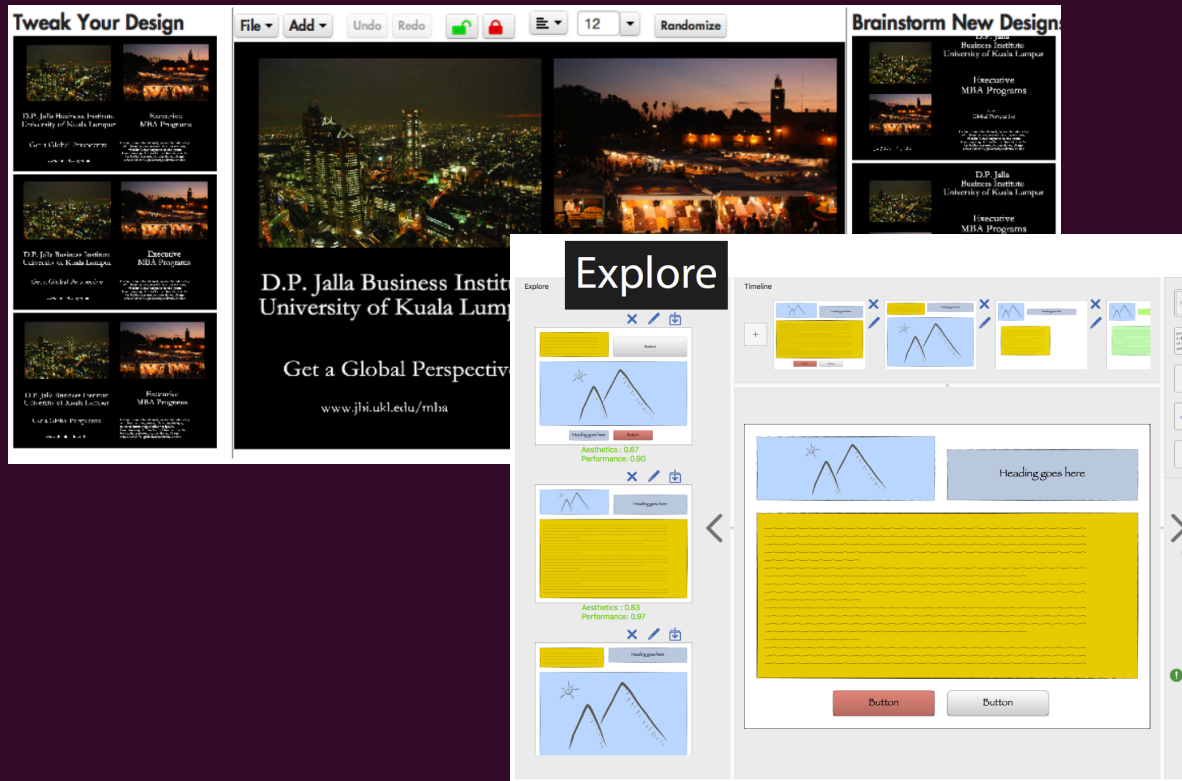
Time & Effort



1. Jansson, et. al., Design Fixation, 1991

Tools for Automatic Exploration of Alternatives

DesignScape¹



No feedback

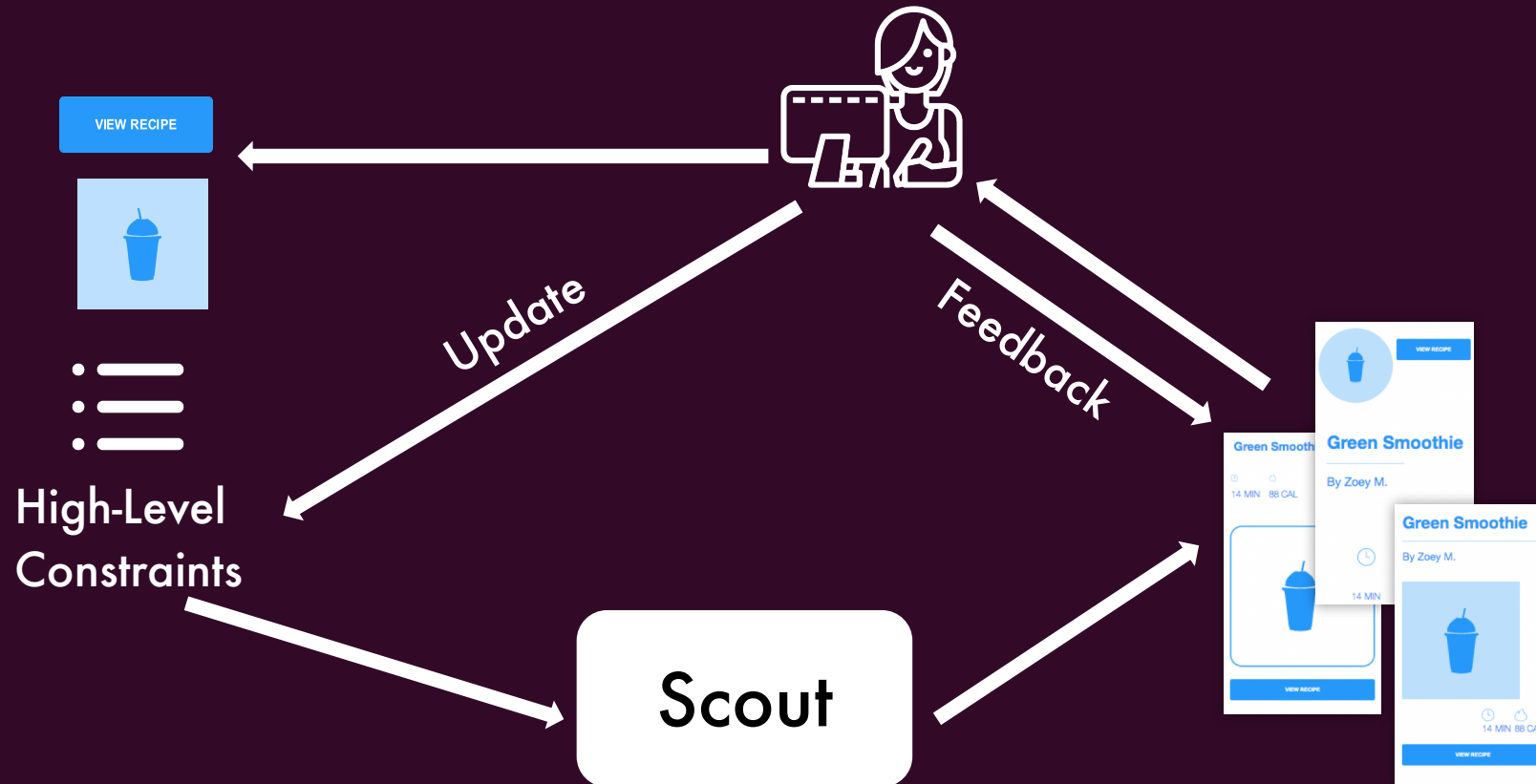
Designer unable to control generation or define constraints on interface semantics

Sketchplore²

1. Peter O'Donovan, Aseem Agarwala, Aaron Hertzmann. "DesignScape: Design with Interactive Layout Suggestions", CHI '15

2. Kashyap Todi, Daryl Weir, and Antti Oulasvirta. "Sketchplore: Sketch and Explore with a Layout Optimizer", DIS '16

Scout: Rapid Exploration of Interface Layout Alternatives using High-Level Design Constraints¹



1. Amanda Swearngin, Chenglong Wang, Alannah Oleson, James Fogarty, Amy Ko, "Scout: Rapid Exploration of Interface Layout Alternatives through High-Level Design Constraints", CHI 2020

Research Questions

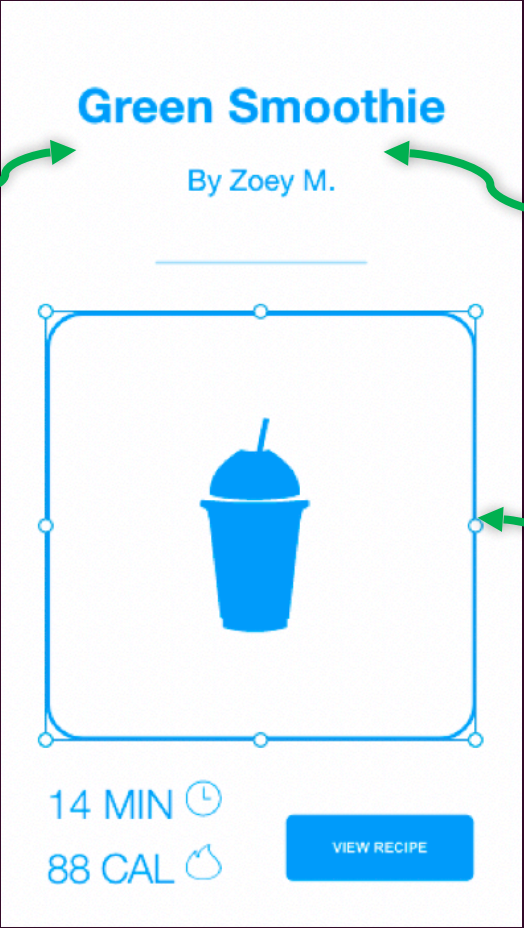
How can we give designers more control over alternative generation, by letting them define constraints on high-level interface semantics?

Research Questions

How can we give designers more control over alternative generation, by letting them define constraints on high-level interface semantics?

High-Level Constraints

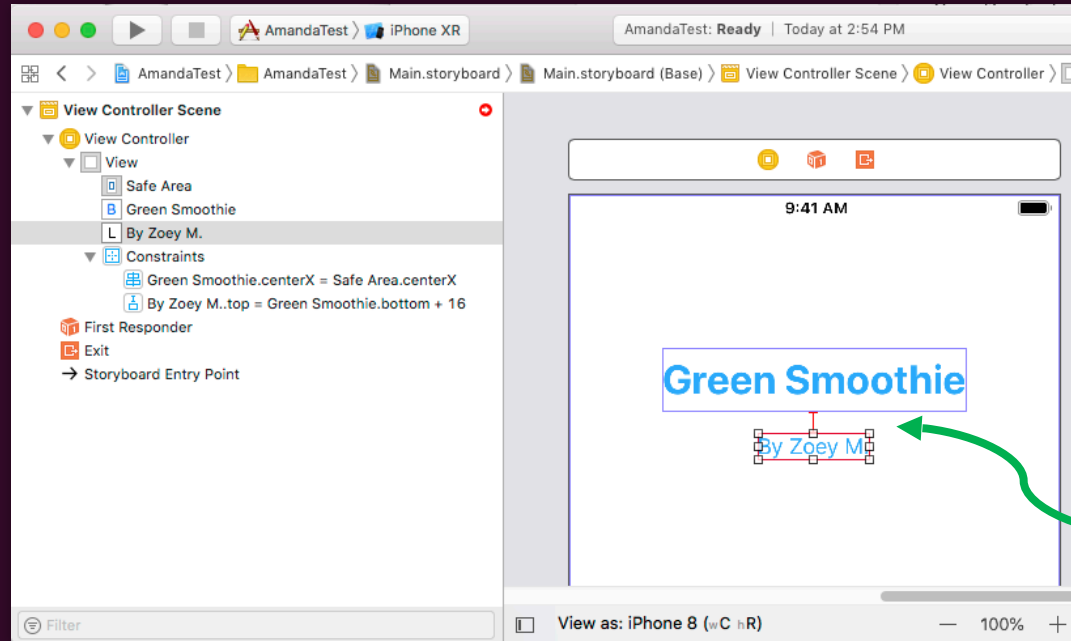
Keep in this order



Keep these together

Most Important

Low-Level Spatial Constraints



Constraint

$subtext.y == header.y + header.height + 20$

Apple AutoLayout

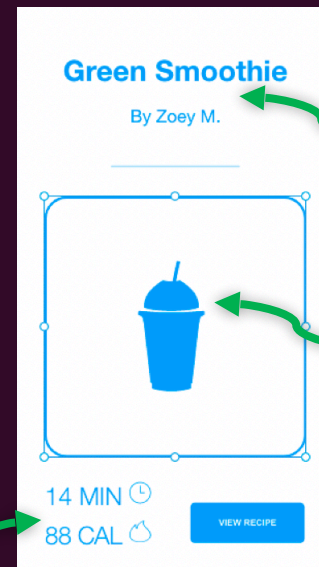
Research Questions

How can we give designers more control over alternative generation, by letting them define constraints on high-level interface semantics?

~~Low-level Spatial Constraint~~

```
subtext.y == header.y +  
header.height + 20
```

High-Level Constraints



Keep these together

Most Important

Keep in this order

Research Questions

How can we use these constraints to help designers rapidly ideate and visualize alternate layouts?

