From Fully Manual to Mostly Automated – Zillow Floor Map Annotation Tools

Zillow Group – 2021& 2022

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Context

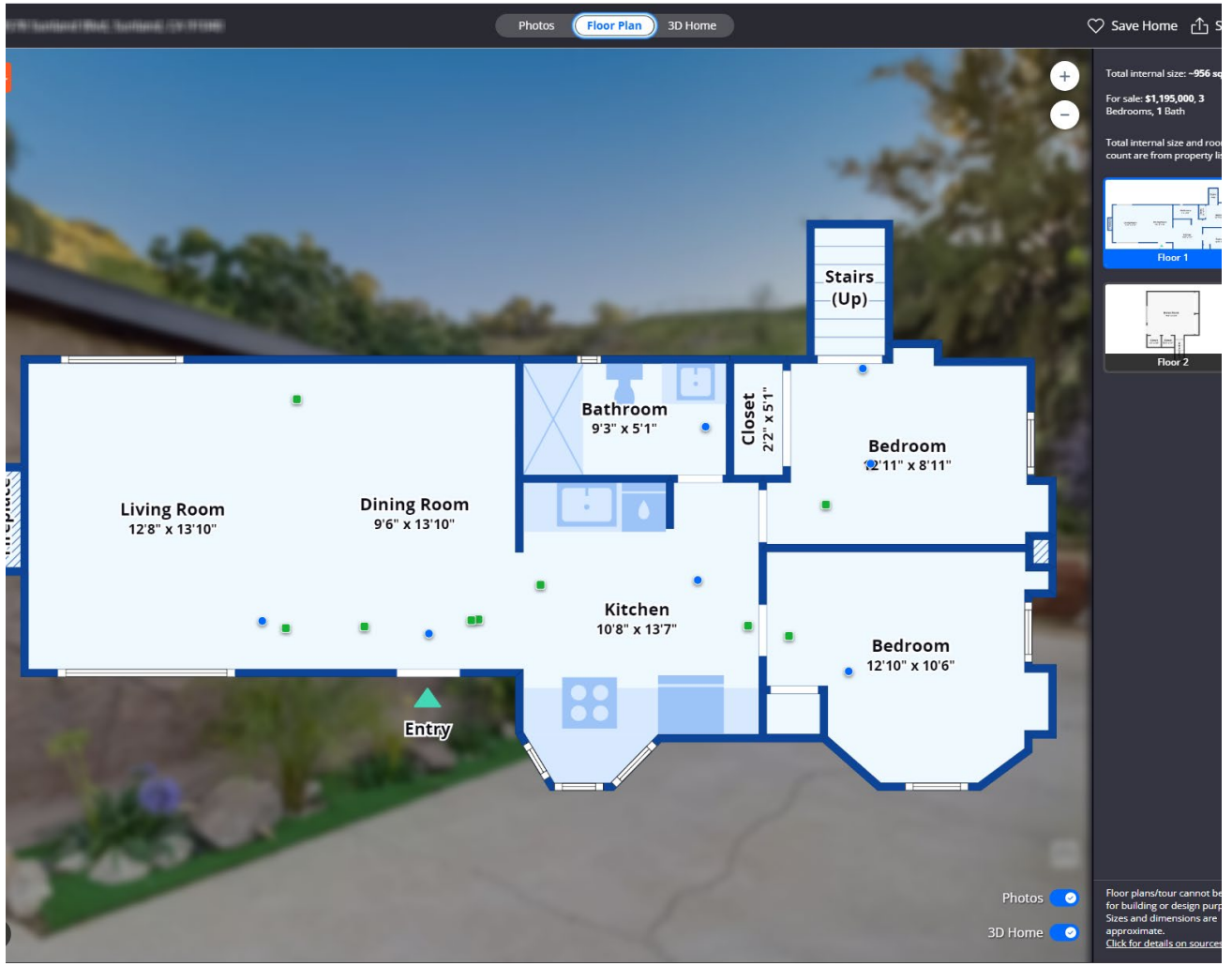
By early 2021, Zillow began to offer the creation of floor plans using the Zillow 3D Home app.

Behind the scenes, these floor plans were created manually by annotators using an in-house tool created by engineers.

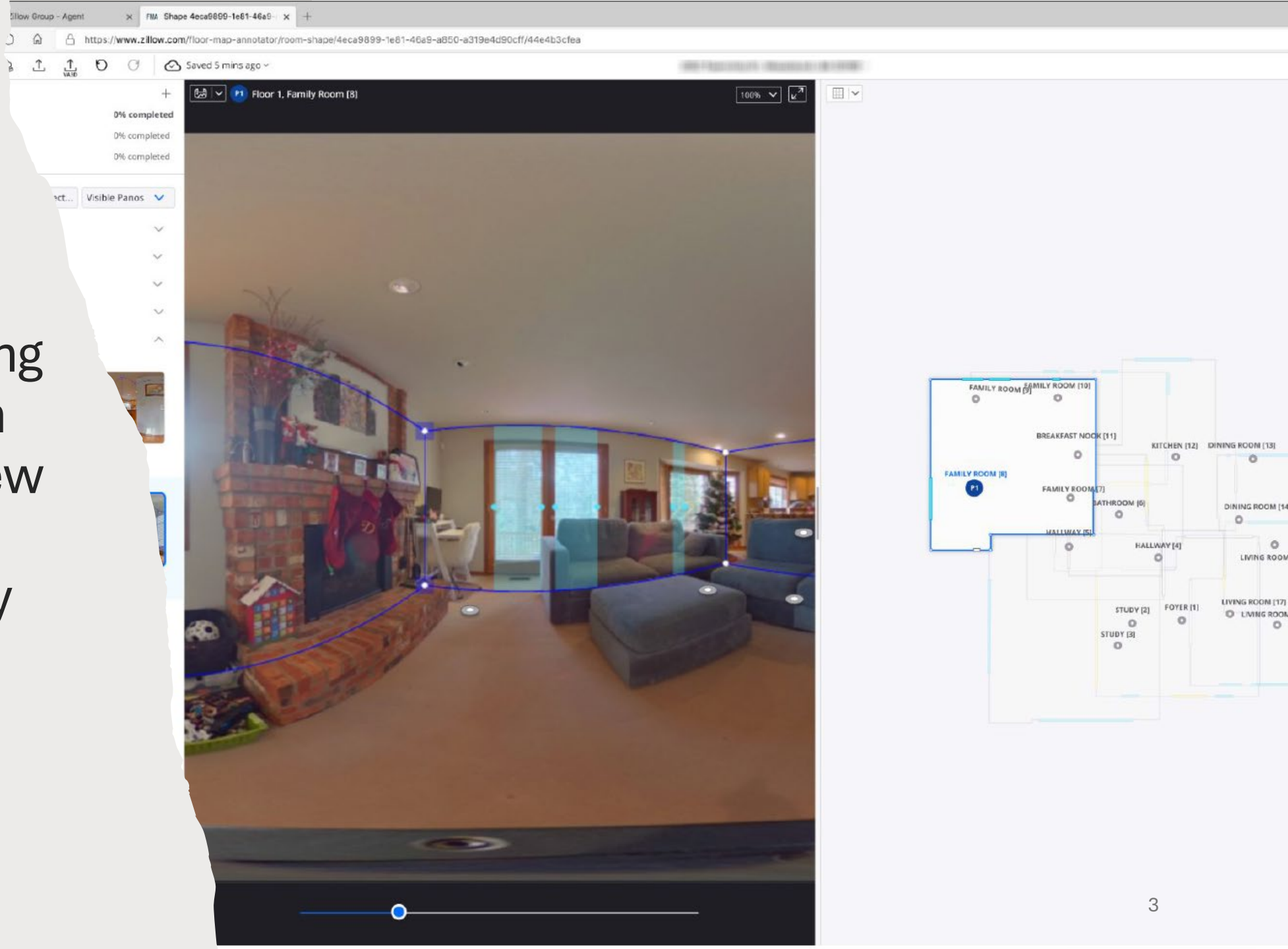
The manual process created many blockers to scaling the service:

- Long annotation time
- Long onboarding time
- Extra quality check steps

However, the biggest blocker to growth was the cost to create each floor plan.



