

# USER PERSPECTIVES ON BRANCHING IN COMPUTER-AIDED DESIGN

**CSCW  
2023** The 26<sup>th</sup> ACM Conference on Computer-Supported  
Cooperative Work and Social Computing

Kathy Cheng, Phil Cuvin, Alison Olechowski, and Shurui Zhou



**Kathy  
Cheng**  
(Presenter)



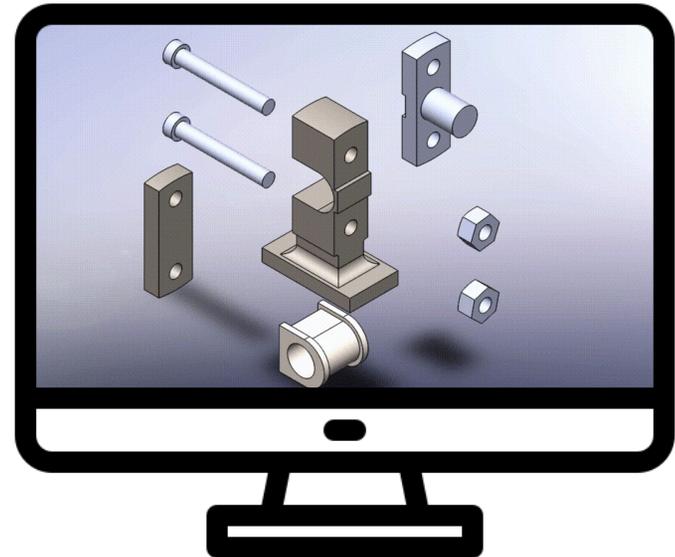
**Dr. Alison  
Olechowski**



**Dr. Shurui  
Zhou**

# CAD is integral to the product development process

**Computer-aided design** is used to virtually design and test product concepts before fabrication



# Nearly all products are designed with CAD

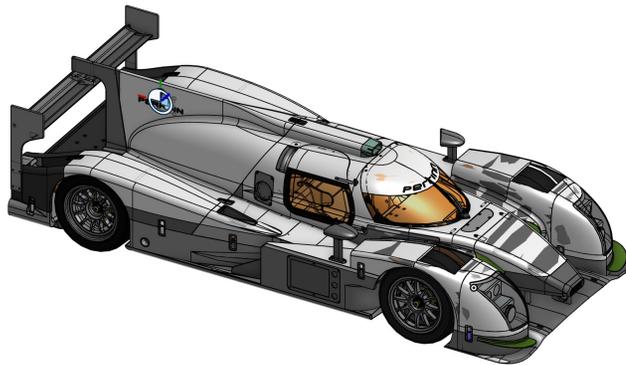
laptop



racecar



# Nearly all products are designed with CAD



# The CAD process is collaborative



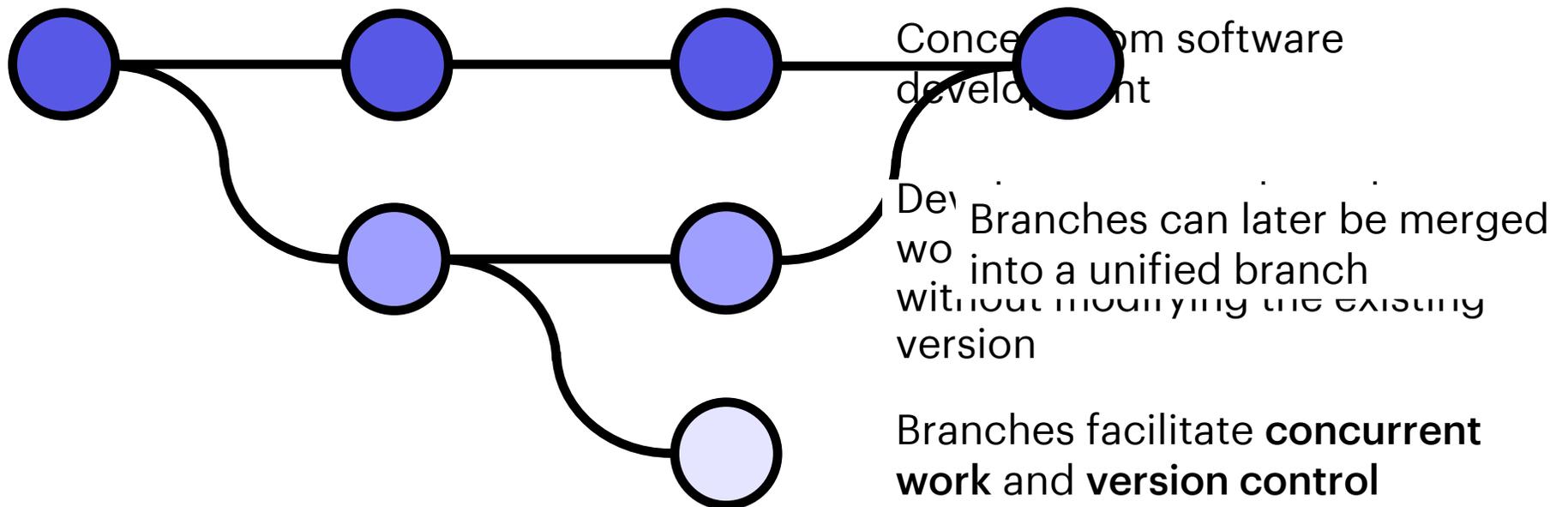