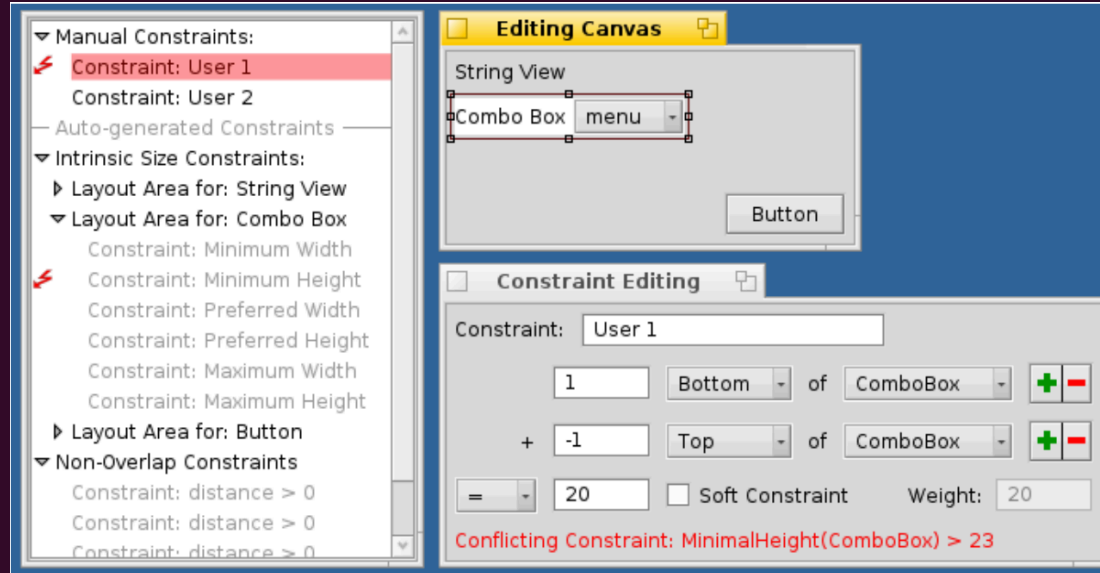
Leveraging Past Work on Constraints

Research Systems

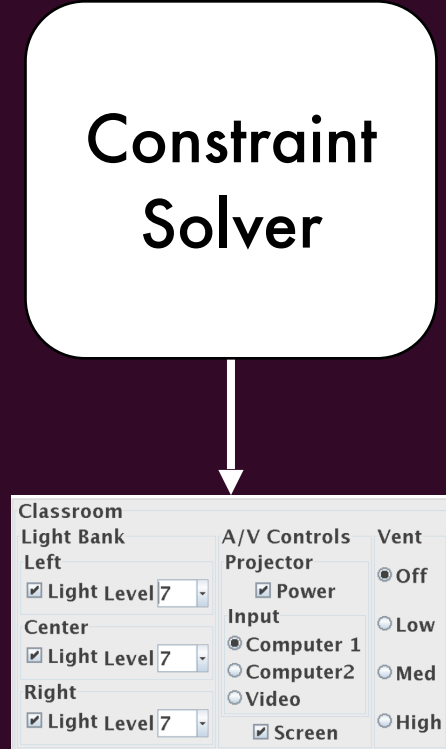
Rockit²

Peridot³

SUPPLE⁴



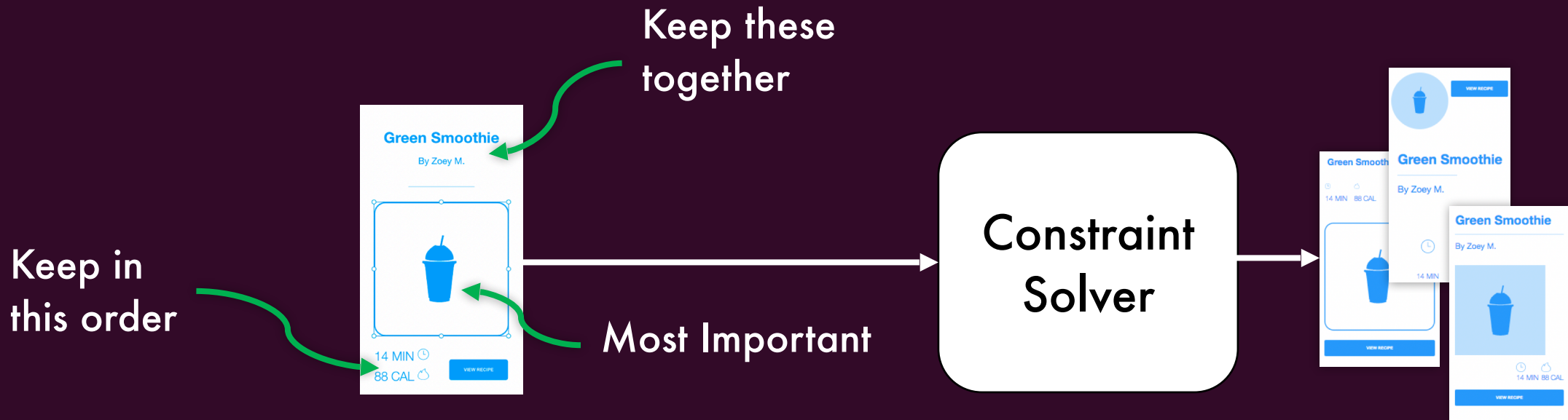
ALE⁵



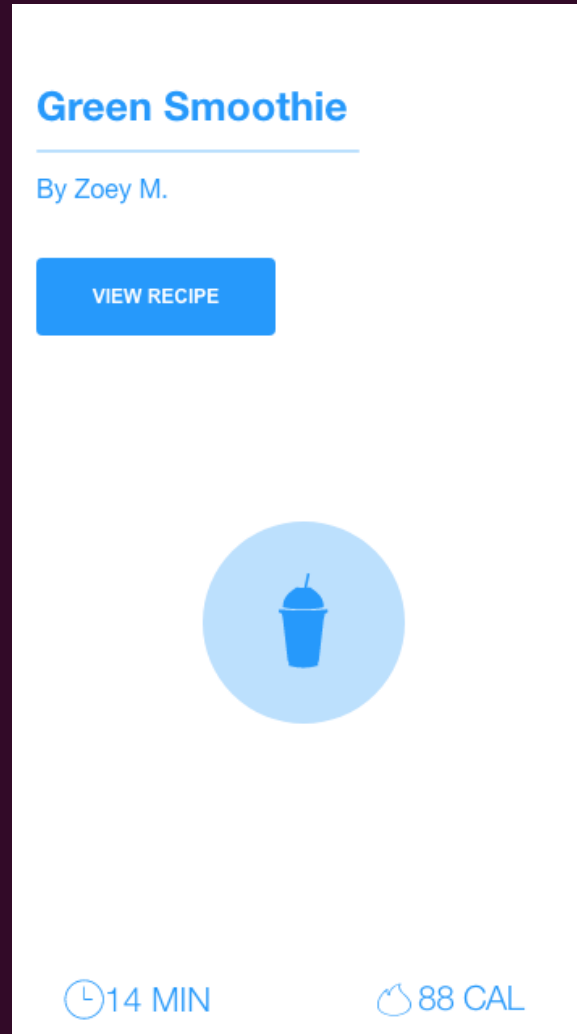
1. Sutherland, "Sketchpad: A Man-machine Graphical Communication System", SHARE, '64
2. Karsenty et al., "Inferring Graphical Constraints with Rockit", CHI '93
3. Myers et al., "Creating Highly Interactive and Graphical User Interfaces by Demonstration", SIGGRAPH '86
4. Gajos et al., "Automatically Generating User Interfaces Adapted to Users' Motor and Vision Capabilities", UIST '07
5. Zeidler et al., "The Auckland Layout Editor: An Improved GUI Layout Specification Process", UIST '13

Research Questions

How can we use these constraints to help designers rapidly ideate and visualize alternate layouts?



Scout – Redesigning a Layout



Widgets Clear Widgets <Outline See more layout ideas

Feedback

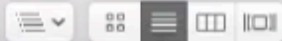
Layout Ideas 0 Under Consideration 0 Saved

Canvas

Order

TeaserComponents_SmoothieRecipe

Rem < >



Search

iCloud Drive

Desktop

AirDrop

Downloads

Google Drive

Recents

Genie

GitHub

Applications

Rewire2

Rewire

Dropbox

layout

Creative Cloud Files

Scout

Videos

iCloud

Documents

Desktop

iCloud Drive

Name

Date Modified

Size

Kind

0_Separator.svg

Jun 15, 2019 at 5:57 PM

171 bytes

MyDoc...

1_CirclePlaceholder.svg

Jun 15, 2019 at 2:43 PM

2 KB

MyDoc...

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MyDoc...

8_ingredients.svg

Jun 15, 2019 at 6:09 PM

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MyDoc...

10_Button2.svg

Jun 15, 2019 at 3:13 PM

506 bytes

MyDoc...


Drag and drop your SVG
interface elements here.

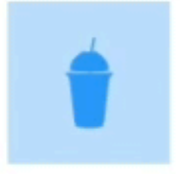

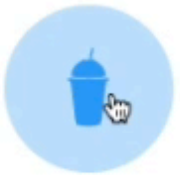
Widgets Clear Widgets <

Outline See more layout ideas

Feedback


Layout Ideas 0 Under Consideration 0 Saved

(Separator)



Green Smoothie

By Zoey M.



14 MIN

Canvas

Order Important

Remove all feedback

Select an element in the Outline Panel or in a layout idea canvas to the right to see feedback options.

You currently have no layout ideas under co

Scout

Not Secure | 10.158.54.128:8082/scout/#

Scout Exploring alternative layout ideas for wireframes

Outline See more layout ideas

Canvas

Order important

Remove all feedback

Alternate

Order Unimportant

Group

Order Unimportant

Green Smoothie

By Zoey M.

14 MIN

88 CAL

VIEW RECIPE

Feedback

Layout Ideas 0 Under Consideration 0 Saved 11 Discarded

Discard Invalid Ideas

Emphasis Normal

Grid Layout & Placement

Left Column Vary Keep Prevent

Right Column Vary Keep Prevent

Y Vary Keep Prevent

Canvas Alignment Vary Keep Prevent

You currently have no layout ideas under consideration.

Green Smoothie

By Zoey M.

14 MIN 88 CAL

VIEW RECIPE

Green Smoothie

By Zoey M.

14 MIN 88 CAL

VIEW RECIPE

Green Smoothie

By Zoey M.

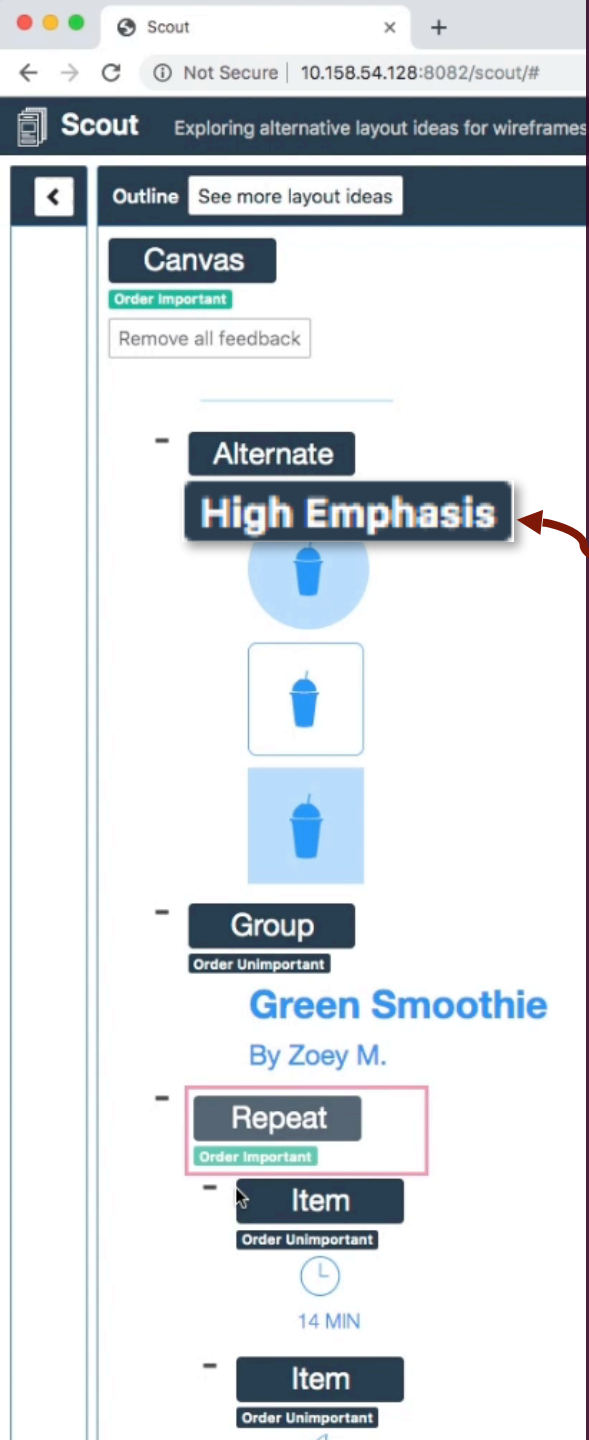
14 MIN 88 CAL

VIEW RECIPE

Alternate Group

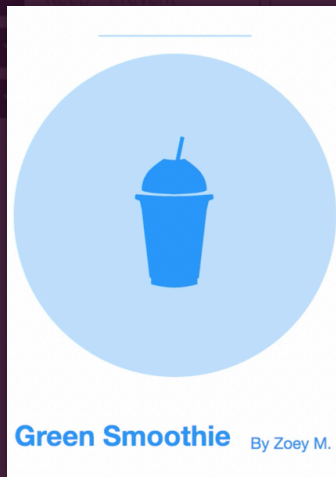
Use one placeholder per layout

High-Level Constraints



Emphasis - High

Principle: Interfaces should have a main focal point.¹



1. Alex White, *The Elements of Graphic Design*, 2011

Outline [See more layout ideas](#)

Canvas
Order Important
Remove all feedback

Alternate
Order Unimportant



Group
Order Unimportant

Green Smoothie

By Zoey M.

Repeat
Order Important

Item
Order Unimportant



14 MIN

Item
Order Unimportant



88 CAL

Feedback

Order Important **ON**

Emphasis **Normal**

Grid Layout & Placement

Left Column **Vary** Keep Prevent

Right Column **Vary** Keep Prevent

Y **Vary** Keep Prevent

Canvas Alignment **Vary** Keep Prevent

Arrangement

Arrangement **Vary** Keep Prevent

Alignment **Vary** Keep Prevent

Padding **Vary** Keep Prevent

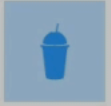
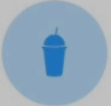
Group Alignment **Vary** Keep Prevent

Layout Ideas **0 Under Consideration** 0 Saved 11 Discarded [Discard Invalid Ideas](#) [Export Saved Ideas](#)

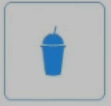
You currently have no layout ideas under consideration. Click **See More Layout Ideas** in the outline to see more.

Widgets Clear Widgets

(Separator)



VIEW RECIPE




Green Smoothie

By Zoey M.

14 MIN

88 CAL

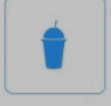
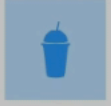
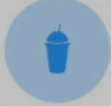


Drag and drop your SVG interface elements here.

Outline See more layout ideas

Canvas Order Unimportant Remove all feedback

Alternate Order Unimportant High Emphasis



VIEW RECIPE


Group Order Important

Green Smoothie

Repeat Order Important Low Emphasis

Keep arrangement horizontal. -

Item Order Unimportant

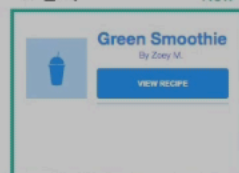
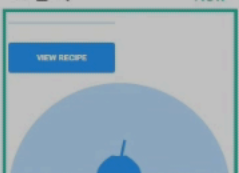
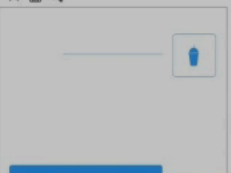
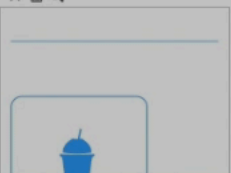
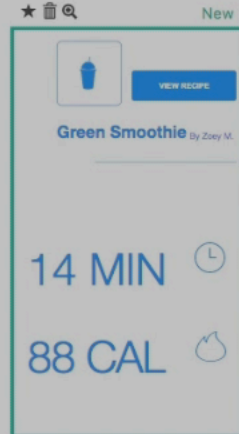
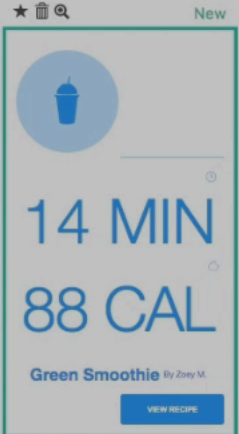
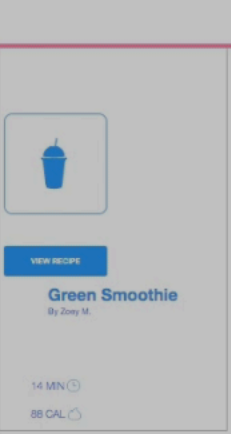
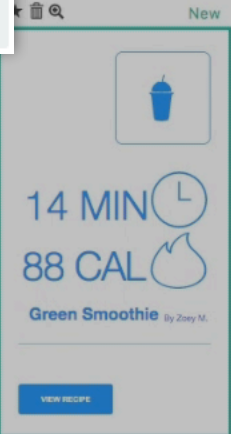
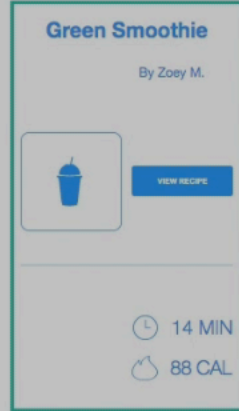
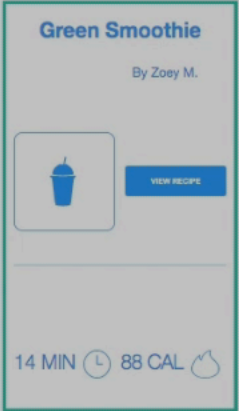
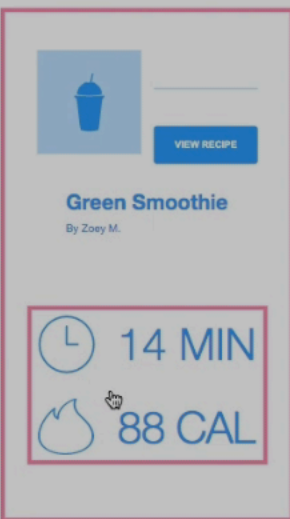
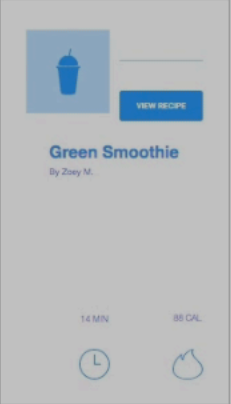


Feedback

Select an element in the Outline Panel or in a layout idea canvas to the right to see feedback options.