I planned and executed a half-year's long research plan to create a new flexible tool with gradually implemented automation plugins.



What opportunities are there to scale?

As the first version of the Floor Map Annotation (FMA) Tool annotators used was created without design team involvement, the UI was cumbersome.

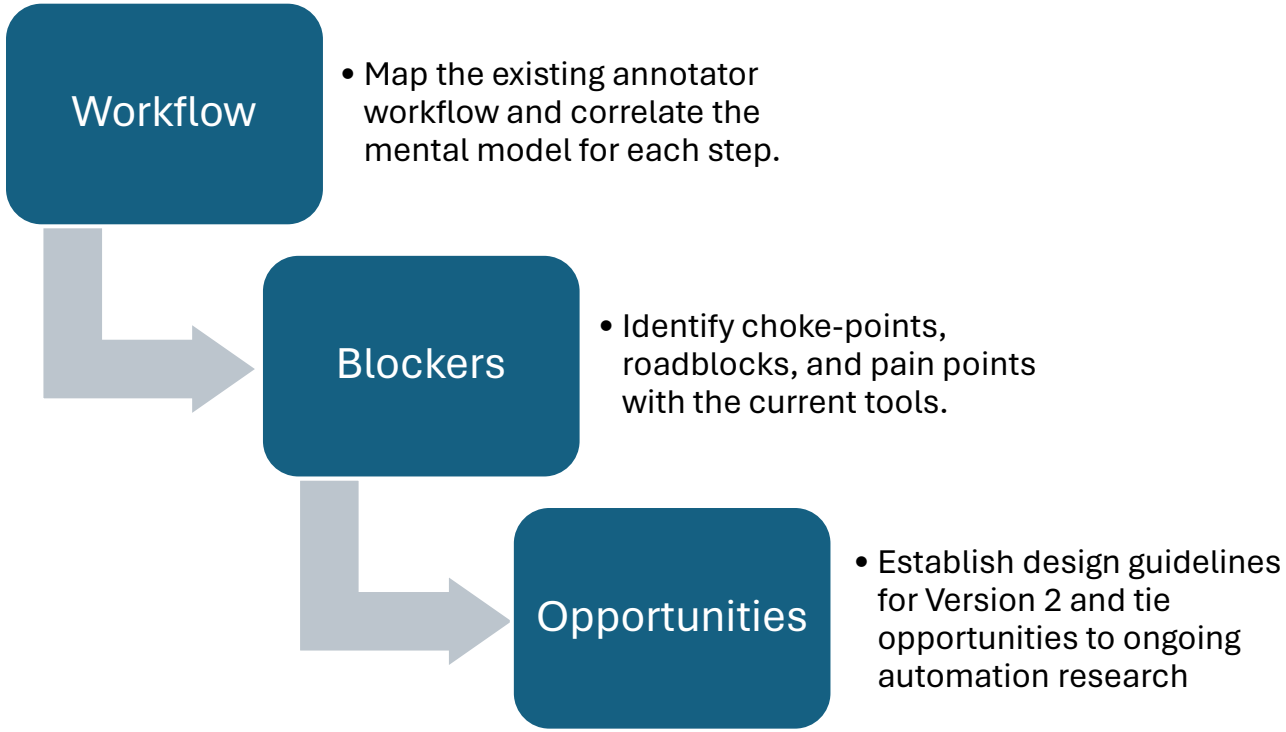
Alongside a Principal Designer, I was brought in to identify opportunities to improve annotator efficiency.

Additionally, several Machine Learning scientists joined the team and began to brainstorm ways to automate parts (and eventually all) of the floor plan creation process.

The (First) Mission:

The FMA teams lacked any insights into how annotators work and had only rudimentary metrics on time-spent working on certain tasks.

Before any design strategy could be implemented, I proposed conducting a round of needs analysis through contextual inquiry.



Goals

While the teams desired to move quickly, it was essential that we make careful and gradual changes to the annotators' workflows.

The primary goal of the Needs Analysis would be to scope and prioritize the design planning:

- Identify design work to be implemented in Version 1
- Determine design goals for a Version 2
- Establish design principles for annotator tools

Additionally, the study would provide early indicators for which parts of the annotation process had the best potential for automation.

Virtual “Ride-alongs”

I organized and conducted half-day “ride-alongs”, observing ten of the roughly thirty annotators complete their work from end-to-end.

I specifically recruited expert annotators who had long tenures as well as recently onboarded annotators to identify how they learn and how efficiencies form.

The stakeholder teams had never worked with design or research previously, so I included them in the sessions as observers.

Afterwards, I mapped the annotator workflows and conducted an affinity mapping exercise with stakeholders to identify the biggest opportunity areas.

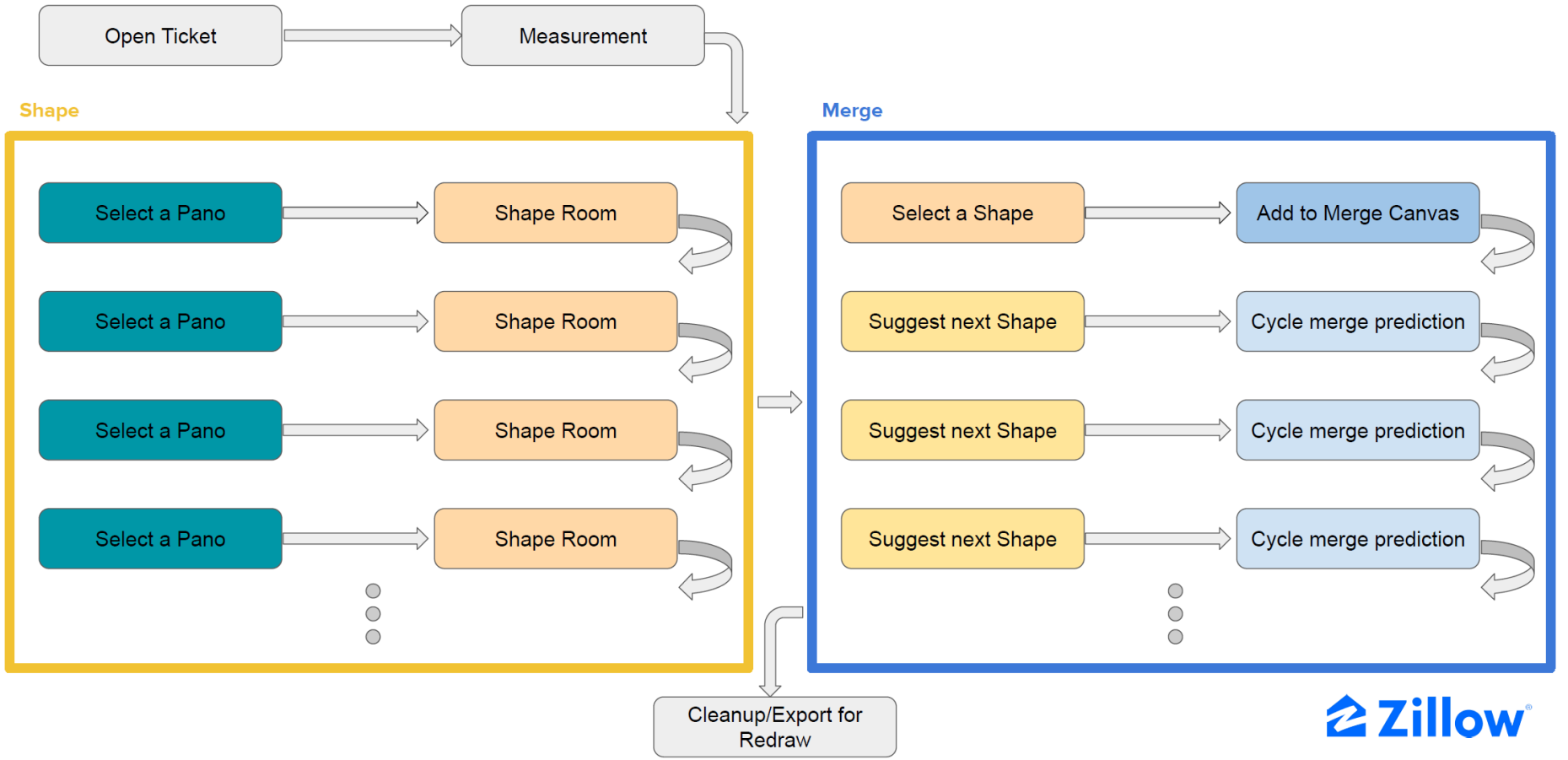
What did we learn?