# CAD collaboration is challenging

Designers struggle with **concurrent work** and **version control**

But, recent advances bring branching and merging.

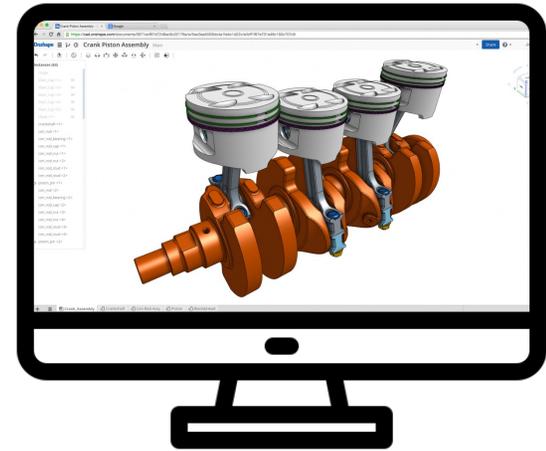
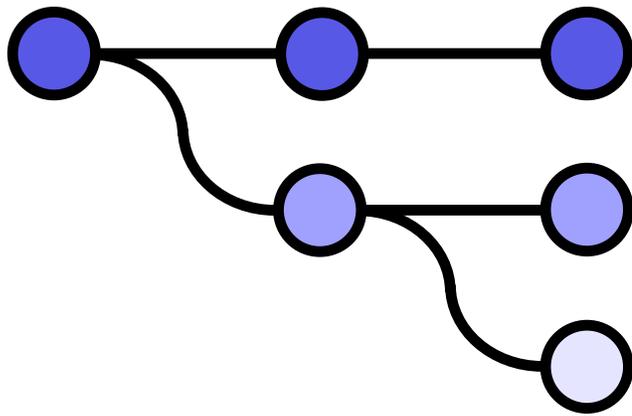


# Branching and merging is an effective means of collaboration



Seems like an obvious strategy to implement in CAD

# Branching is still new to CAD



Existing work is theoretical and lacks empirical studies.

## RQ1:

How do CAD designers use **branching functionality** for hardware design?

## RQ2:

What are the **design shortcomings** and gaps of existing CAD branching tools?

# Why mine online CAD forums?

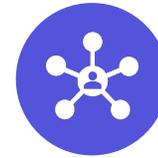
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Considered a  
community of  
practice