Arrangement Horizontal Keep Prevent

Layout Ideas 14 Under Consideration 0 Saved 6 Discarded



Feedback

Select an element in the Outline Panel or in a layout idea canvas to the right to see feedback options.

Layout Ideas

44 Under Consideration

0 Saved

23 Discarded

Discard Invalid Ideas

Export Saved Ideas

★ 🗑️ 🔍

Green Smoothie By Zoey M.

14 MIN ⌚

88 CAL 🍏

VIEW RECIPE

★ 🗑️ 🔍

Green Smoothie By Zoey M.

14 MIN ⌚

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VIEW RECIPE

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Green Smoothie By Zoey M.

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Green Smoothie By Zoey M.

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Green Smoothie By Zoey M.

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VIEW RECIPE

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Green Smoothie By Zoey M.

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VIEW RECIPE

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Green Smoothie By Zoey M.

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VIEW RECIPE

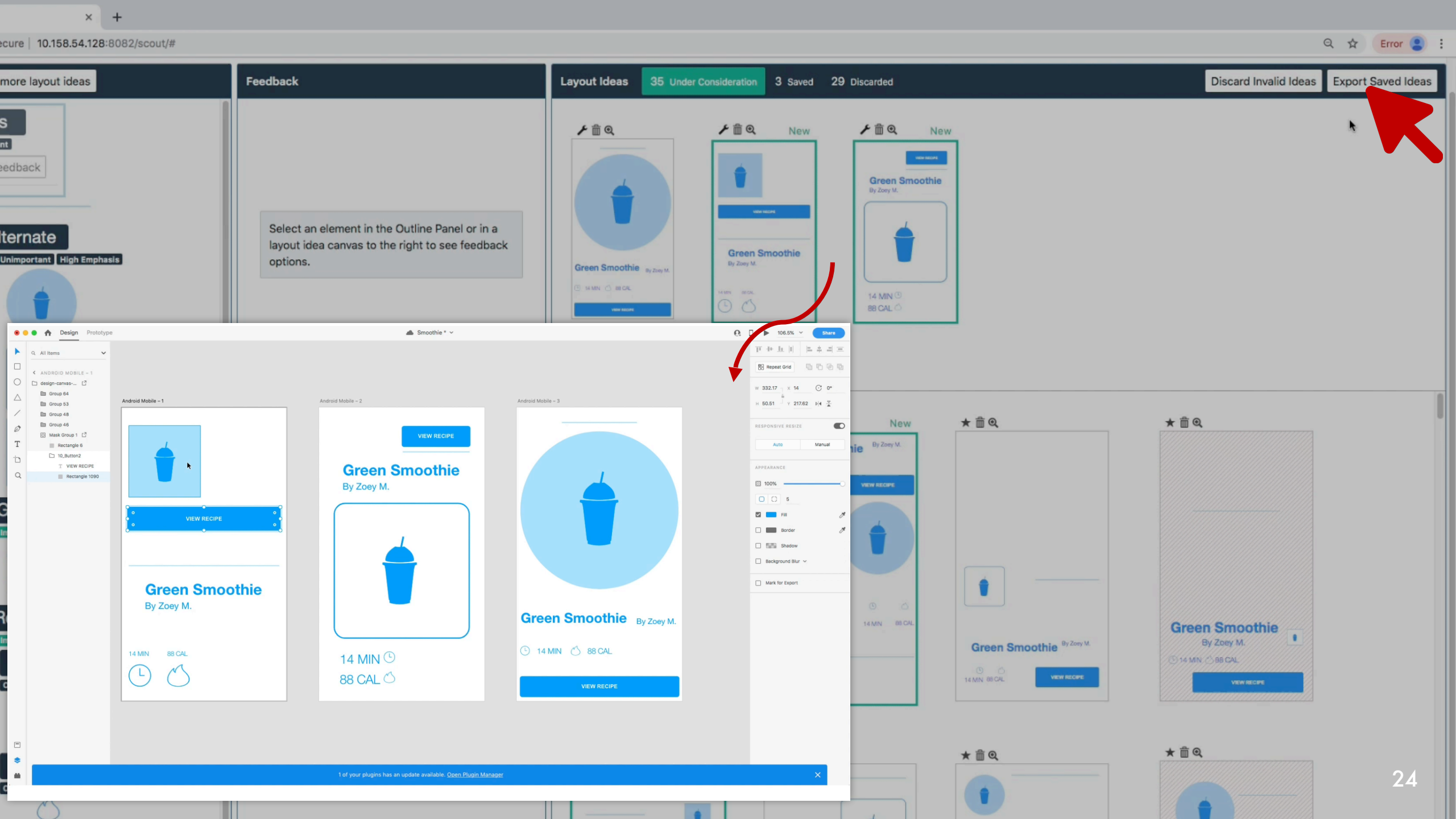
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Green Smoothie By Zoey M.

14 MIN ⌚

88 CAL 🍏

VIEW RECIPE



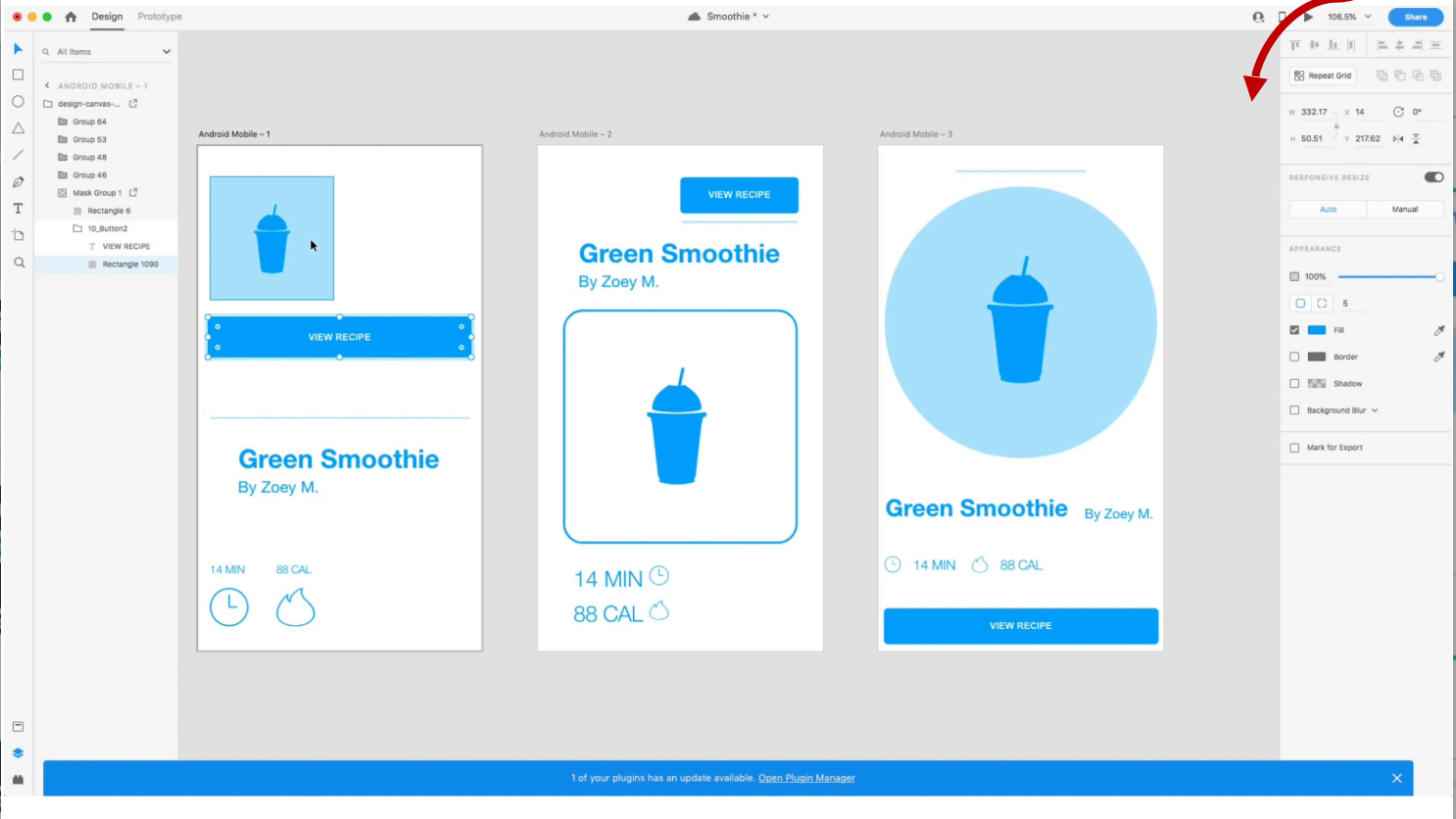
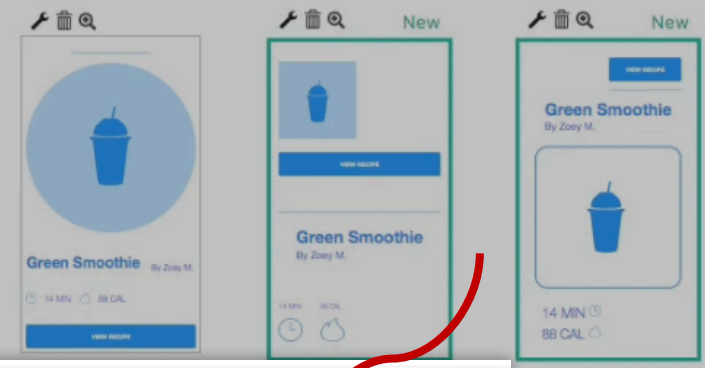
more layout ideas

Feedback

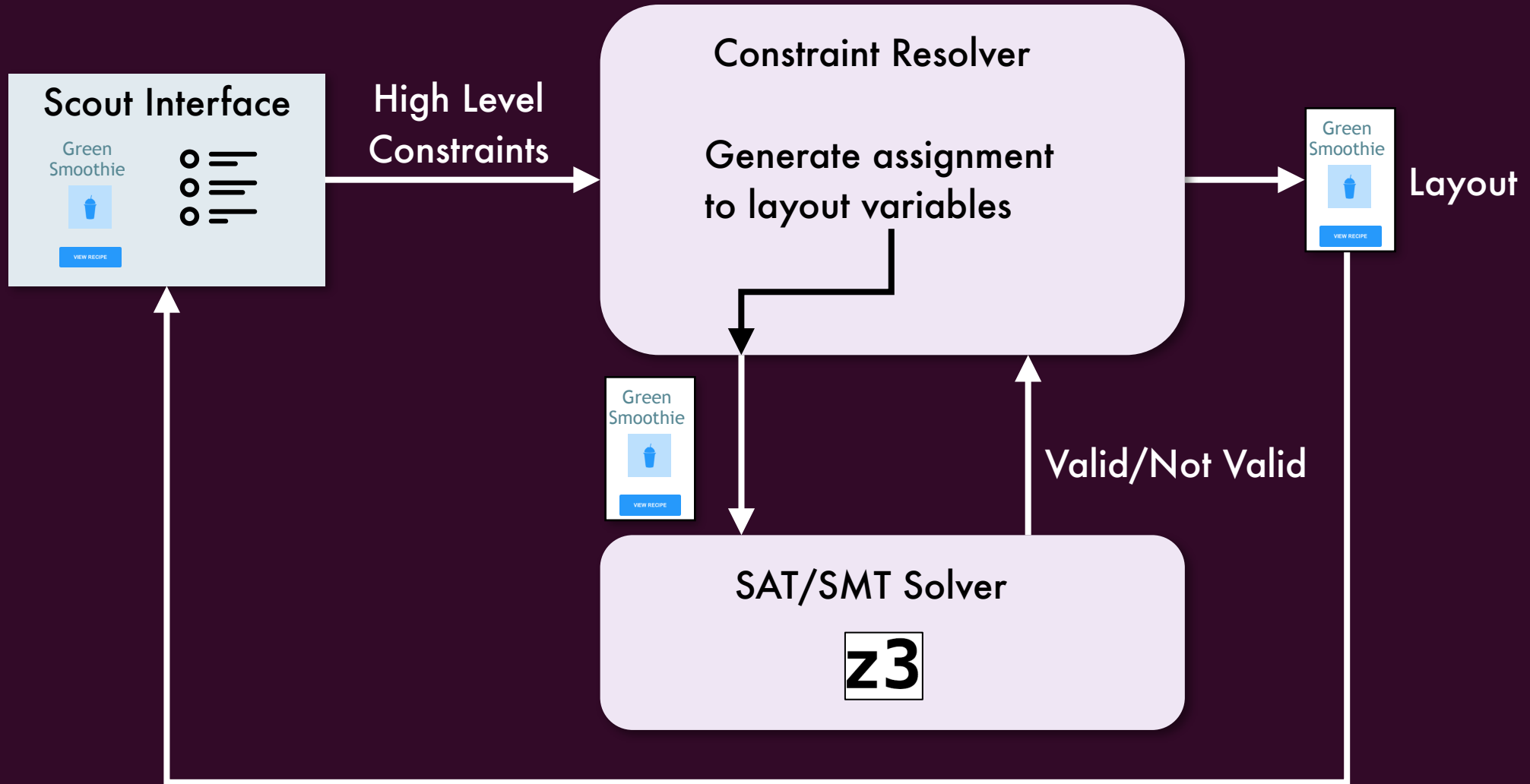
Layout Ideas 35 Under Consideration 3 Saved 29 Discarded