Annotator workflows with the current tool were extremely linear and unforgiving for even minor errors.

Annotators followed very a strict order of operations that did not leverage information and observations from other parts of the workflow.

The gap in efficiency between expert and novice annotators occurred due to novice annotators having to switch tools more often to correct mistakes, usually to re-shape a room that didn't quite fit when trying to merge all rooms together.

Existing Ideal Annotator Workflow



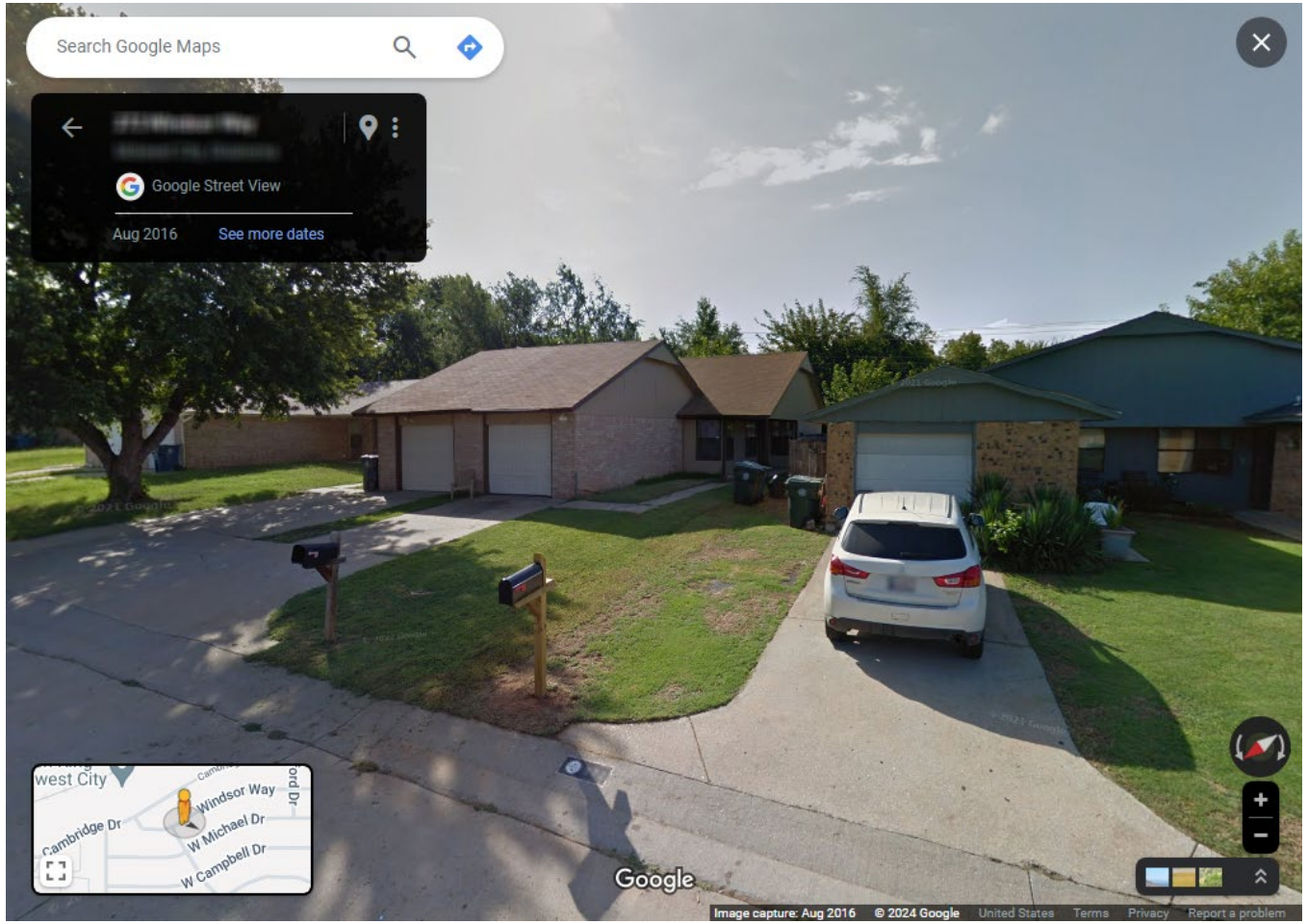
Takeaways

Design solutions should aim to reduce tool switching and reduce second-guessing.

Any mistakes in one step are amplified unless corrected before the next part of the process. For instance, having to re-shape a room during the merge step would take nearly 225% longer than shaping correctly.

Annotators, therefore feared mistakes and attempted to find perfection.

Many annotators would resort to using satellite or google street view images to “spy” on the exterior shape of a home for confirmation.



Design Opportunities

- Combine Shape and Merge steps to display room shapes relative to others already completed.
- Move away from 1 panorama = 1 room model for the software. Allow multiple panorama views to be used to construct a single room.
- Provide powerful quality of life fixes to boost annotator confidence and improve learnability.

Automation Opportunities

- Improve rudimentary Merge prediction.
- Implement Shape prediction
- Automate the measurement calibration step
- Clean-up during annotation
- Eliminate the Redraw step*
- Explore photographer data capture opportunities

*The Redraw step occurred in a 3rd party blueprinting software, requiring an exporting and importing step

What happened next?

After the report out meeting, Stakeholders had fully bought into a tool redesign with and ultimate goal of automating the majority of the annotation work using Computer Vision and Machine Learning in order to reduce cost per home.

A new designer and I worked backwards from this future automated state and planned feature development to both improve efficiency quickly and prepare annotators how to best work with upcoming automation.

Communication between teams and alignment on design decisions became crucial as sprints began. To ensure a common North-Star vision to ensure design opportunities were fully realized, I organized a 3-day long design sprint exercise.

Design Sprint

The designers and I invited our stakeholders and engineering teams to participate in 3 days of activities meant to:

- Reinforce fundamental learnings about annotator and photographer processes.
- Align on high-level design goals for the FMA V2 tools.
- Ideate on early V2 design changes.
- Build empathy for annotators among product leaders.

Having access to immediate feedback and input from product managers and engineers helped to streamline the design process.

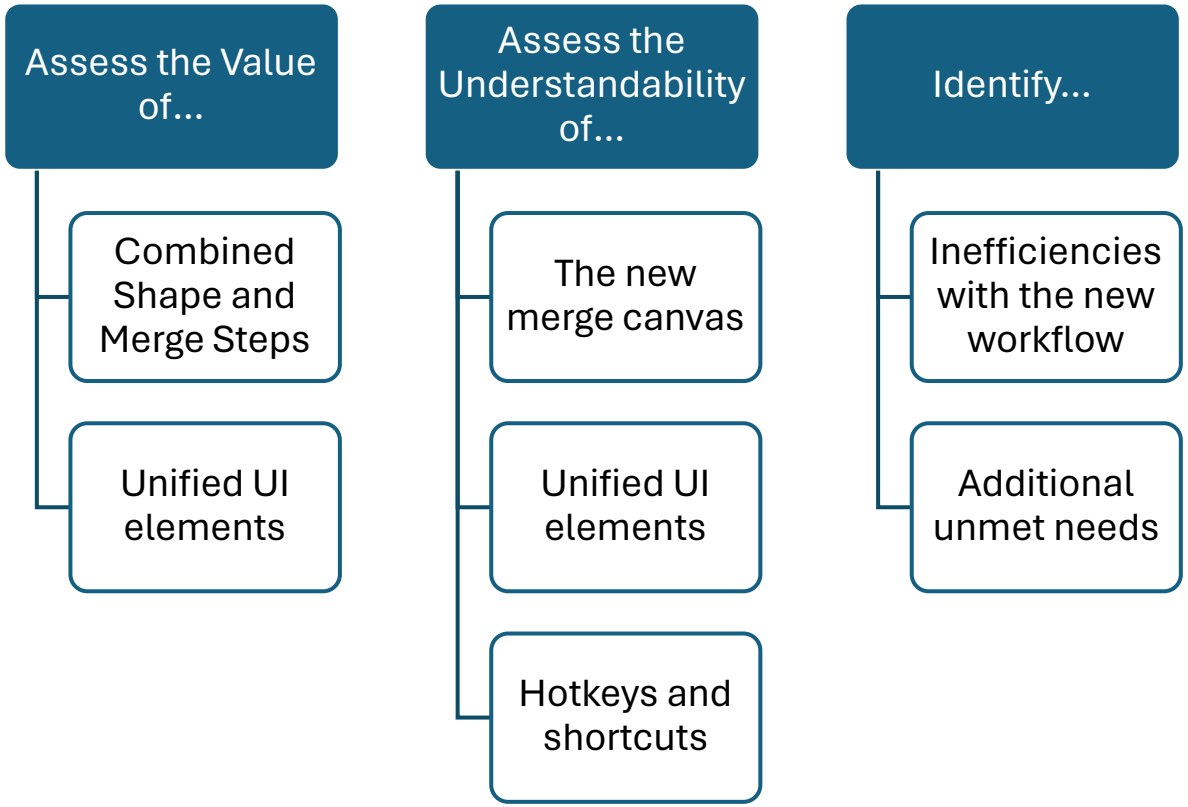
As a result, the new designer was able focus efforts within the realm of feasibility while still working towards ambitious north star goals around automation.