Popular resource  
among CAD  
users



Reach more CAD  
users than with  
interviews

# We selected widely used CAD forums

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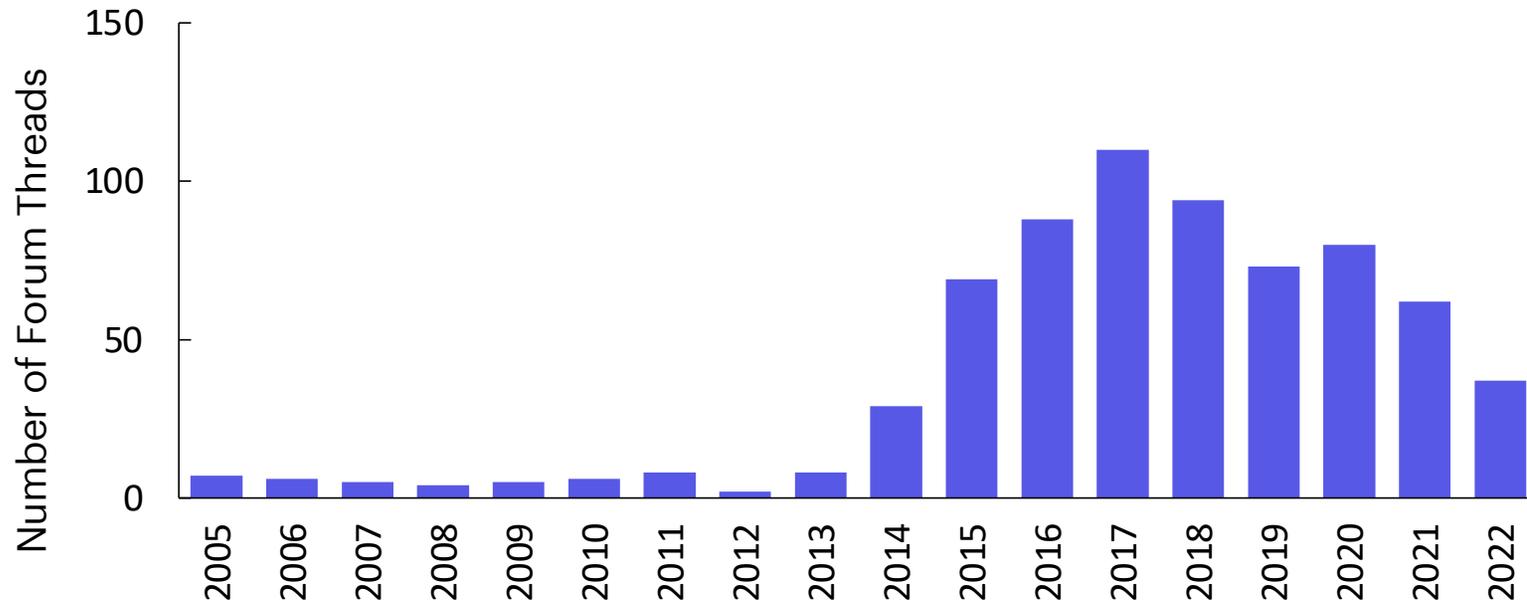
Forums owned by  
platforms that  
support(ed) branching



General platform-  
agnostic forums



# Our dataset included 719 discussion threads



# Analyzing forum threads was a multi-step process

1.

**Scrape forum discussions**



using keyword search  
(e.g., 'branch' OR  
'clone')

2.

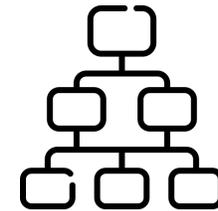
**Code qualitative text data**



to determine  
relevance to research  
questions (i.e., use  
case or shortcoming)

3.