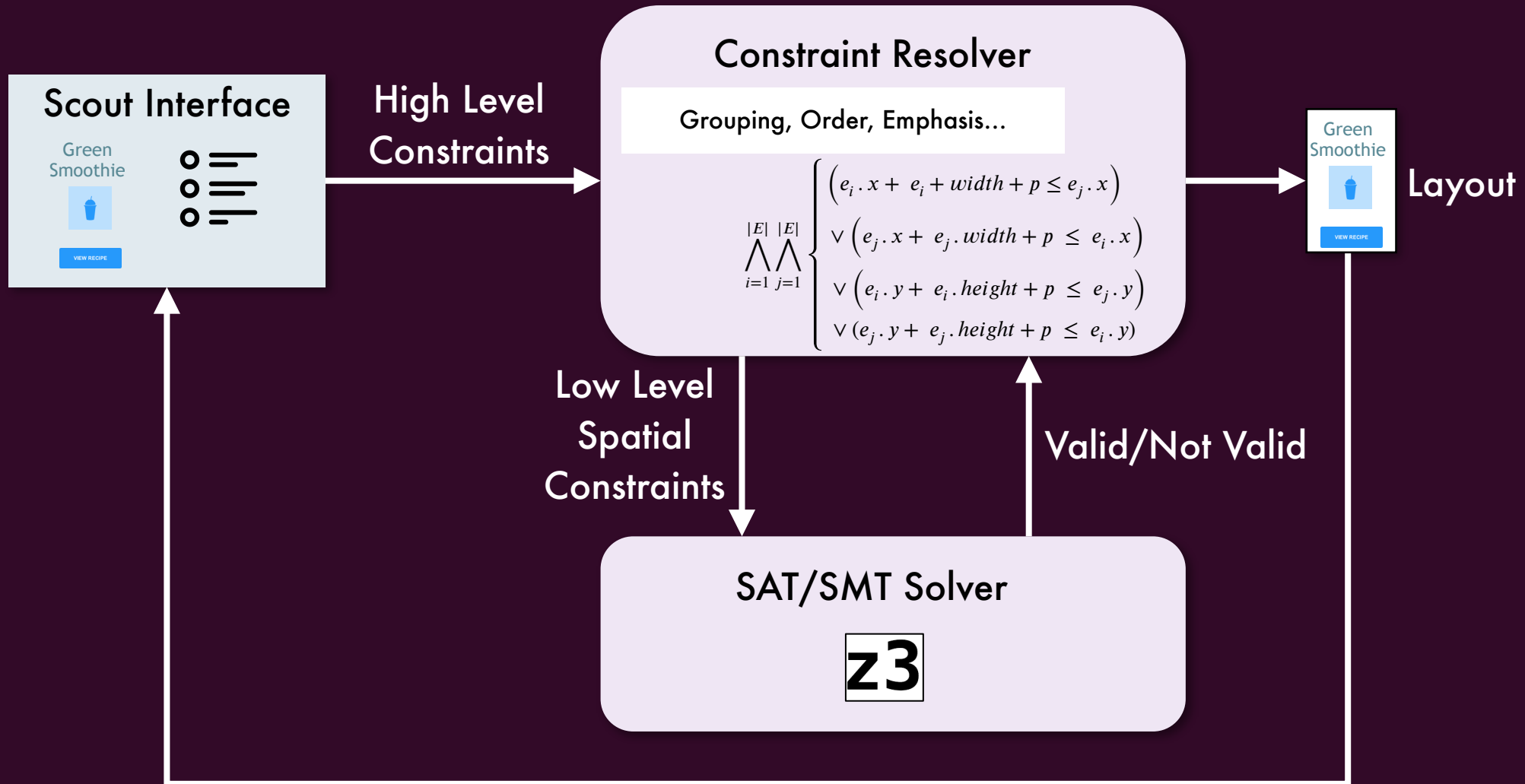
Discard Invalid Ideas Export Saved Ideas

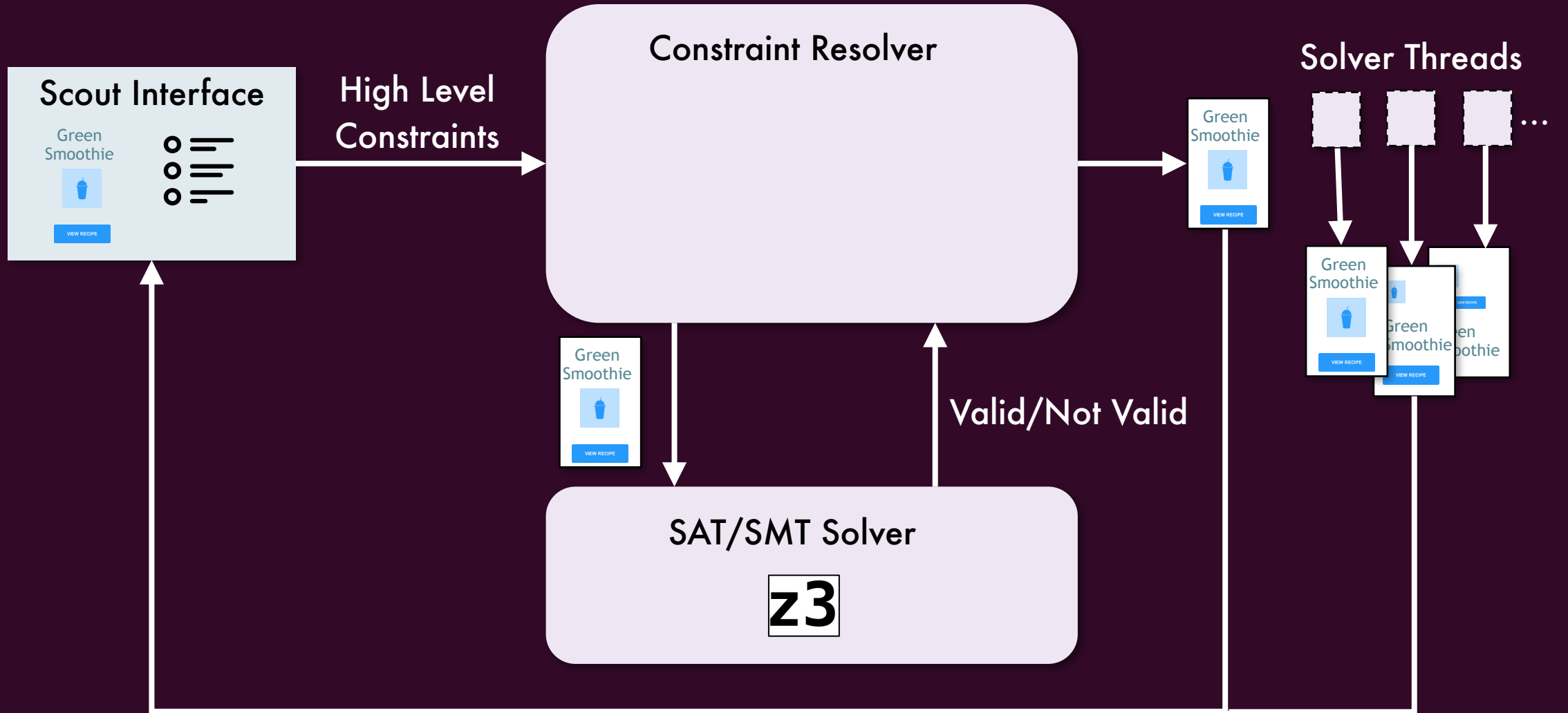
Select an element in the Outline Panel or in a layout idea canvas to the right to see feedback options.

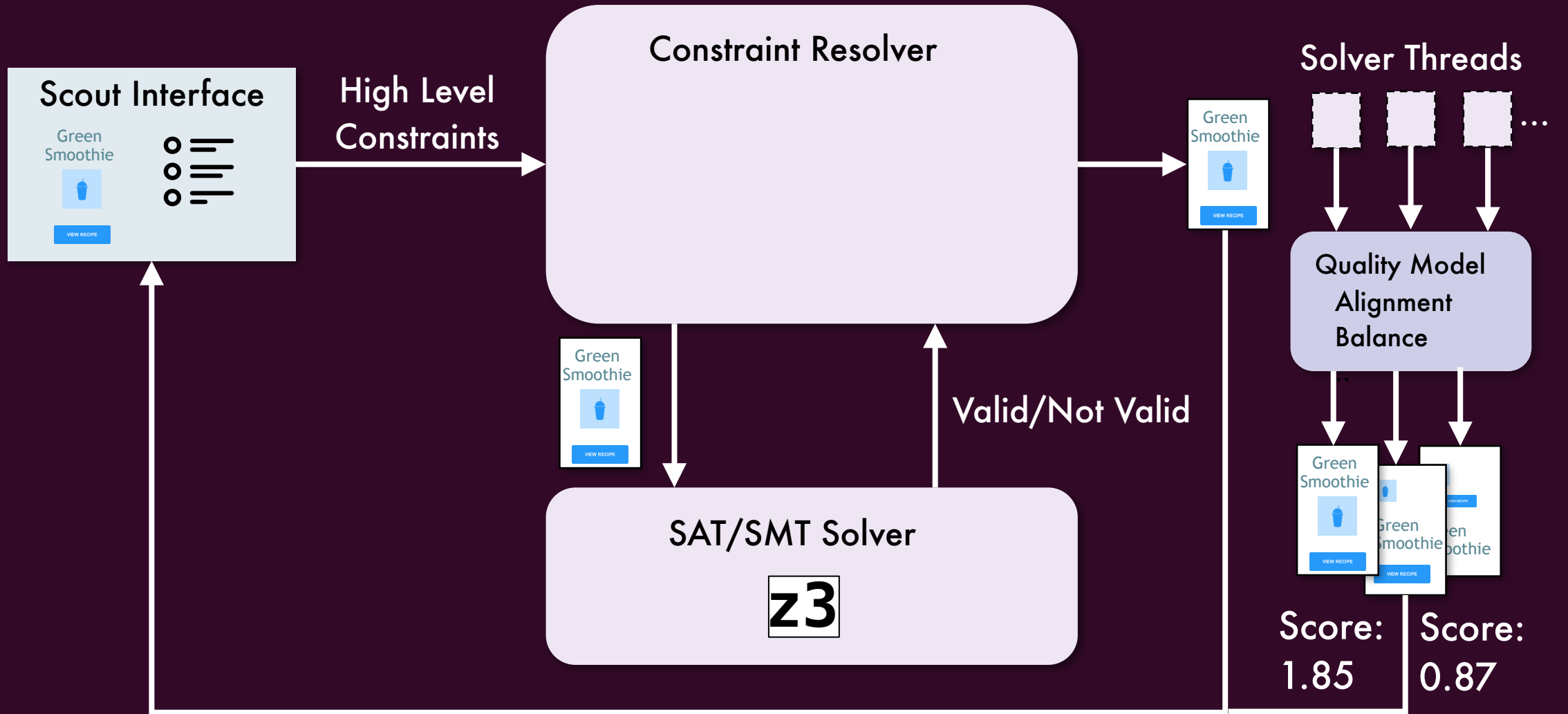


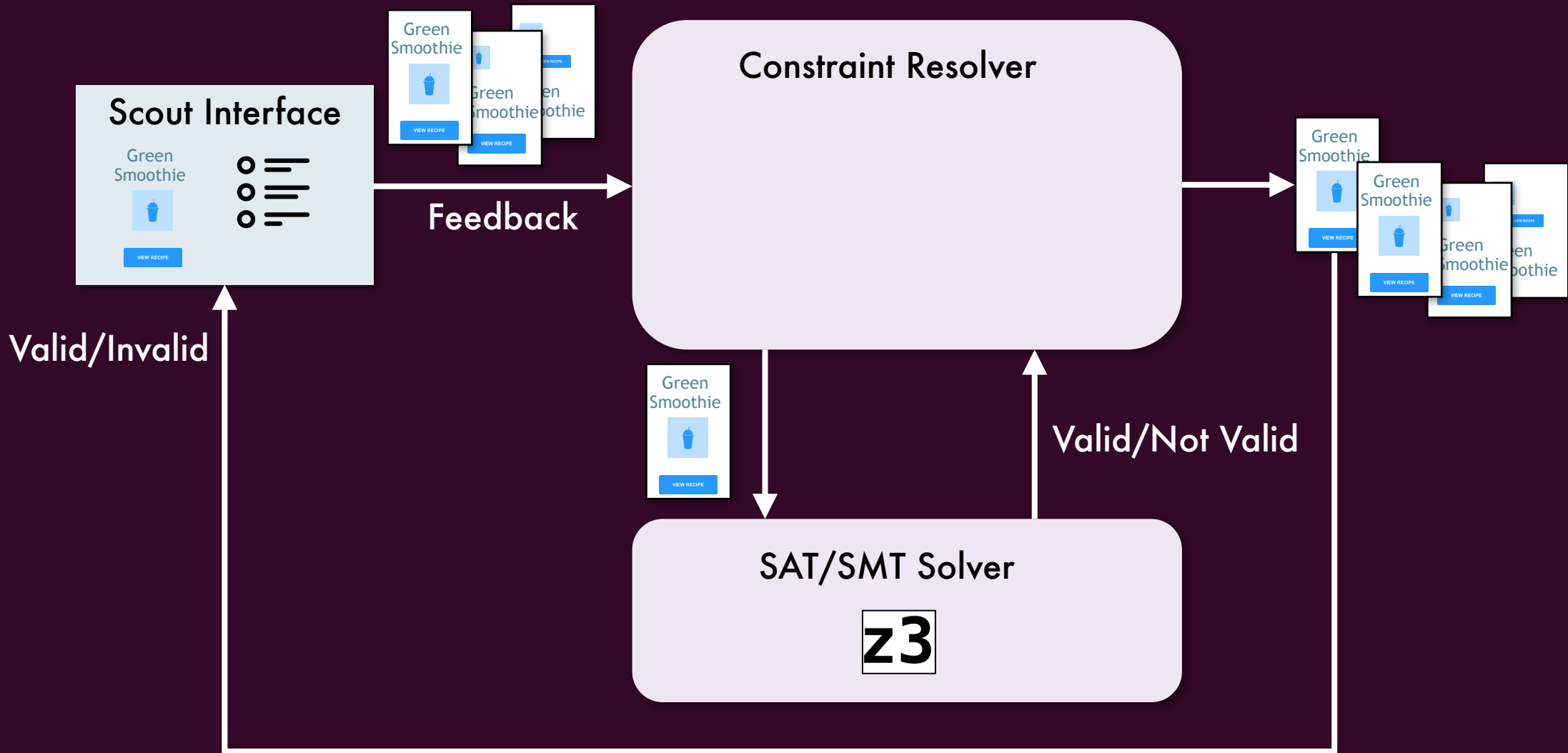
Architecture











Evaluation



18 Interface Designers

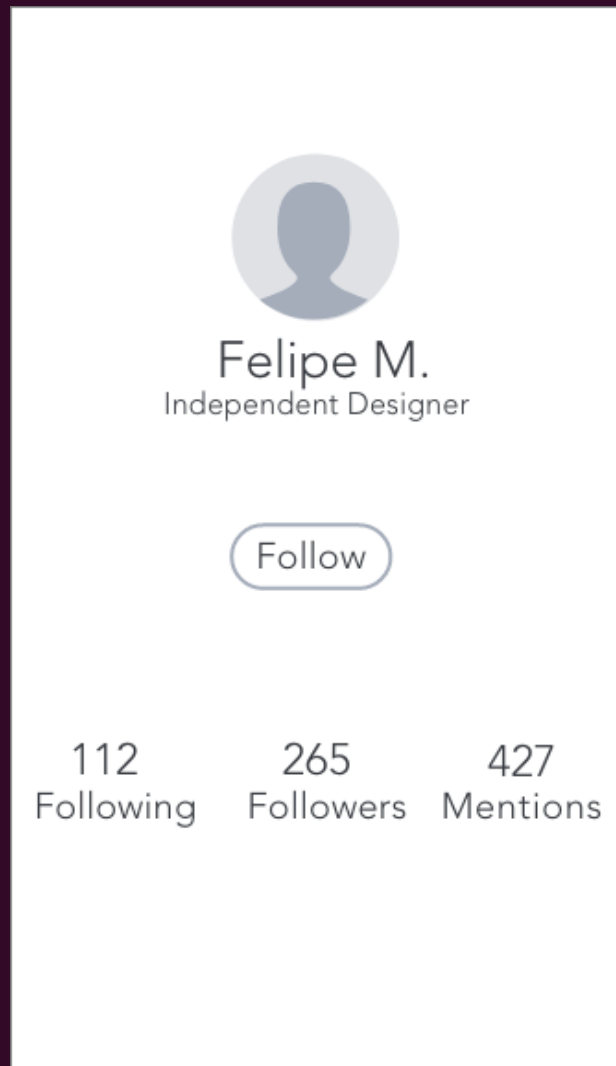
Evaluation Research Questions

RQ1: Does Scout help designers generate more diverse interface layouts?