The Next Mission:

The team needed insight into how planned design changes could fit into annotator's current mental models with as little friction as possible.

The designer and I split the design plans into major and minor changes to test more efficiently.

I created a recurring weekly study with three to five annotators to test minor changes and planned a full usability study with another six for major changes to overall workflows.



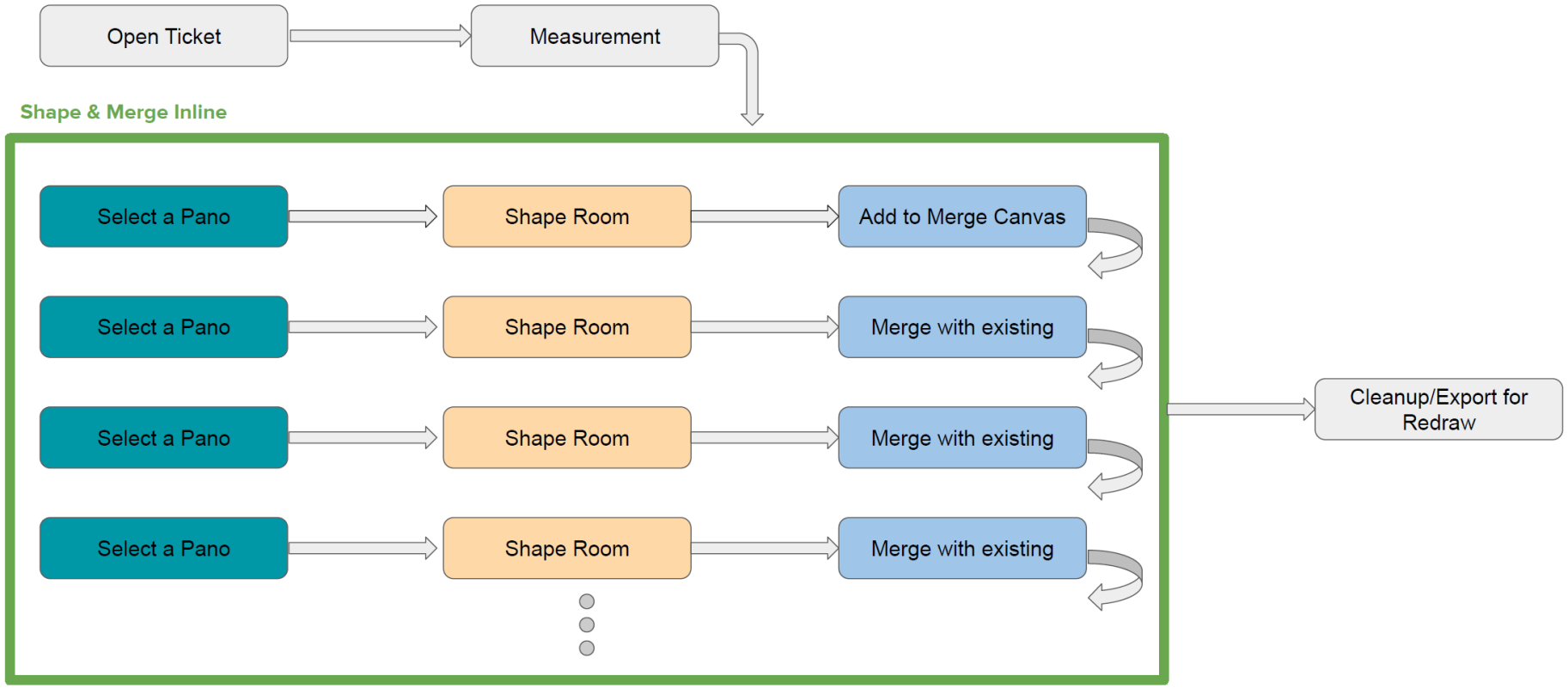
Goals (for the Usability Test)

After reporting out the results of the initial needs analysis and working with Design and Engineering, the team was able to create a prototype of the Version 2 tool and include a functional beta version as a new tab.

The primary goal of the Usability Study would be to assess the value and understandability of the design changes.

The study would also be an opportunity for some initial data on improvements in operator efficiency.

How would annotators adapt to this new workflow?



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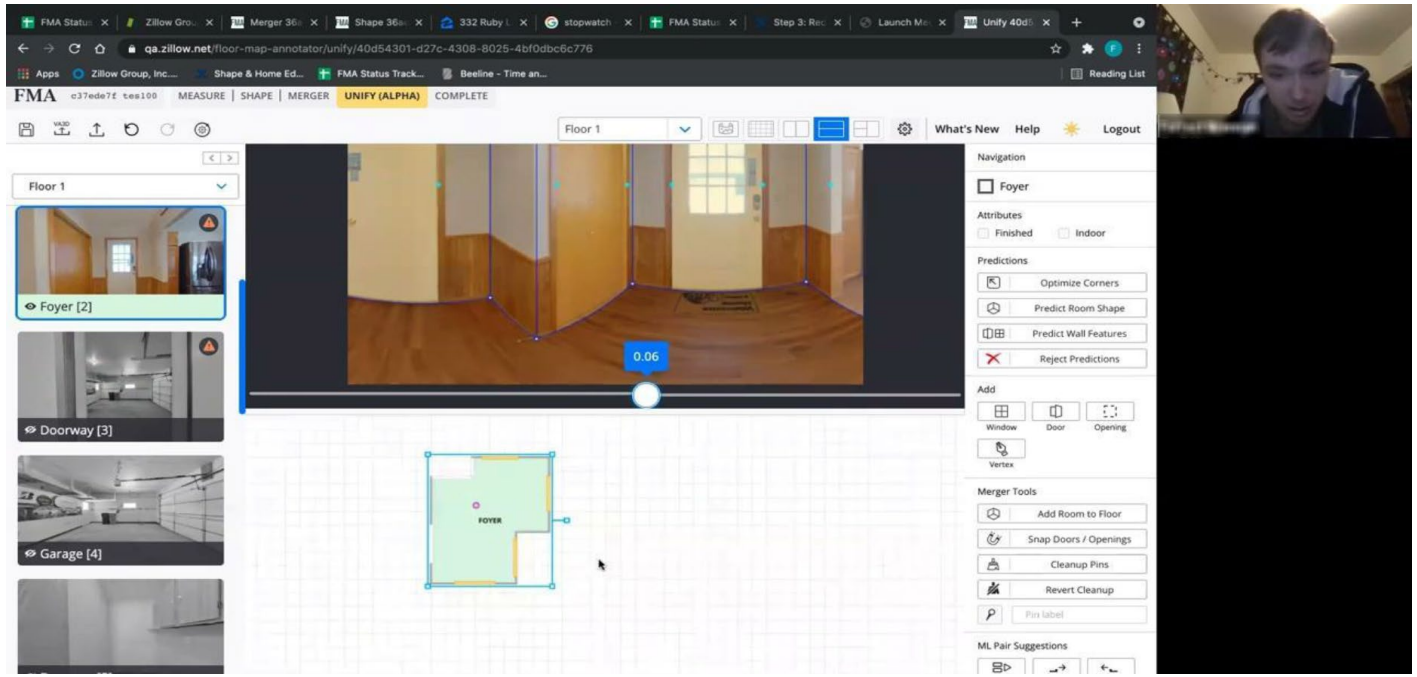
Remote Usability Testing

Due to high workloads and low availability, I was limited to recruiting two sets of three annotators across two separate weeks to conduct remote usability study sessions.