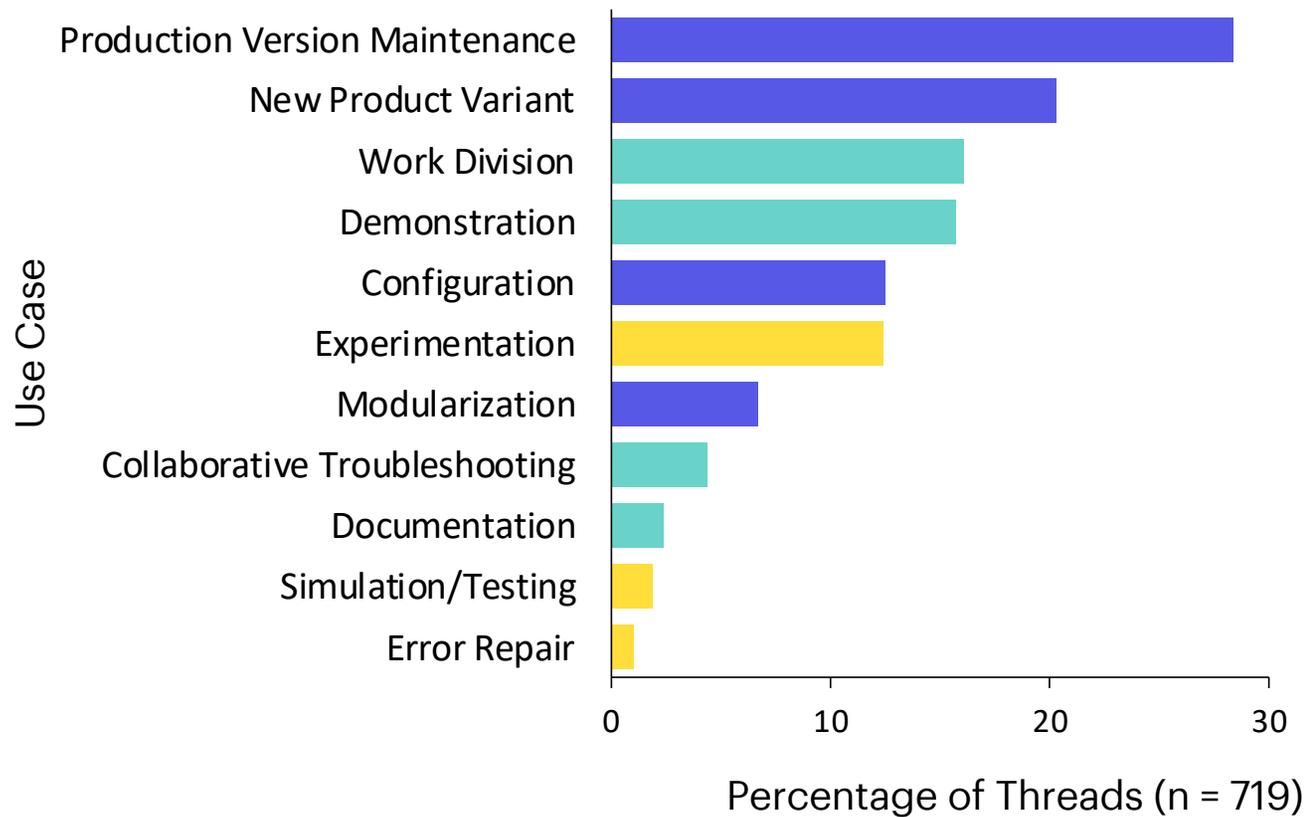
**Develop taxonomy of use cases**