RQ2: Does Scout help designers generate higher quality interface layouts?

RQ3: How does Scout affect designer processes of exploring potential interface layouts?

Scout Evaluation - Designers' Task



Redesign the layout of a mobile app design wireframe.

Task: Create 3 diverse alternative layouts

Desirability Study¹ Keywords

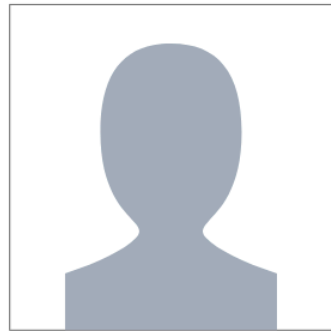
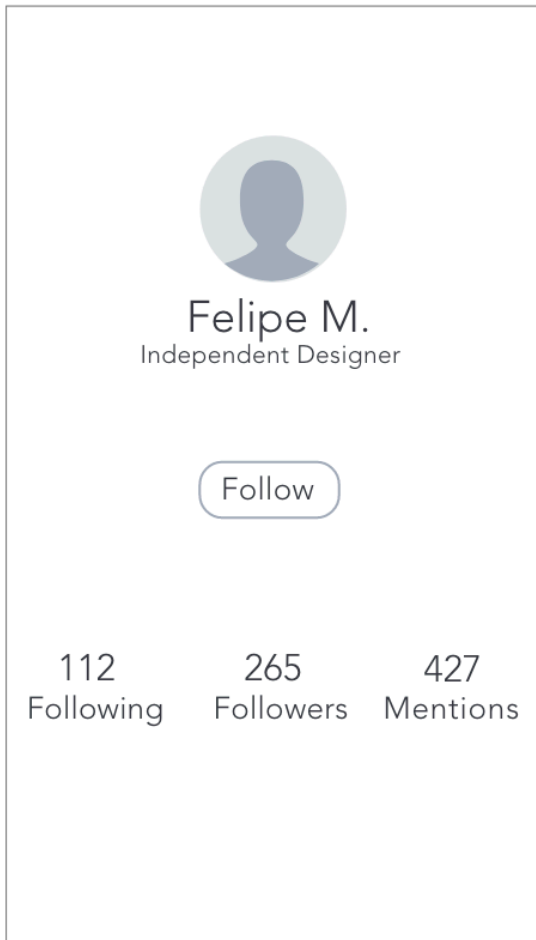
"dull" "familiar"

Goal Keywords

"clean" "compelling"

Scout Evaluation – 2 Scenarios

Social Media

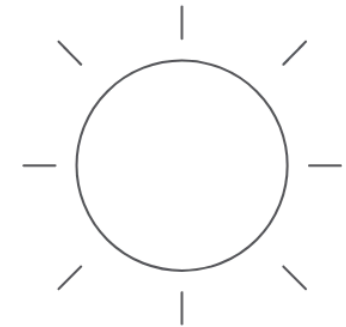
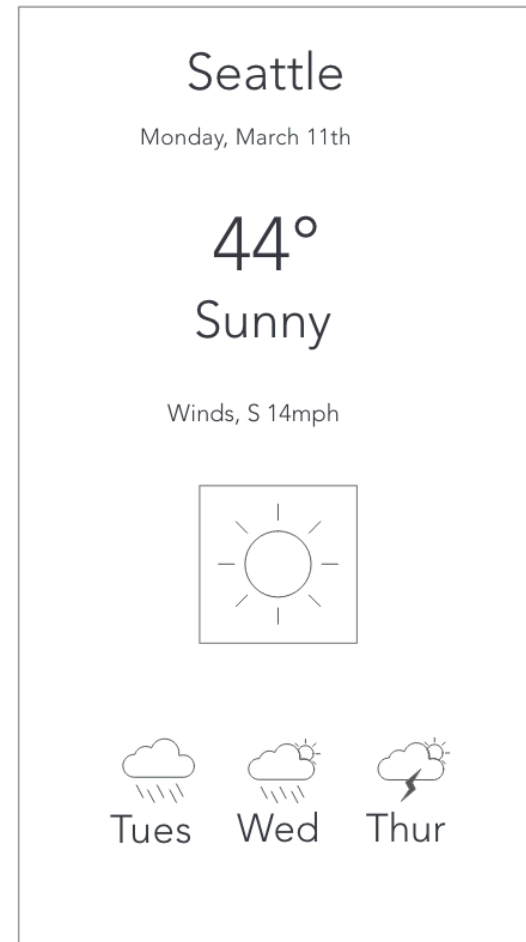


Profile Picture
Alternate 1



Profile Picture
Alternate 2

Weather



Sunny Icon
Alternate 1



Sunny Icon
Alternate 2

Scout Evaluation – 2 Conditions

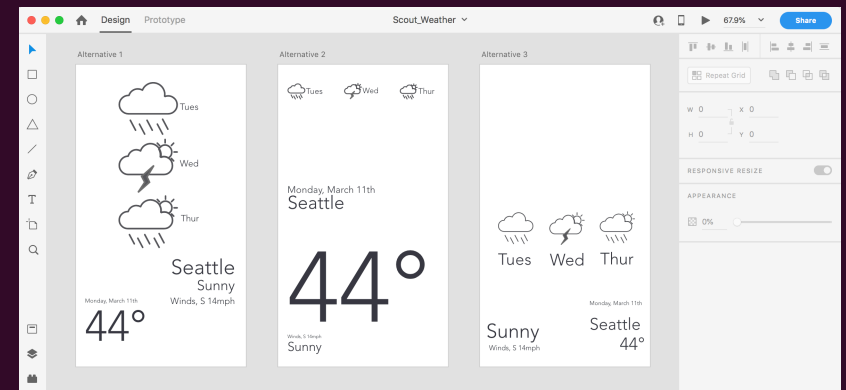
Scout Task

- Use Scout and save 3 designs (20 minutes)
- Export to Adobe XD for refinement (10 minutes)



Baseline Task

- Scratch paper
- Create 3 alternatives in Adobe XD

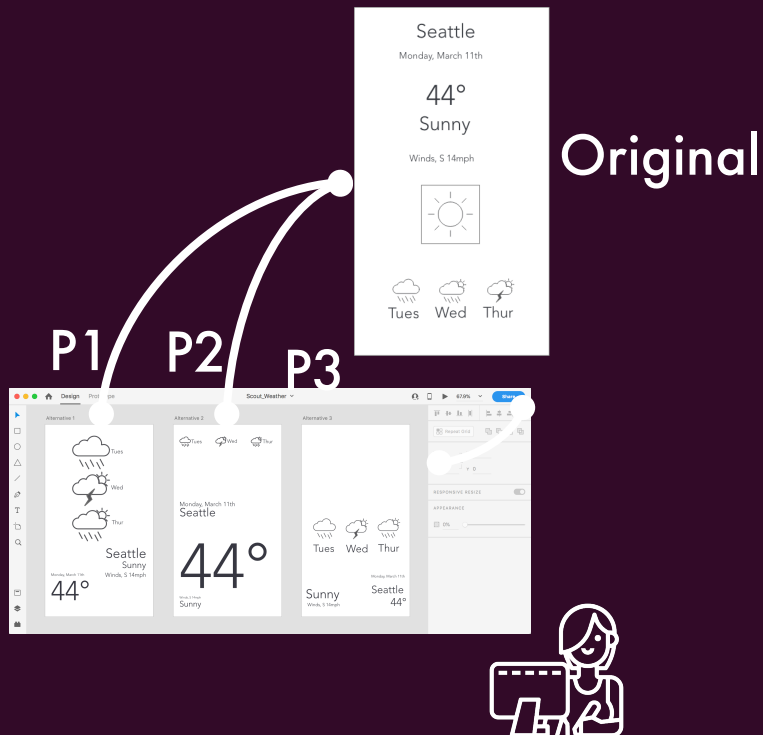


RQ1: Does Scout help designers generate more diverse interface layouts than with a baseline tool?



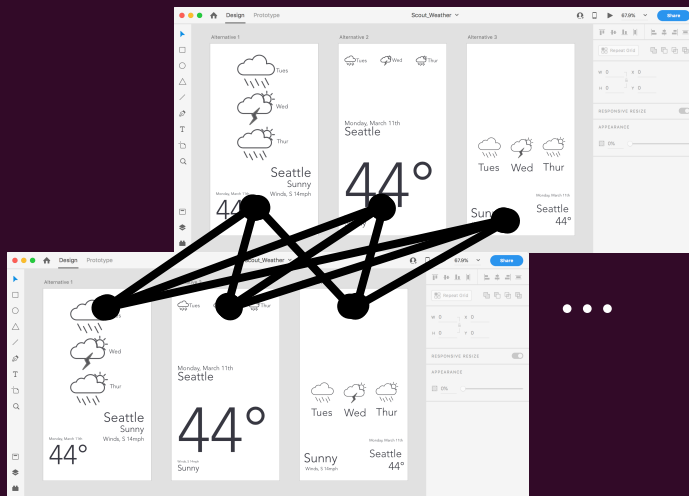
Scout layouts were 12% more spatially diverse from than the Baseline pairs (n=54, $p < 0.027$)

RQ1: Does Scout help designers generate more diverse interface layouts than with a baseline tool?



Scout layouts were 15% more spatially diverse from the Original layout than the Baseline pairs (n=54, $p < 0.023$)

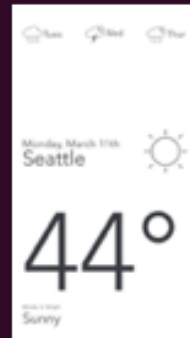
RQ1: Does Scout help designers generate more diverse interface layouts than with a baseline tool?



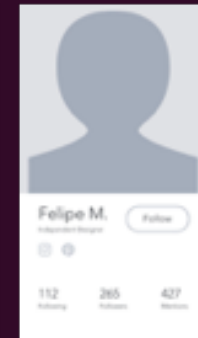
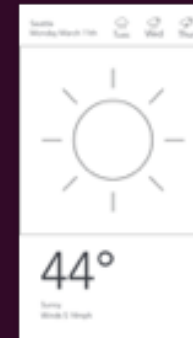
Scout increased the overall mean spatial diversity by 25% for Social Media and 10% for Weather. ($n = 351, p < 0.0001$)



RQ2: Does Scout help designers generate higher quality interface layouts?



Scout Designs



Baseline Designs

No significant differences in quality.

RQ3: How does Scout affect designer processes of exploring potential interface layouts?



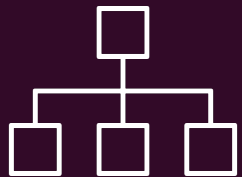
Scout helped designers think of new ideas.

P18: "I thought, wow it's square and I don't like it, but because it said diverse and I had the option to easily look at different ideas with different shapes, I was more open to it. If I had done this on my own, I probably would have used the circle and nothing else."

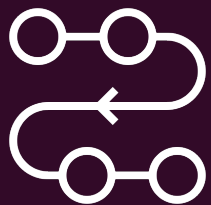
RQ3: How does Scout affect designer processes of exploring potential interface layouts?



Designers would use Scout to quickly ideate or visualize layouts or to get unstuck.



Designers used more structured, less linear design process with Scout (2) vs Baseline (12).



Reflecting on past approach to creating alternatives:

P21: "It's something I need to work on. Usually I just end up work on one [idea] and then iterating on that single idea."

Scout: Rapid Exploration of Interface Layout Alternatives through High-Level Design Constraints

Amanda Swearngin

Chenglong Wang

Alannah Oleson

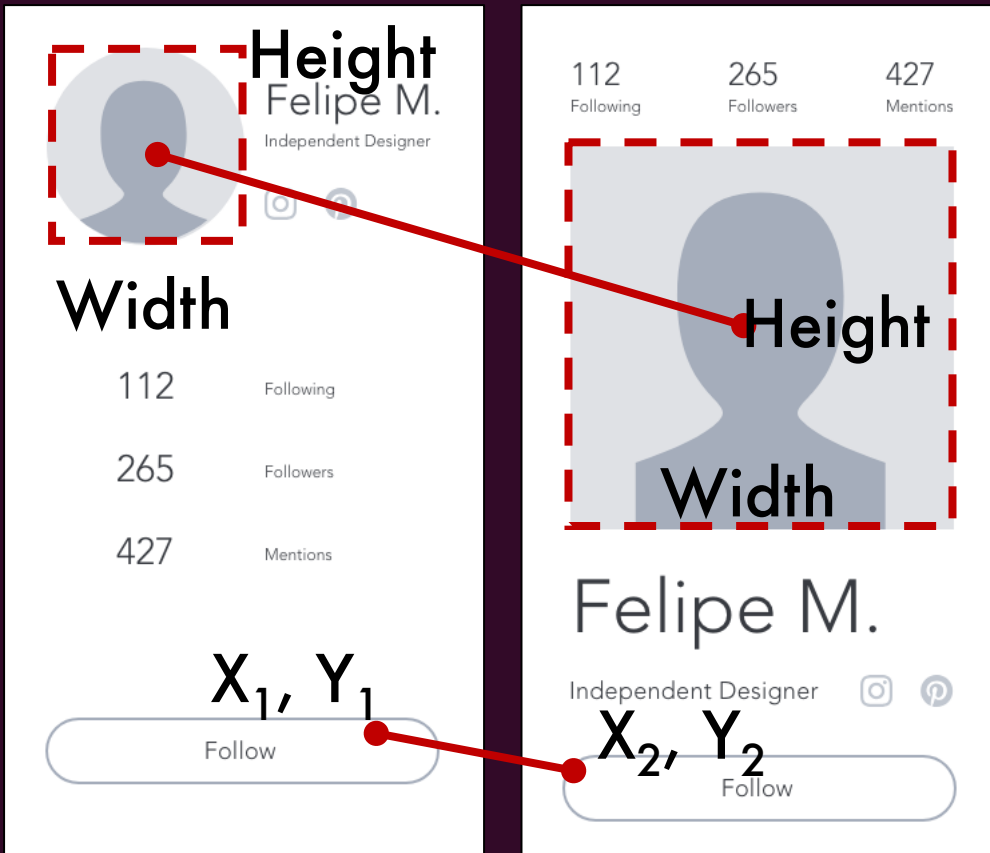
Amy Ko

James Fogarty

Key Takeaways

- Designers can use high-level constraints to rapidly explore layout alternatives.
- Scout can help designers explore more spatially diverse layout ideas.
- Scout can make the process of exploring alternatives more structured & less linear, and help designers think of new & divergent ideas.