Each session consisted of common timed tasks, performed on both Version 1 and Version 2, alternating which version participants saw initially.

Additionally, after all tasks were completed, annotators were instructed to freely partially complete a floor plan using Version 2 while thinking out loud.



Takeaways

Annotators unanimously felt the new tool would save time. Participants demonstrated the overall merge and shape steps became easier to understand and manipulate.

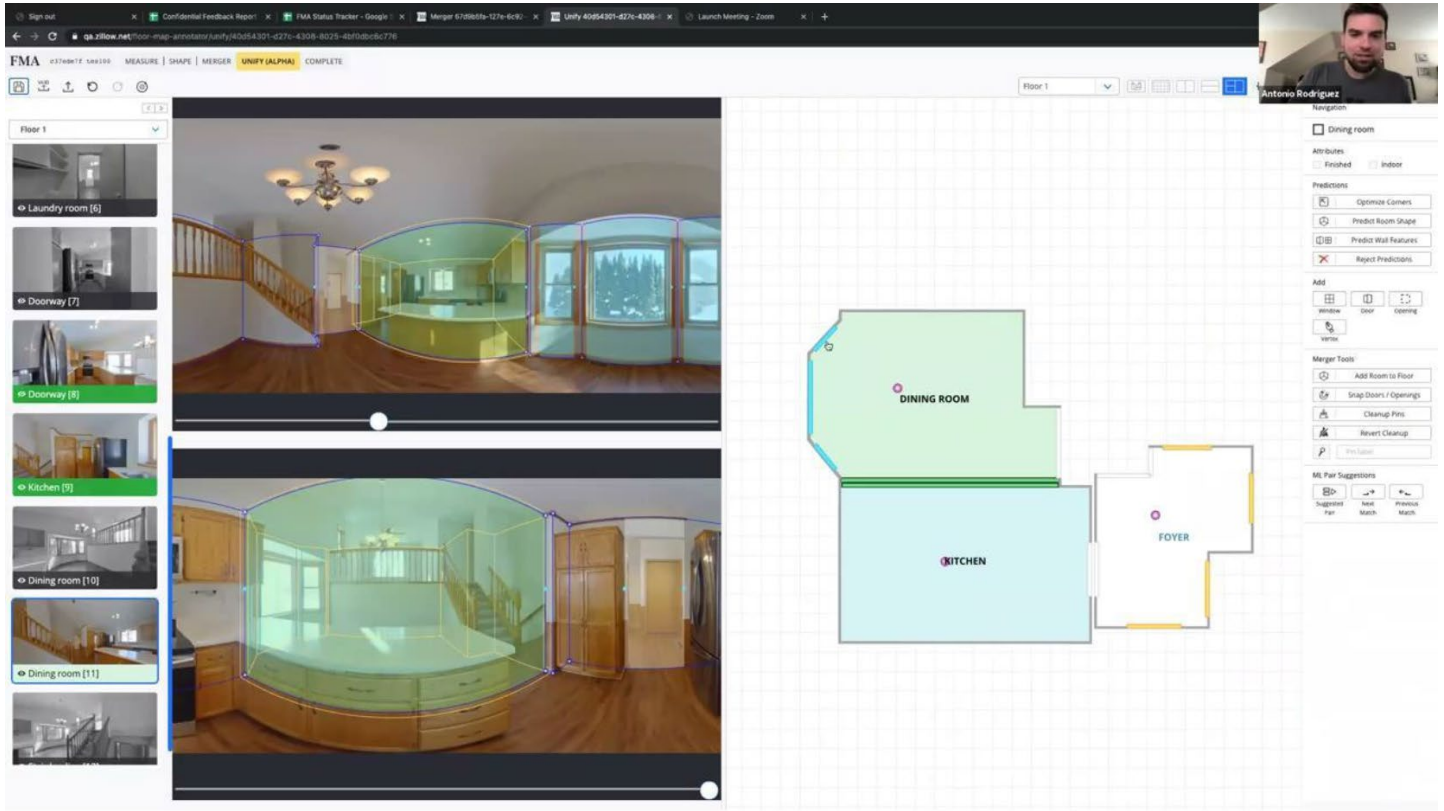
- More information is readily available in a single workspace.
- The layout and combined steps allow for more flexibility.
- Work is checked & corrected immediately instead of carrying errors along to other steps.

Most importantly, the new interface felt highly intuitive even for tenured annotators, strongly suggesting the mental model for Version 2 could be adopted easily.

Quotes	
	"[In Version 1, you] waste a lot of time going back & forth. Now it makes it so much easier to do that." - A3
	"[Version 2] Adds a lot of freedom to do the work." - A1
	"[Version 2] eliminates the step of checking your work. [It can be done] immediately, which is a time saver." - A1

Design Opportunities

- The optional vertical split layout of the panoramas and merge canvas felt more intuitive than the default horizontal split.
- Many keyboard shortcuts were re-mapped due to combining the shape and merge steps. Annotators felt many of these new mappings were unintuitive.
- Several quality-of-life changes such as snapping to lines, color coding selections, click-and-drag, and auto-saving could have high impact on annotator performance.



The Ongoing Mission:

The immediate impact for annotators who switched to using Version 2 full time was a 10% reduction in time per home. As annotators further familiarized and adjusted mental models, efficiency increased steadily.

The initial results revealed more opportunities for design to improve efficiency. By next focusing on improvements to individual specific interactions, annotators could continue to adapt to and familiarize with the new tools more quickly.

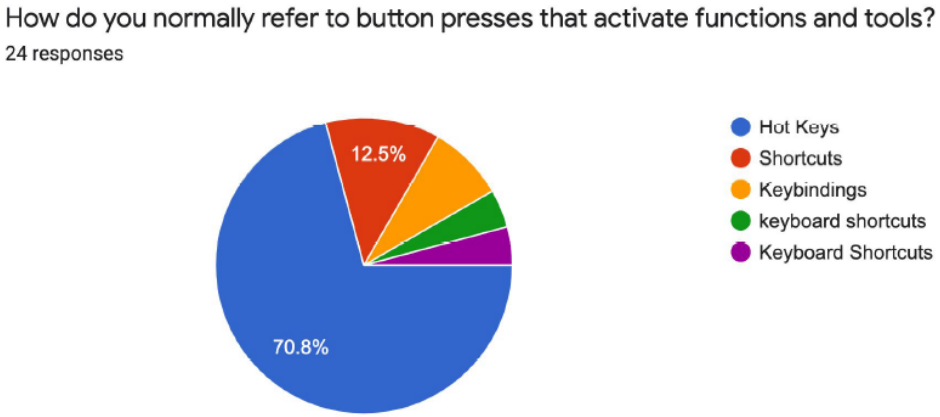
During the recurring weekly study, I began to test new feature optimizations which could be implemented quickly into the live tool.

Recurring Studies

Due to high workload volumes, I typically only included three or four annotators in weekly studies.

I conducted cognitive walkthroughs and usability tests of various mock-ups, prototypes, and live code versions depending on availability, often with engineer and PM observers.

I also conducted several surveys among annotator teams.