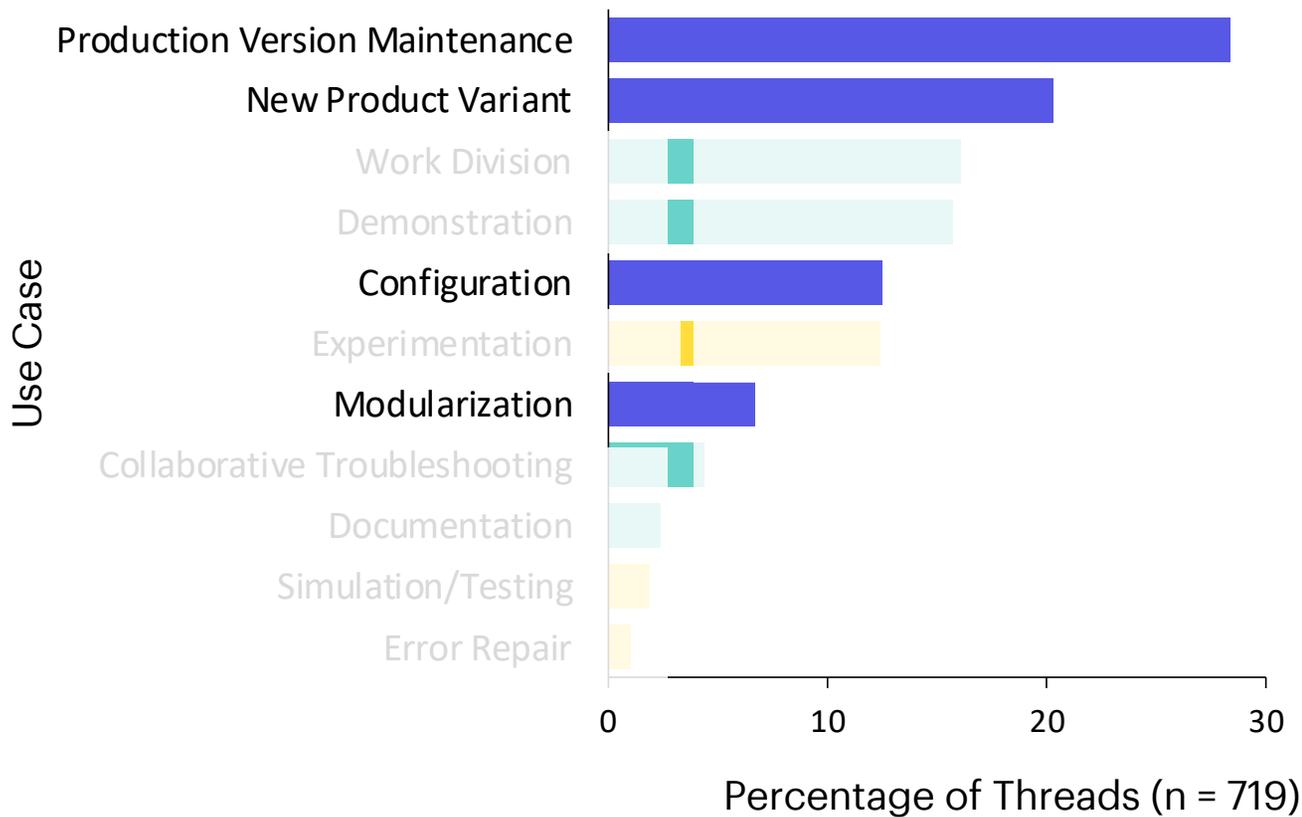
to understand  
CAD branching  
practices