RQ1: Does Scout help designers generate more diverse interface layouts?



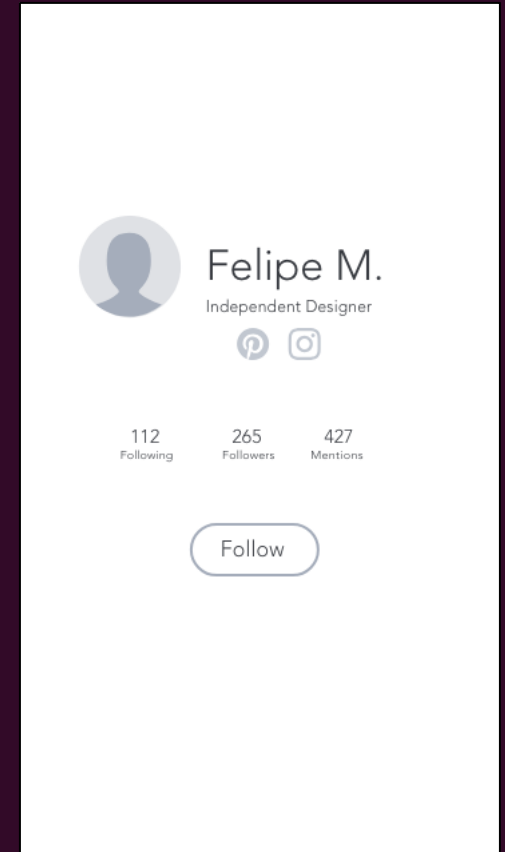
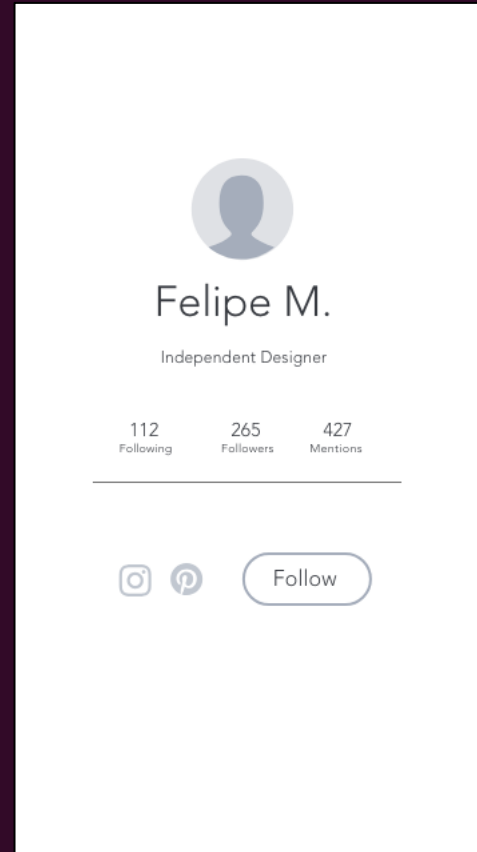
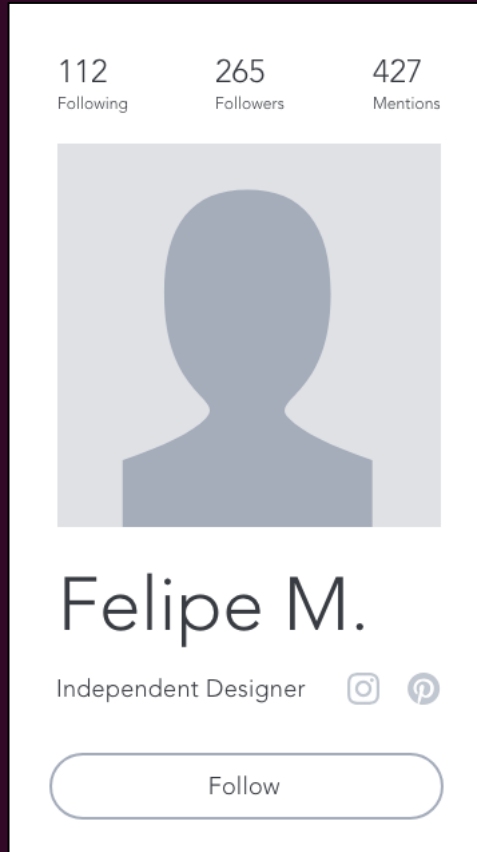
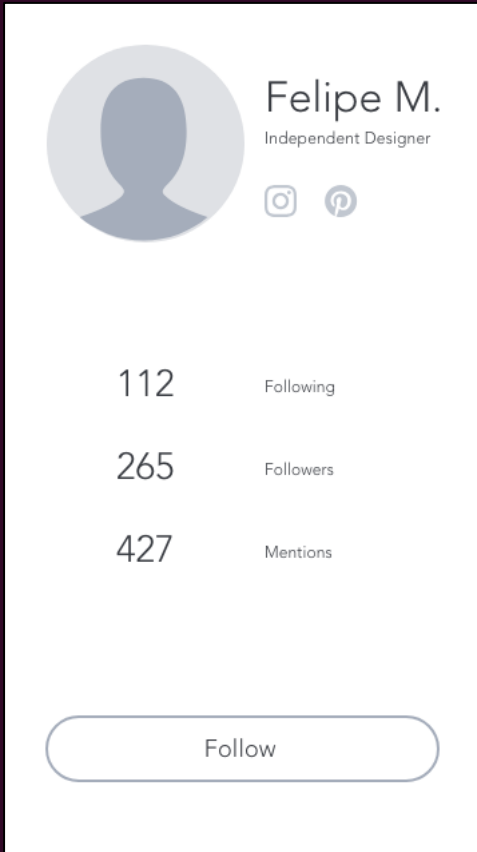
“More diverse” ?

Spatial Diversity Metric

Measure of how much size, position, relationship to other elements changed

$$S_{diversity} = w_{dist} * s_{dist} + w_{size} * s_{size} + w_{rel} * s_{rel}$$

RQ1: Does Scout help designers generate more diverse interface layouts than with a baseline tool?



Spatial Diversity = 1.53

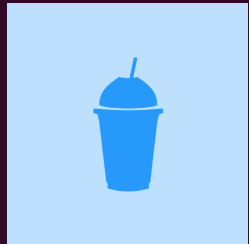
Spatial Diversity = 0.194

$$S_{diversity} = w_{dist} * s_{dist} + w_{size} * s_{size} + w_{rel} * s_{rel}$$

RQ1 and RQ2 Summary

Scout helped designers explore a more spatially diverse set of layout ideas, within and across designers, with similar quality to layouts created with a baseline tool.

Scout – Importing Elements






VIEW RECIPE



Widgets Clear Widgets

(Separator)



Green Smoothie

By Zoey M.

14 MIN

88 CAL

VIEW RECIPE

Drag and drop your SVG interface elements here.

Outline See more layout ideas




Canvas

Order Unimportant

Remove all feedback

Alternate

Order Unimportant High Emphasis



Group

Order Important

Green Smoothie

By Zoey M.

Repeat

Order Important Low Emphasis

Keep arrangement horizontal.

Item

Order Unimportant

14 MIN

Item

Order Unimportant

VIEW RECIPE

Feedback

Order Important **ON**

Emphasis **Normal**

Size **328x170** Keep Prevent

Grid Layout & Placement

Left Column **1** Keep Prevent

Right Column **3** Keep Prevent

Y **448** Keep Prevent

Canvas Alignment **Right** Keep Prevent

Arrangement **Vertical** Keep Prevent

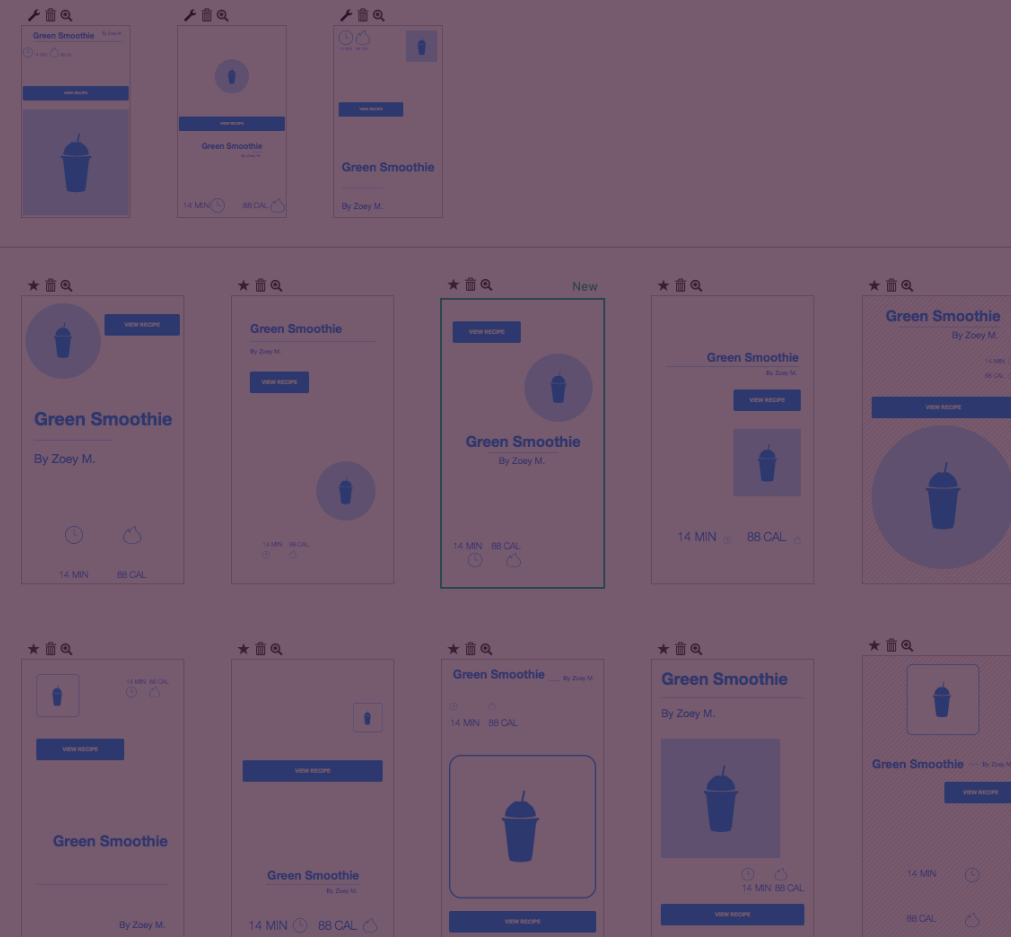
Alignment **Top-Left** Keep Prevent

Padding **44** Keep Prevent

Group Alignment **Center** Keep Prevent

Layout Ideas 10 Under Consideration 3 Saved 115 Discarded

Discard Invalid Ideas Export Saved Ideas



Scout – Defining High-Level Constraints

The image displays the Scout design tool interface, divided into several panels:

- Widgets Panel:** Shows a list of widgets for a "Green Smoothie" recipe card, including a separator, three instances of a smoothie icon, the title "Green Smoothie", author "By Zoey M.", time "14 MIN", calories "88 CAL", and a "VIEW RECIPE" button.
- Outline Panel:** Shows a hierarchical tree of the widget structure. It includes a "Canvas" container, an "Alternate" group with three icons, a "Group" containing the title and author, a "Repeat" group with one instance of the time and calories widget, and another "Item" with the recipe button. A red arrow points from the "Repeat" group to the "Feedback" panel.
- Feedback Panel:** Lists various constraints for the design:
 - Order Important:** ON
 - Emphasis:** Normal
 - Size:** 328x170 (Keep Prevent)
 - Grid Layout & Placement:**
 - Left Column:** 1 (Keep Prevent)
 - Right Column:** 3 (Keep Prevent)
 - Y:** 448 (Keep Prevent)
 - Canvas Alignment:** Right (Keep Prevent)
 - Arrangement:** Vertical (Keep Prevent)
 - Alignment:** Top-Left (Keep Prevent)
 - Padding:** 44 (Keep Prevent)
 - Group Alignment:** Center (Keep Prevent)
- Layout Ideas Panel:** Displays a grid of 15 different layout variations for the recipe card, with 10 under consideration, 3 saved, and 115 discarded. A red arrow points from the "Repeat" group in the Outline panel to the "Feedback" panel.



High-Level Constraints

RQ3: New and Different Ideas

9 designers mentioned Scout helped them come up with a **new idea** they didn't think they would have had on their own.

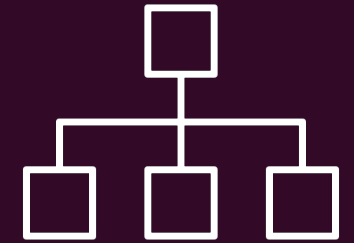


11 designers noted that Scout designs were different than a typical Weather or Social Media app screen

P18: "I thought, wow it's square and I don't like it, but because it said diverse and I had the option to easily look at different ideas with different shapes, I was more open to it. If I had done this on my own, I probably would have used the circle and nothing else."

RQ3: More structured and less linear process

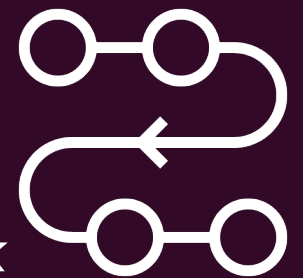
More designers mentioned or considered the interface structure with Scout (i.e., emphasis, grouping, order).