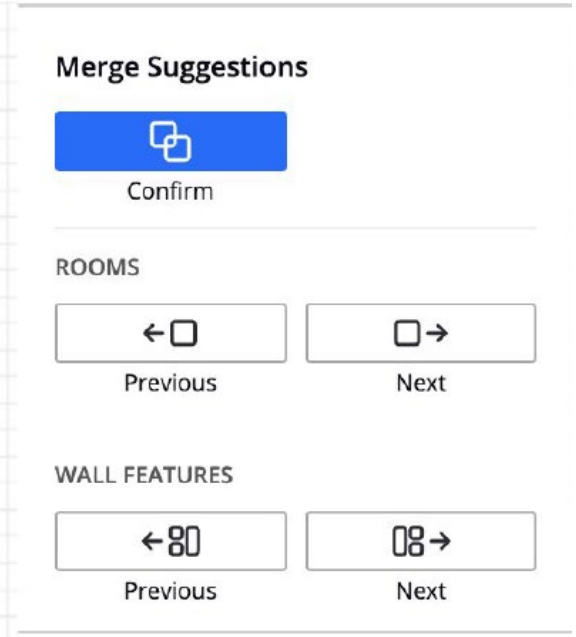


Recurring Studies

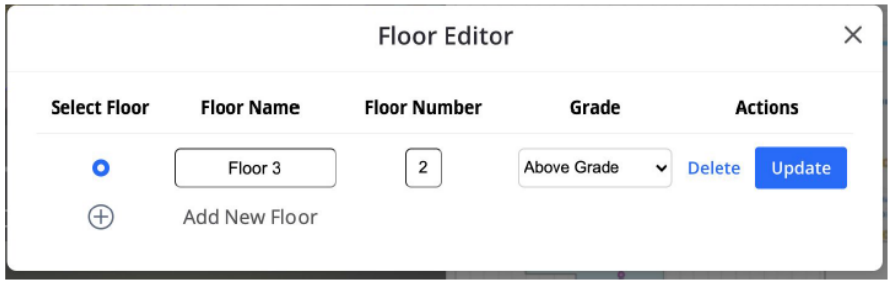
Other recurring studies included optimizations and features such as:

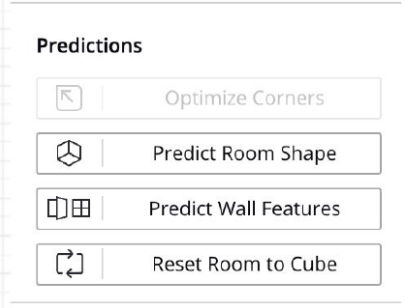
- Autosaving
- Improved merge suggestions
- Predictive room shape
- Floor editing
- Wall feature editing
- Wall feature detection
- Preview Export
- Grouping shapes
- Vertex angle preservation
- Automated scaling
- Highlighted panorama labels
- Panorama jump points
- New Hot Keys

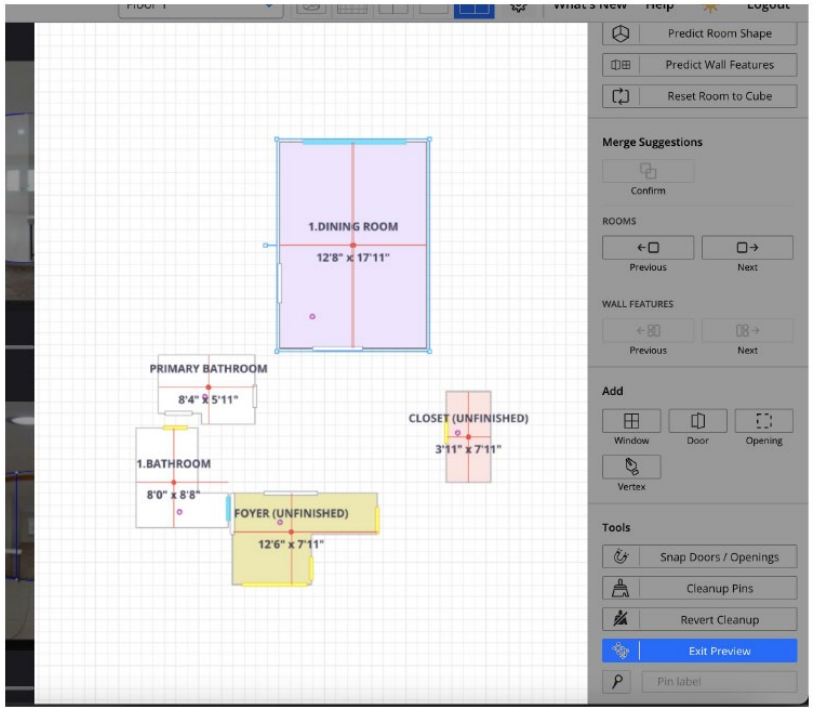
Overall, within 8 months, the team incorporated nearly 100 new design feature considerations for the tool.

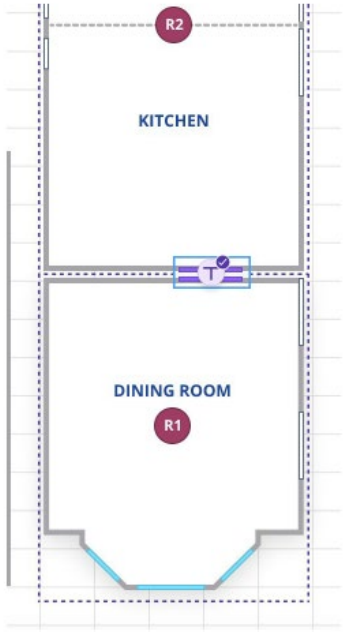


Examples of features tested during recurring studies:









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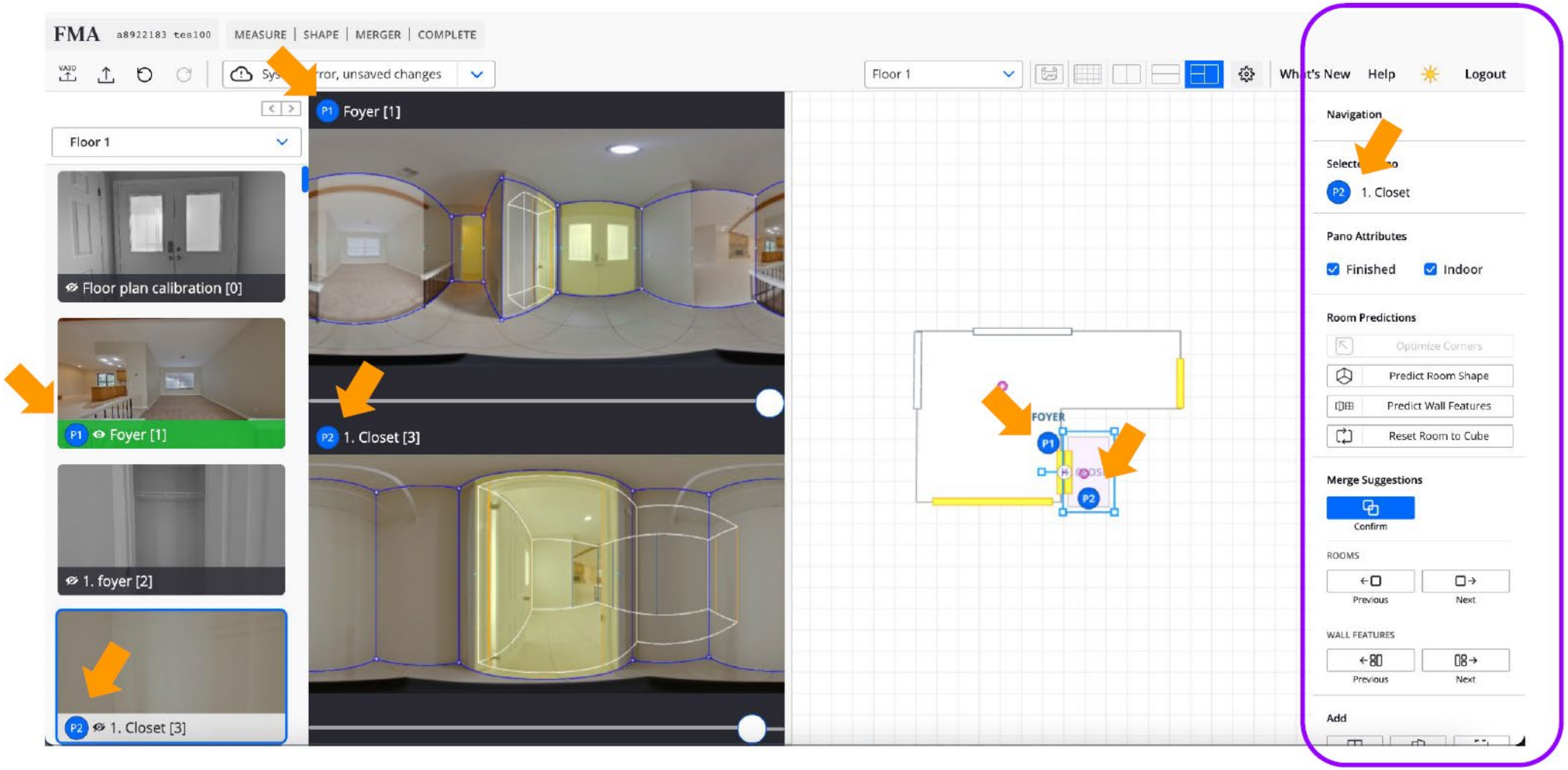


How did my research impact the floor plan program overall?