# RQ1: Use Cases for Branching



# Product Line Management branches are used for supporting the production version design evolution



Legend

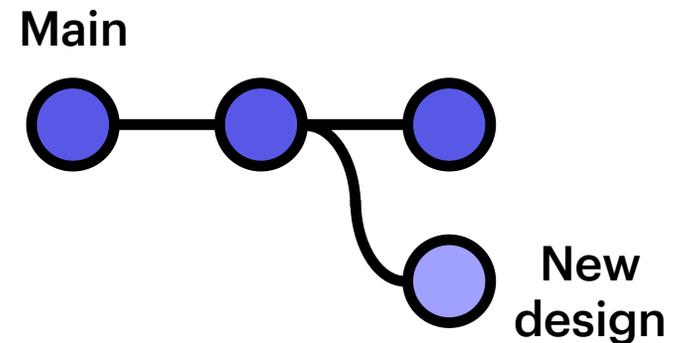
- Product Line Management**
- Risk Isolation**
- Designer Support**

# A use case of **Product Line Management** branching is for: creating a **new product variant**

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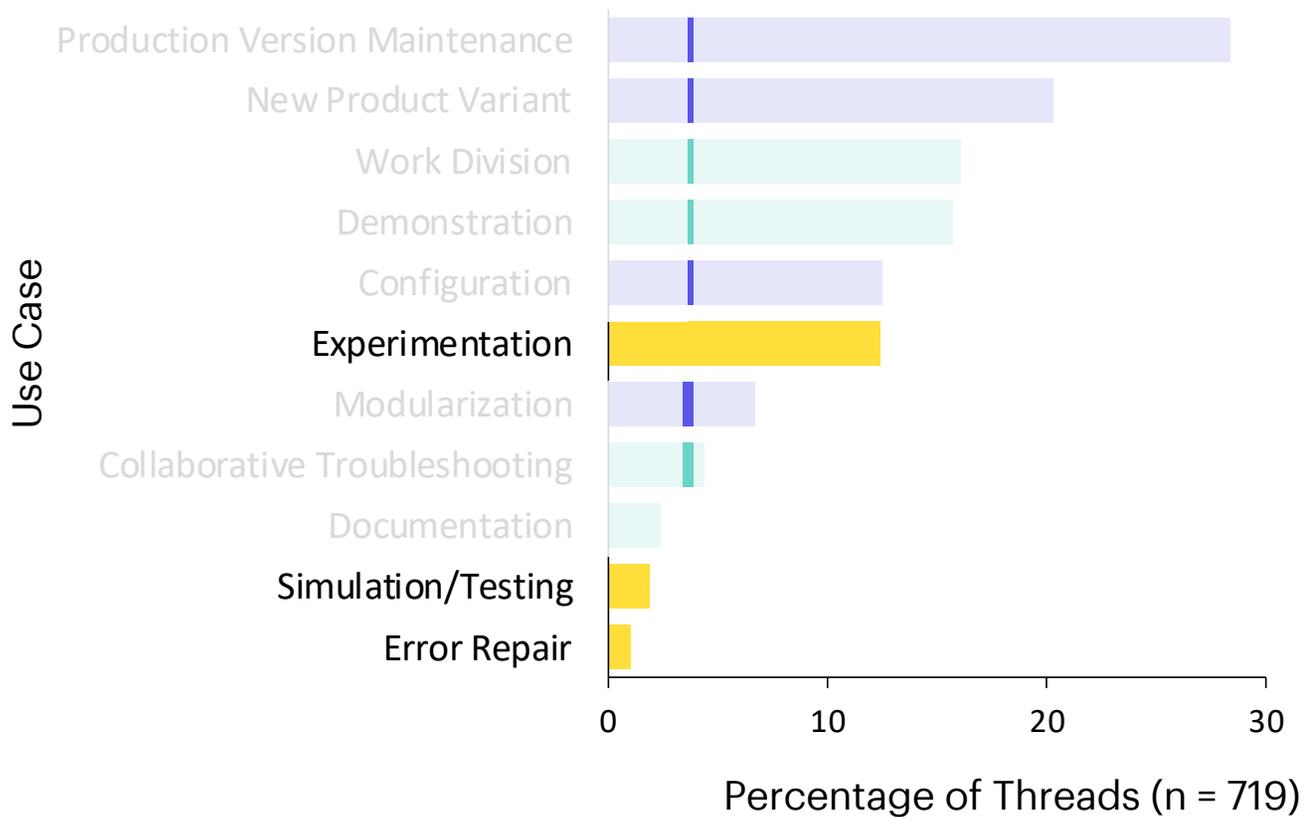
“I would like to add a completely new design without starting from scratch, but keep using the finished design for further enhancements to reach a new finished version and so on.”

Autodesk (2021)