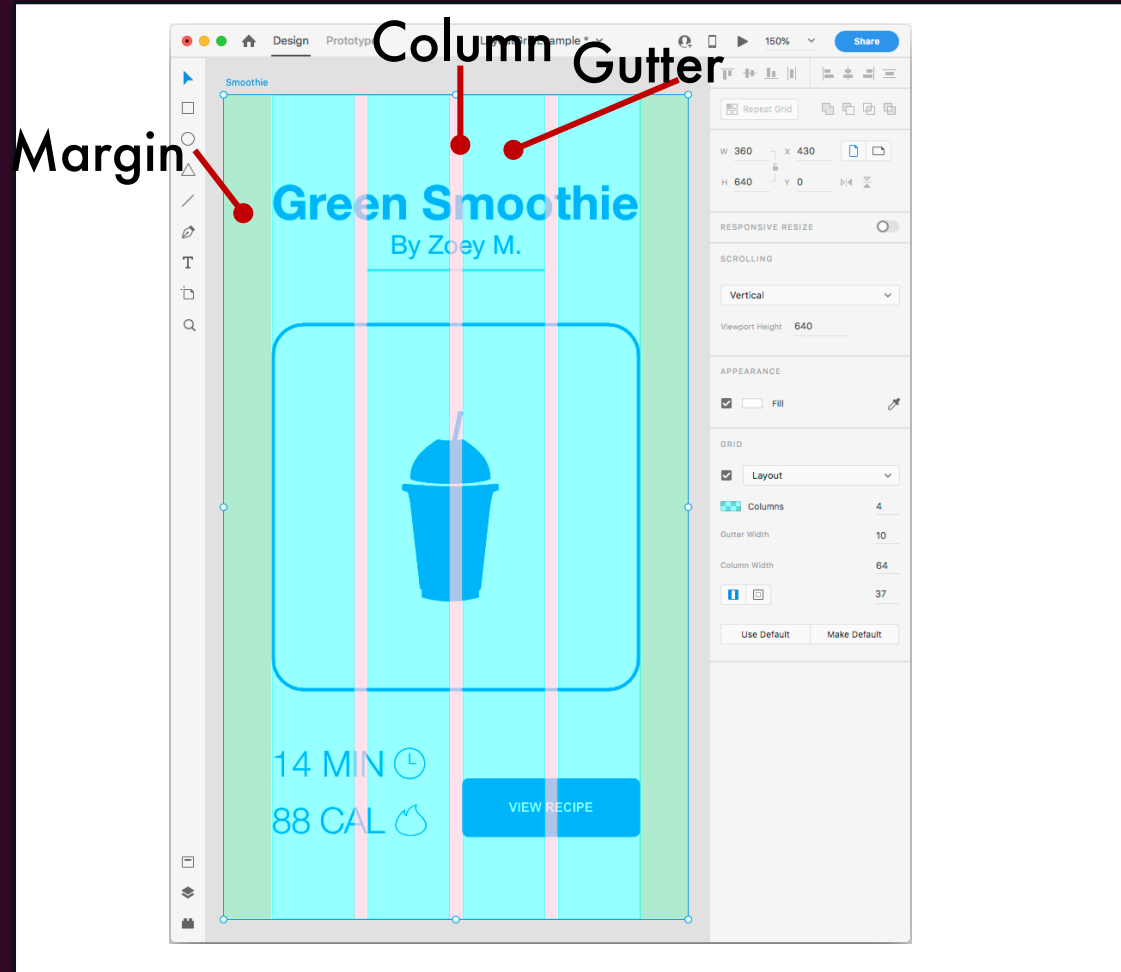
Less designers mentioned a linear design process to create alternatives with Scout (2) vs the Baseline (12).

Reflecting on past approach to creating alternatives:

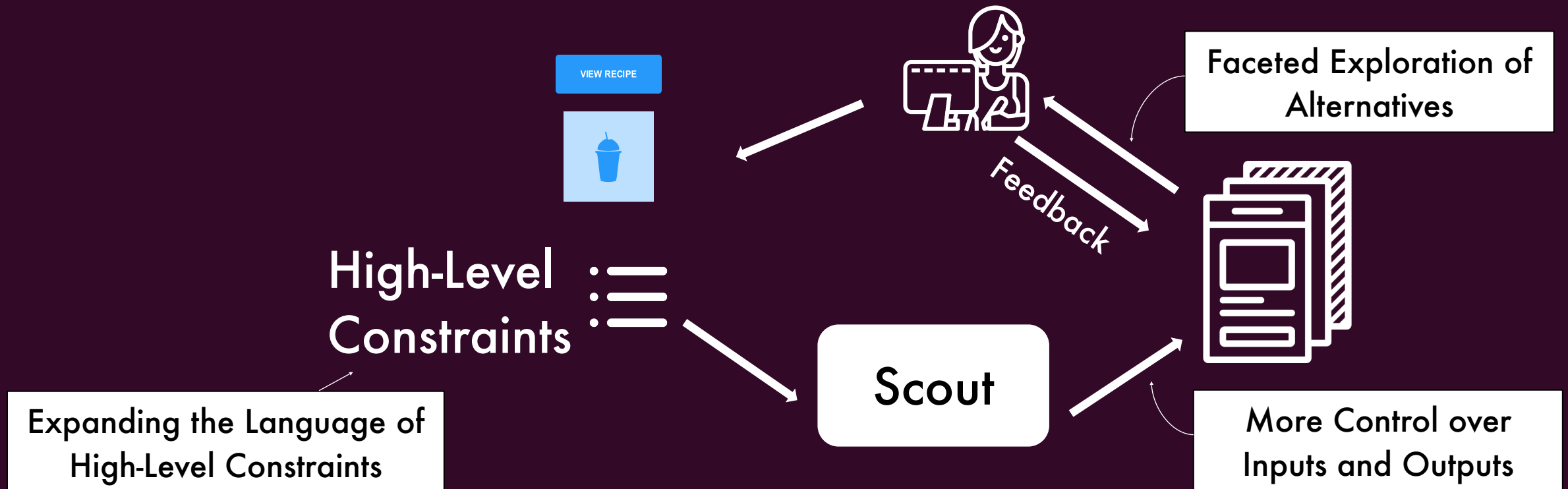
P21: "It's something I need to work on. Usually I just end up work on one [idea] and then iterating on that single idea."



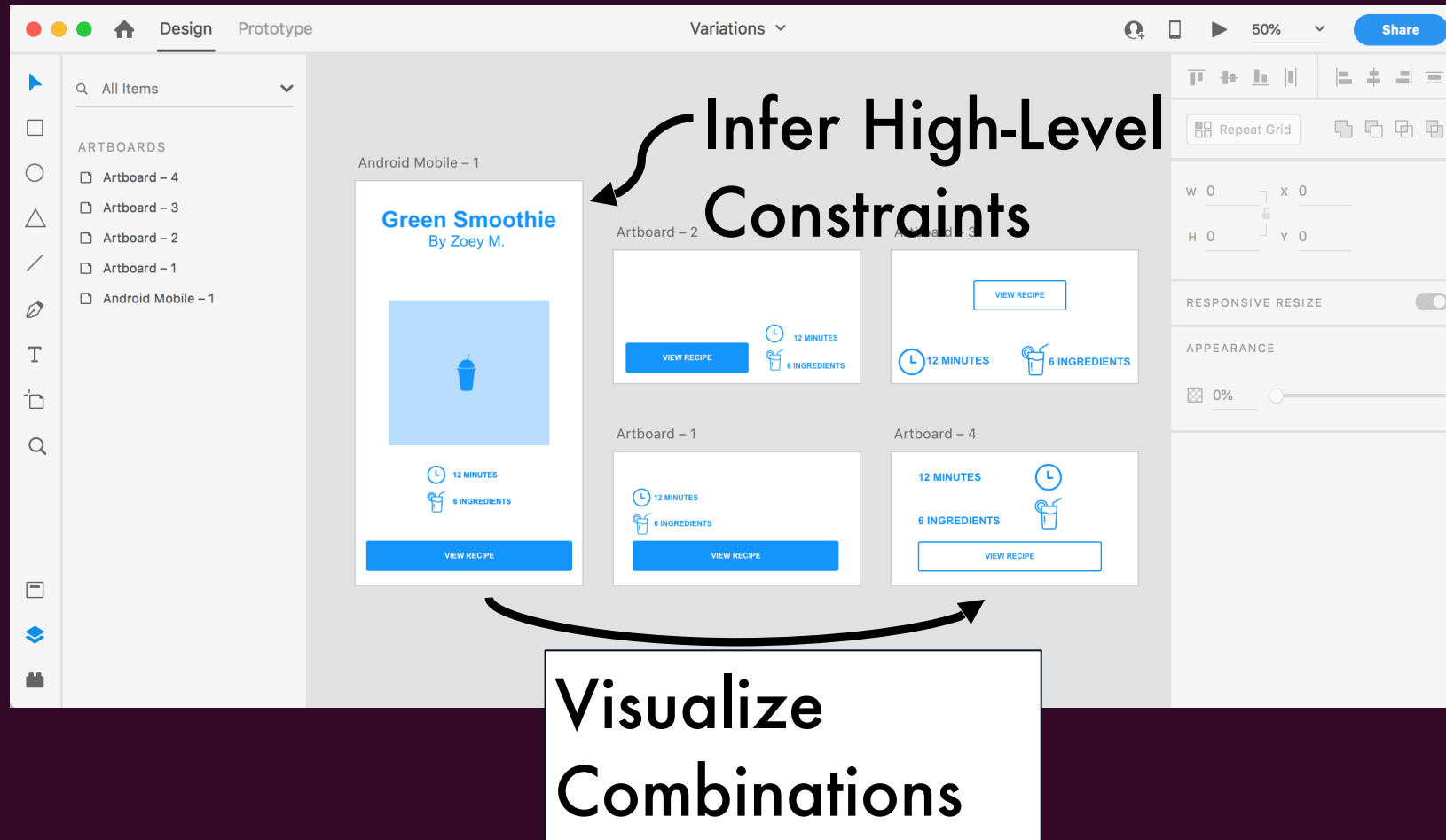
Architectural Insight – Layout Grids



Mixed Initiative Exploration of Alternatives



Inferring High-Level Constraints & Visualizing Combinations



Scout - Constraints

High-Level Constraints

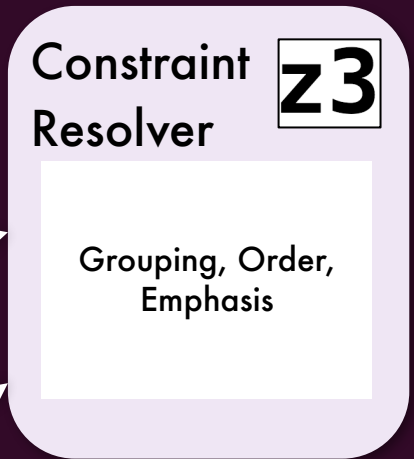
- Emphasis, Repeat/Alternate Group
- Grouping, Order, Arrangement

$$\bigwedge_{i=1}^{|E_c|} \left\{ \begin{array}{l} \text{above}(E_{c_i}, E_{c_{i+1}}) \vee \text{left}(E_{c_i}, E_{c_{i+1}}) \\ \text{if } c.\text{order} = \text{"important"} \end{array} \right.$$

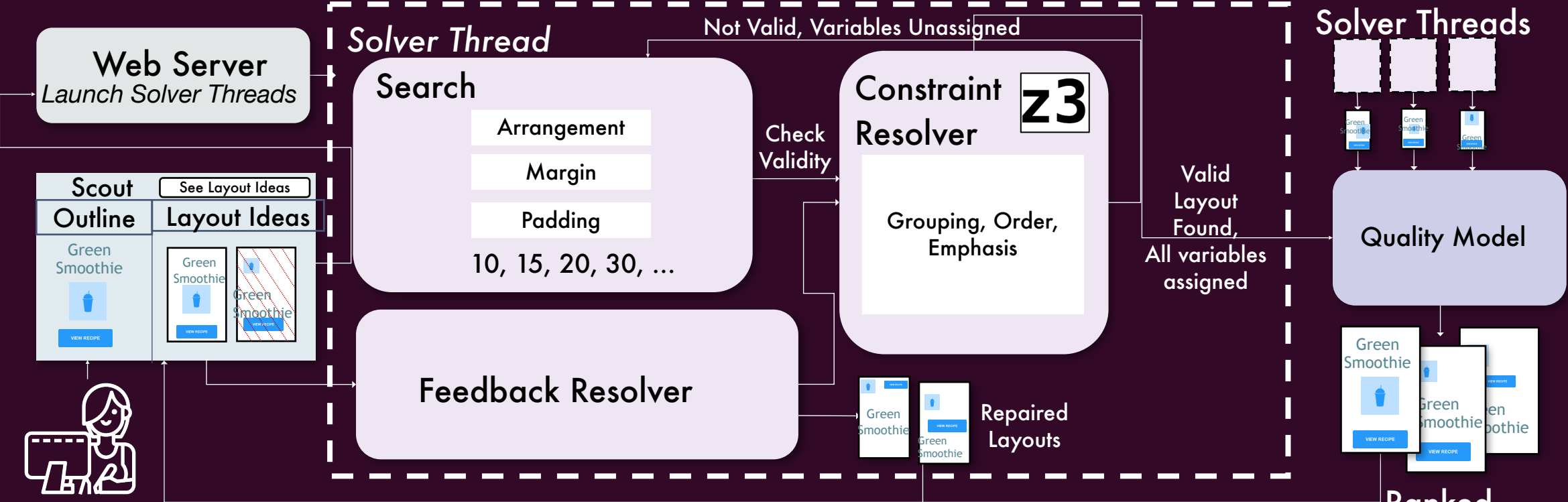
Quality Constraints

- Basic Design Quality
- Layout Grid
- Visual Hierarchy

$$\bigwedge_{i=1}^{|E|} \bigwedge_{j=1}^{|E|} \left\{ \begin{array}{l} (e_i.x + e_i.width + p \leq e_j.x) \\ \vee (e_j.x + e_j.width + p \leq e_i.x) \\ \vee (e_i.y + e_i.height + p \leq e_j.y) \\ \vee (e_j.y + e_j.height + p \leq e_i.y) \end{array} \right.$$