As new features, new automations, and other design changes were tested and implemented, efficiency among annotators greatly improved.

The reduced cognitive load also greatly sped up the onboarding process for new annotators.

As a result:

- Per-home annotation time reduced 90% from Version .
- Onboarding & ramp-up time reduced from 6 months to 6 weeks (-75%).
- The number of annotators doubled in the first year.
- The cost per floor plan reduced from around $150 to $11.

How did my research impact the floor plan program overall?

Most importantly, Zillow 3D became competitive.

Zillow began to take market share from the largest competitor, Matterport, drawing the attention of Zillow executives.

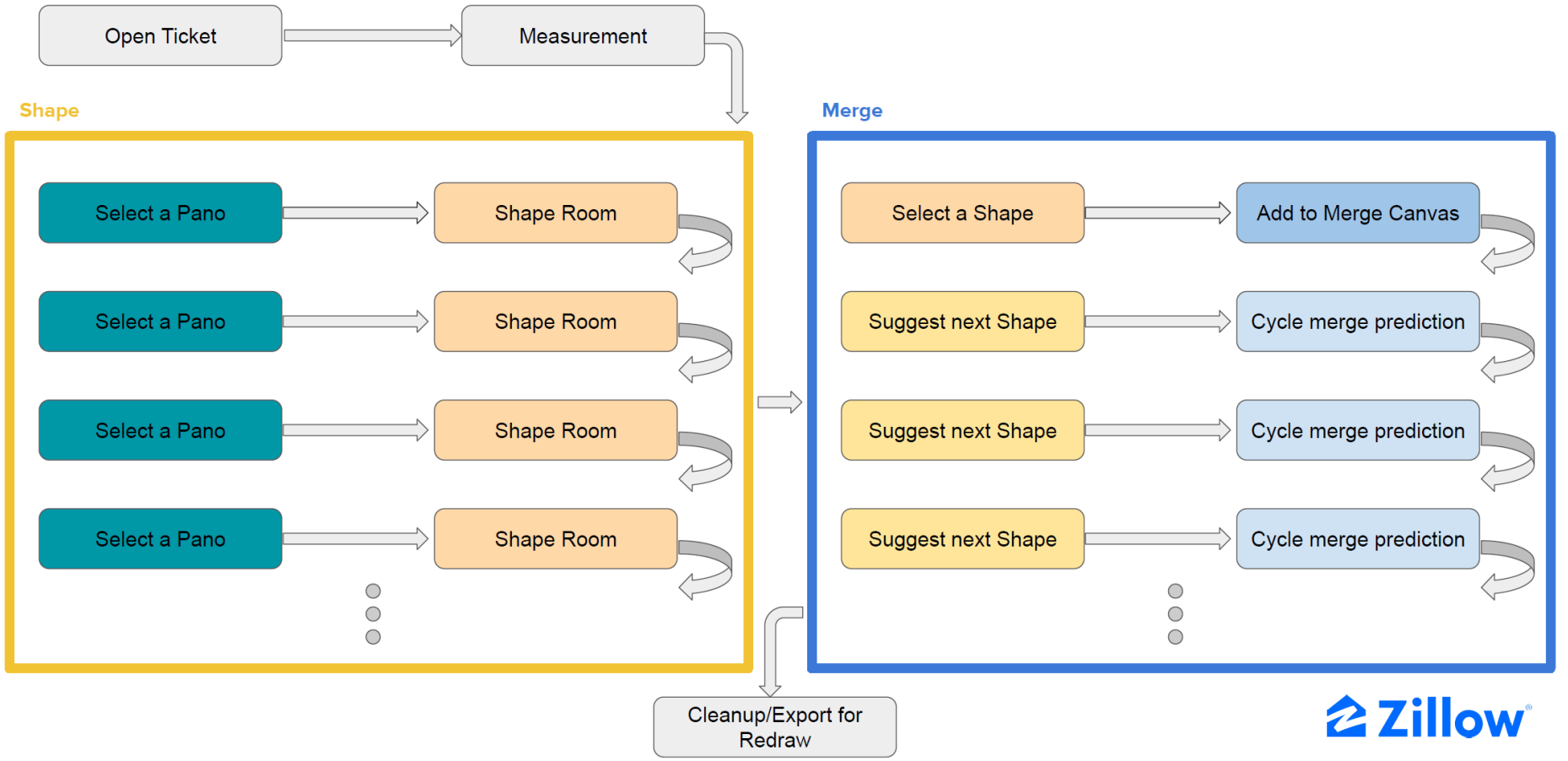
As Zillow 3D Home became profitable, executives invested in the org, growing to over 450 employees world-wide. Z3D is now a top 5 revenue stream for Zillow Group.

Thank you!

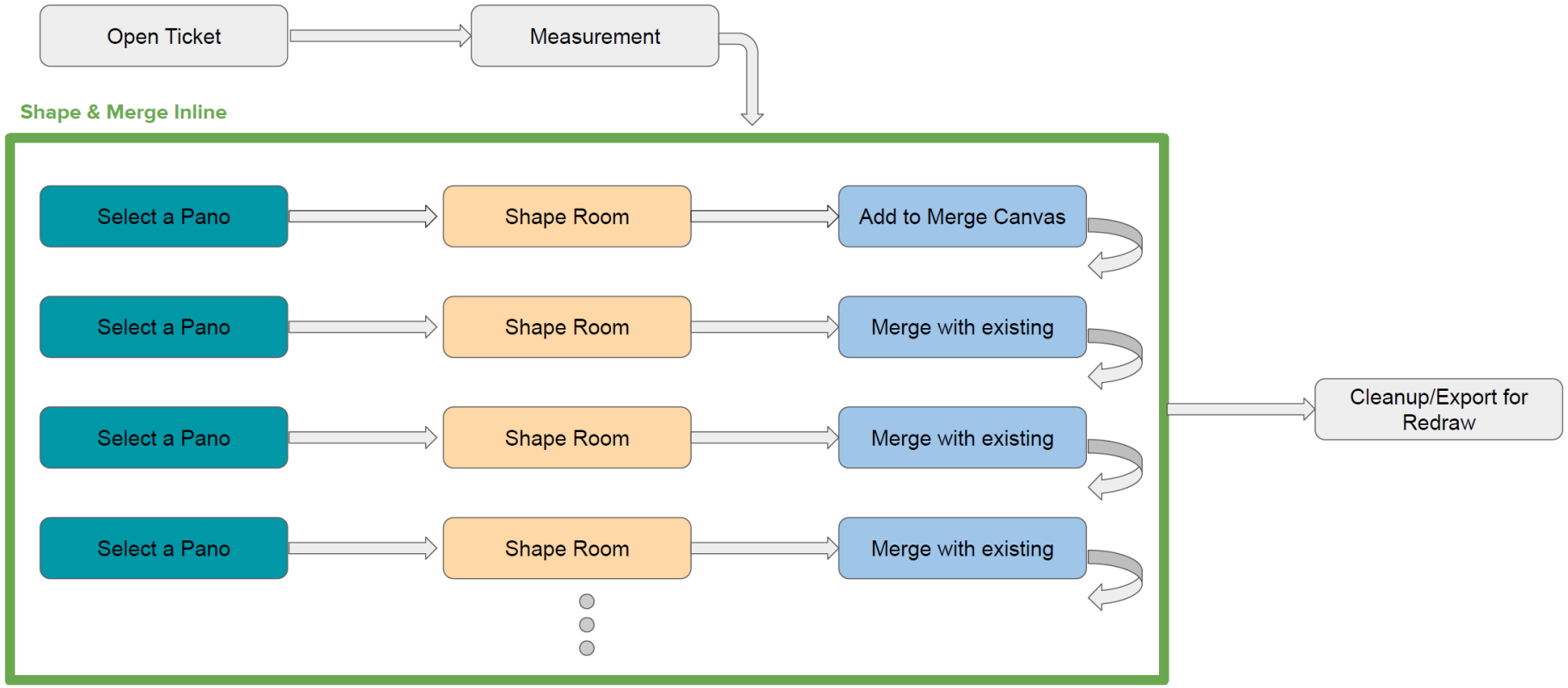
Questions?