Analogous to “hard forking”  
in software development

# Risk Isolation branches are used for separating unapproved or unstable file changes

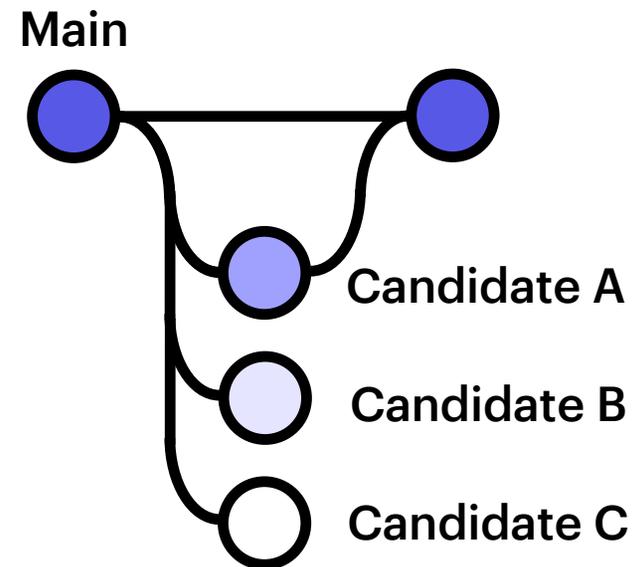


## A use case of **Risk Isolation** branching is for: experimenting with candidate designs

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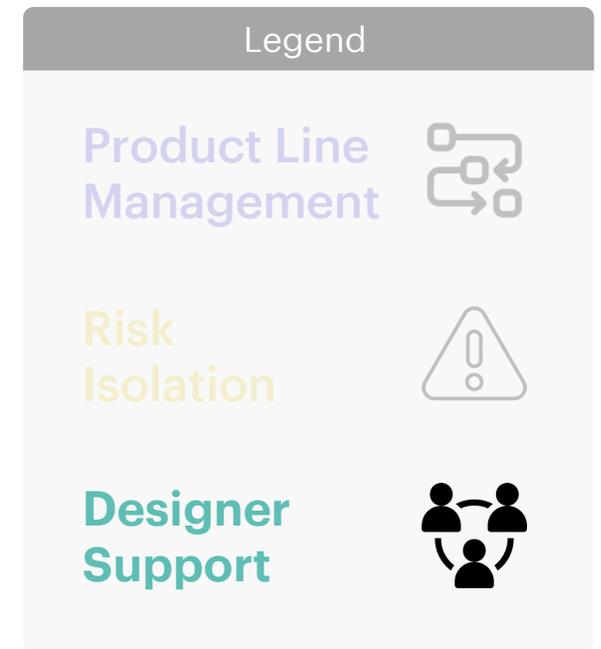
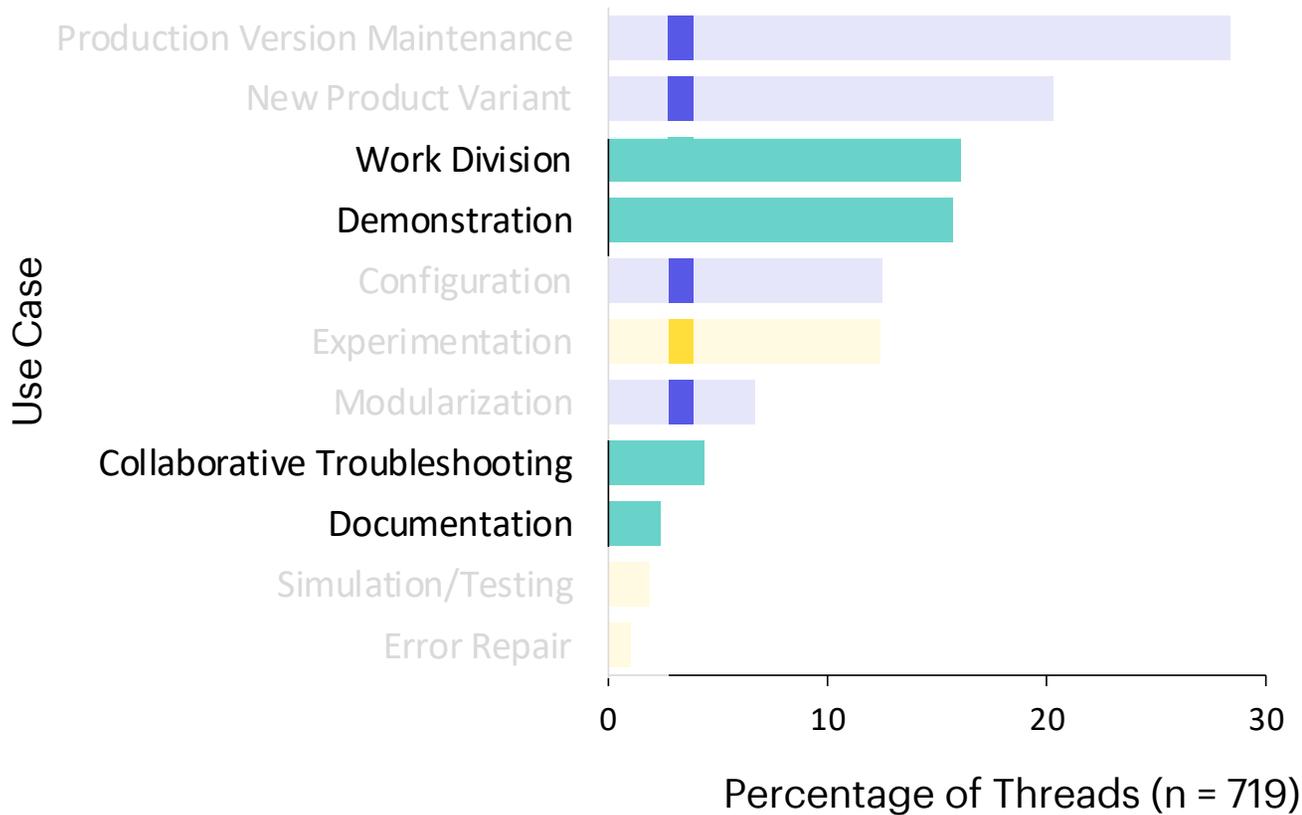
“Being able to make variations of a design and have them available if you need to change directions beats manual copies or playing with references.