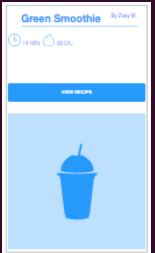


Generating Layouts from High-Level Constraints

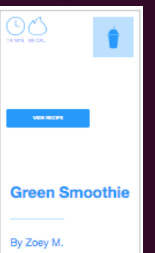


Designer

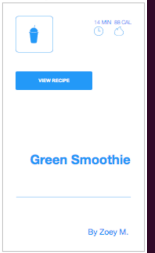
Score:
1.85



Score:
1.25

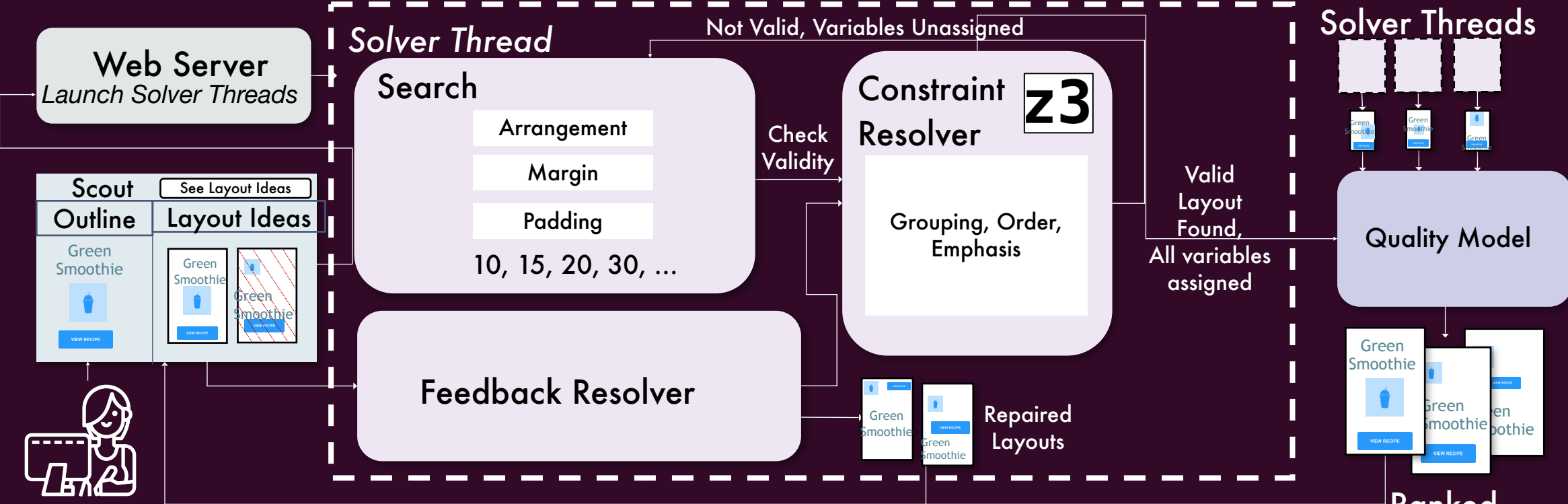


Score:
0.87



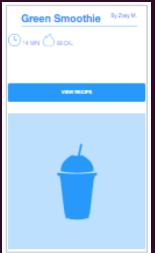
Alignment
Balance
Density

Generating Layouts from High-Level Constraints

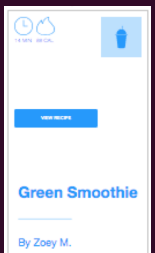


Designer

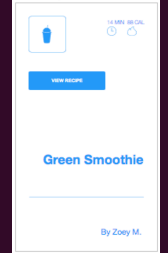
Score: 1.85



Score: 1.25



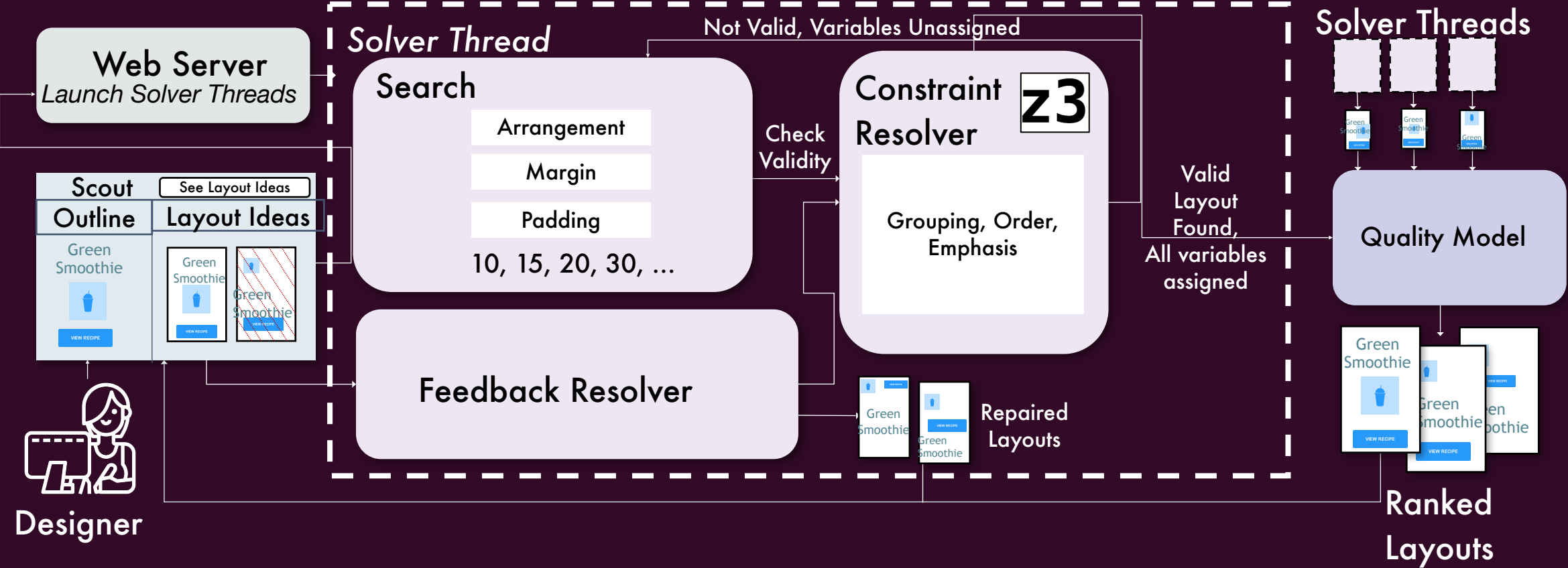
Score: 0.87



Alignment
Balance
Density

Ranked
Layouts

Generating Layouts from High-Level Constraints



Scout – Defining High-Level Constraints

The image shows a multi-panel design tool interface for creating a recipe card. The panels include:

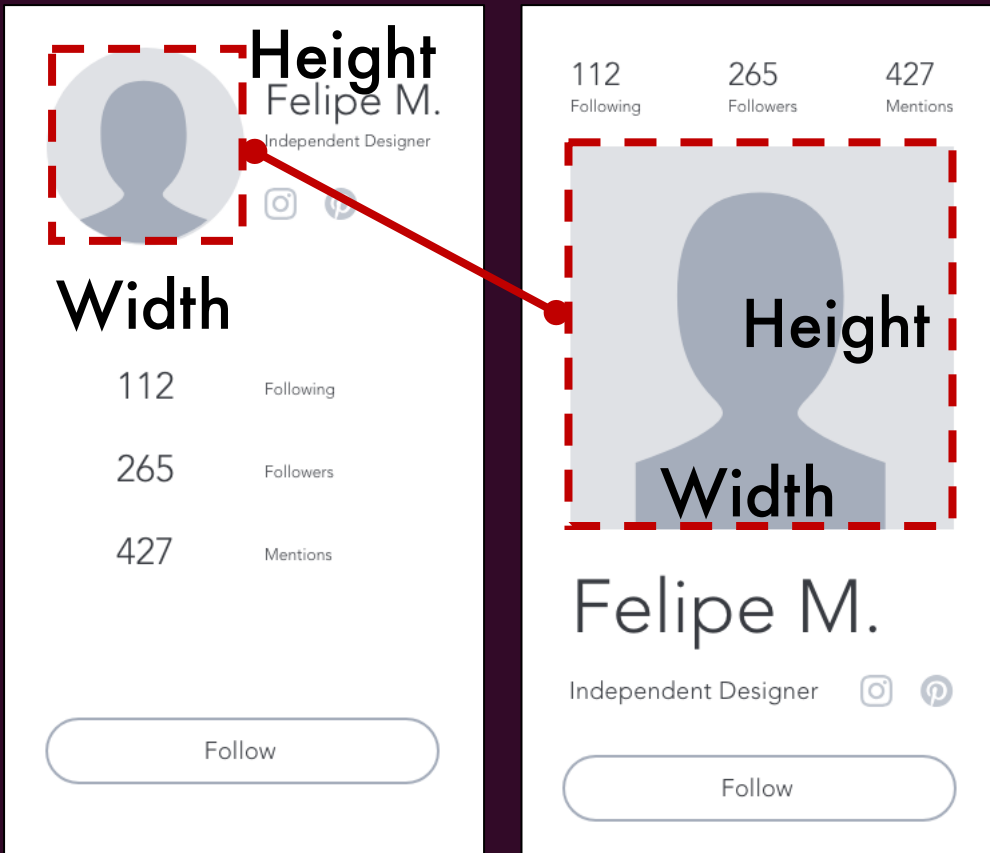
- Widgets:** A list of interface elements like a smoothie icon, text, and a button.
- Outline:** A hierarchical tree of the layout. The 'Group' containing the author name 'By Zoey M.' is highlighted in green with the text 'Order Important' and a red arrow pointing to it.
- Feedback:** A list of constraints such as 'Order Important' (ON), 'Emphasis' (Normal), and 'Size' (328x170).
- Layout Ideas:** A grid of different layout variations for the recipe card.
- Recipe Card Preview:** A final view of the recipe card with a smoothie icon, author name, title 'Green Smoothie', preparation time '14 MIN', calories '88 CAL', and a 'VIEW RECIPE' button.

Order - Important

Principle: Keep elements in order used for a task¹

1. Nielsen and Molich, "Heuristic Evaluation of User Interfaces", CHI '90

RQ1: Does Scout help designers generate more diverse interface layouts than with a baseline tool?

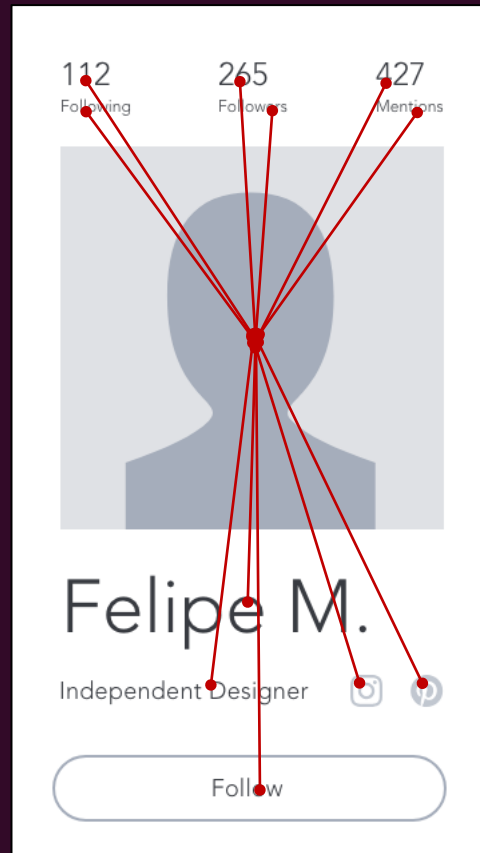
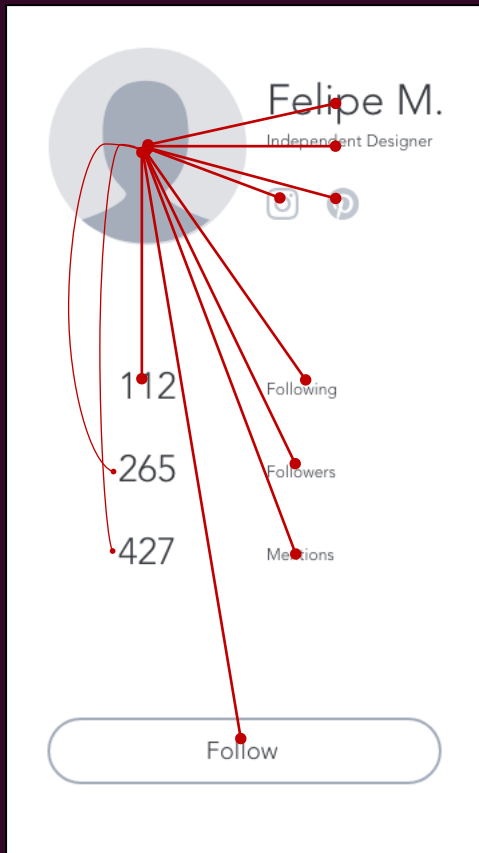


Spatial Diversity Metric

Mean of how much the position of each element changed.

Mean of how much the size of each element changed.

RQ1: Does Scout help designers generate more diverse interface layouts than with a baseline tool?



Spatial Diversity Metric

Mean of how much the position of each element changed.

Mean of how much the size of each element changed.

Mean of how much each element changed in relation to all other elements in the layout.

RQ3: How do designers envision using Scout?

14 designers said they would use Scout to quickly ideate or visualize layouts or to get unstuck.



P5: "I wanted to see a bunch of different things upfront, just to see if different concepts would even work...[P5 describes different ways they moved the elements around the screen.] It would have been nice to quickly see that, like, I didn't want every [element] up there [top of screen], I just wanted profile picture, name and title."

RQ3: Impact on Diversity and Quality

12 designers thought Scout designs were *more diverse*.



Majority of designers thought Scout designs were *more compelling*, but *less clean*.

P4: *“It does a good job with the compelling thing...The hierarchy is not dull or boring or and to some extent is not even familiar. ... Like this [Scout design], it breaks [design] cliches, that's for sure. It does a good job of not being boring...”*

RQ2: Does Scout help designers of varying expertise generate higher quality interface layouts than with a baseline tool?

2 expert designers (>3 years professional experience)



Rubric Items

Scale

Visual Balance

Great - 2

Typographical Hierarchy

Good - 1

Clear Point of Emphasis

Needs Improvement - 0

Alignment

Whitespace

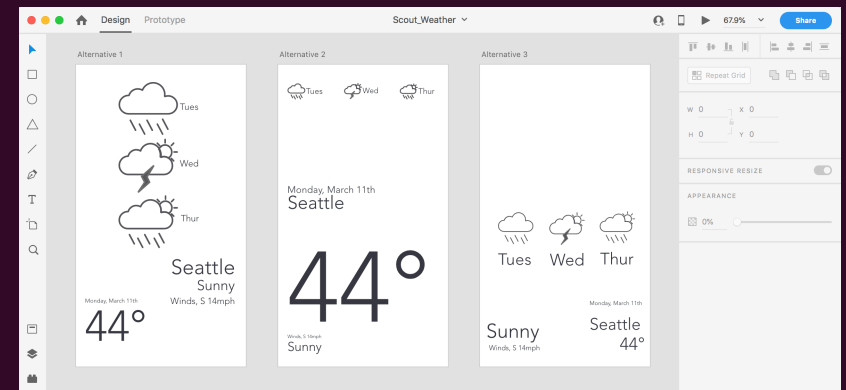
Scout Evaluation – Process

Tutorial & Warmup Task

2 30-Minute Redesign Tasks

- 1 per scenario, counterbalanced

Interview after each task & at end of study



RQ3: Designers' Suggestions for Improvement

Give designers more control over the inputs and outputs to Scout.

Make it easier to combine sub-parts of different layouts (i.e., mix and match).

Scaffold designers learning of high-level constraints and feedback better (e.g., preview or tooltips for feedback properties).



Emphasis Constraints

$$\phi_{size_increase_or_decrease_only}(E, c) = \bigwedge_{i=1}^{|E|} \bigwedge_{j=1}^{|E|} \begin{cases} e_i.area > e_i.orig - area & \text{if } e_i.emph = \text{"high"} \\ e_i.area < e_i.orig - area & \text{if } e_i.emph = \text{"low"} \end{cases}$$

$\phi_{order_before_or_after}$

...