Appendix

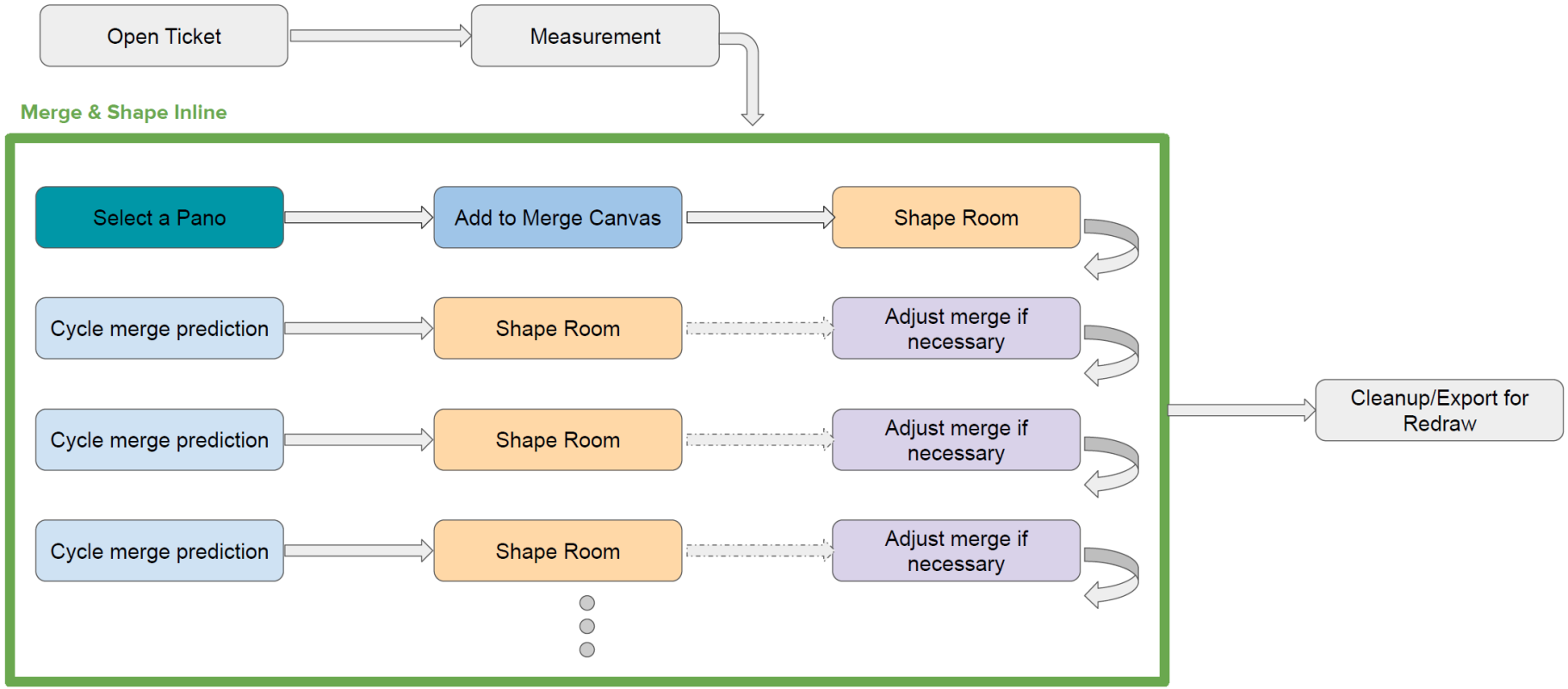
Version 1 Workflow



Initial Version 2 workflow combining shape and merge



Including merge predictions reversed the previous shape and merge orders, which further improved efficiency.



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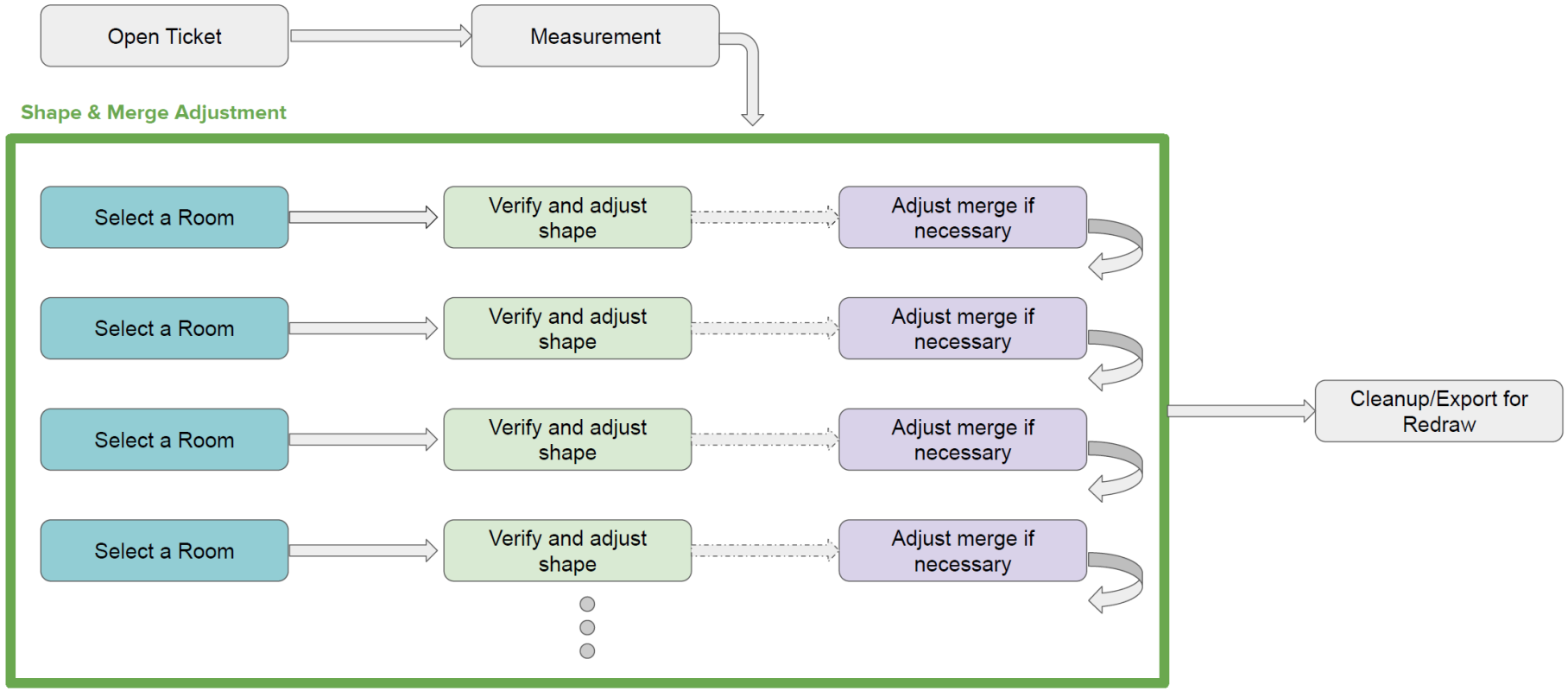
As the machine learning improved, annotator workflows again simplified becoming more efficient and reliable.



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