SolidWorks (2022)



Similar to exploratory programming

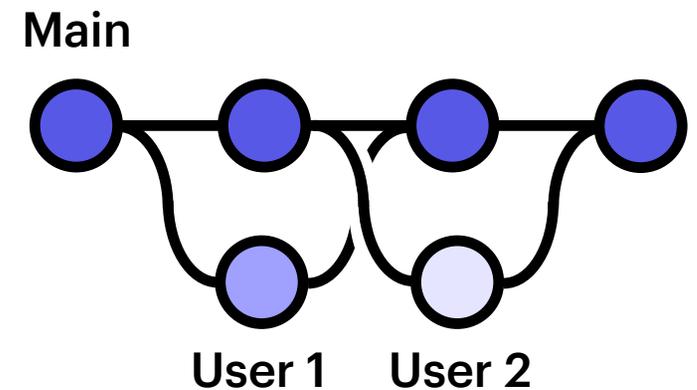
# Designer Support branches are used for facilitating collaborative or non-technical needs



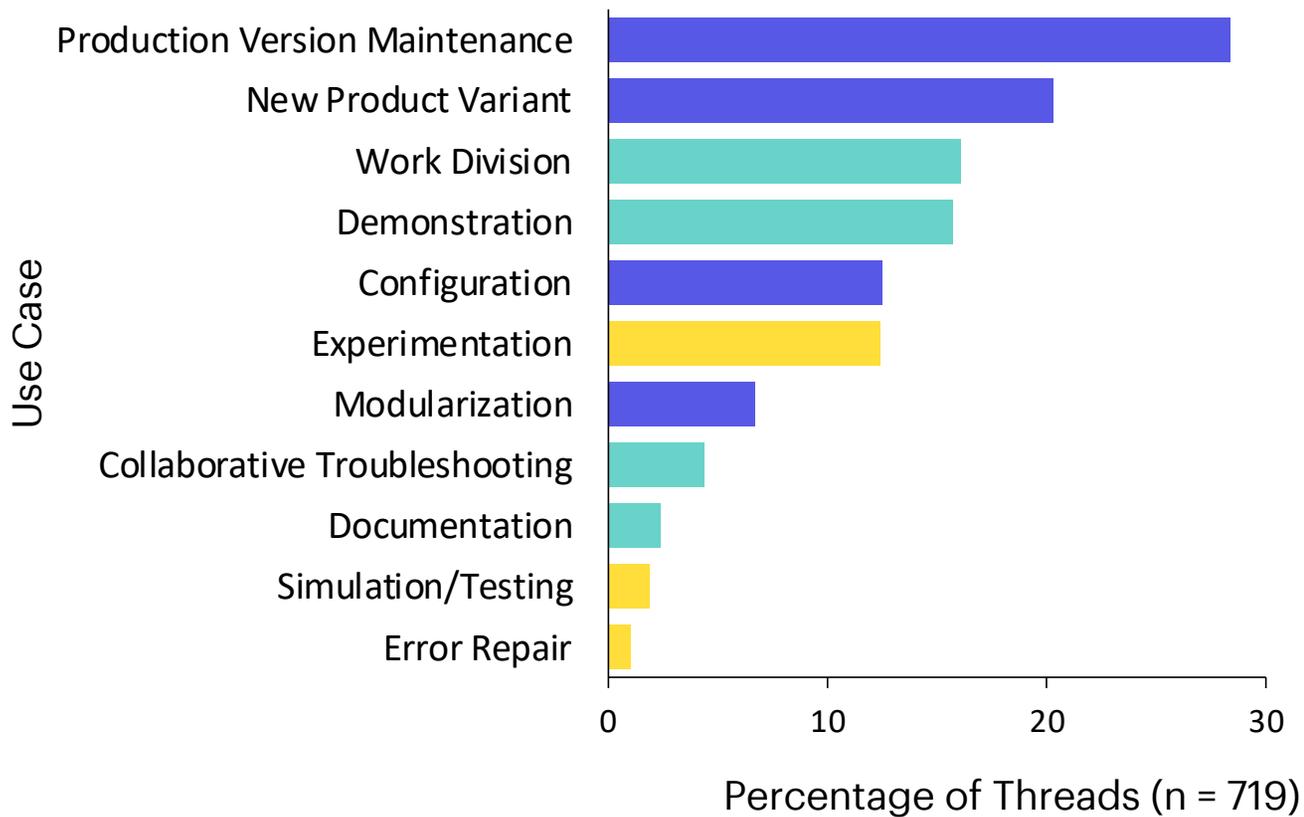
# A use case of **Designer Support** branching is for: **dividing work between individuals**

“User 1 creates a branch and adds a hole. User 2 creates a branch and modifies the size of a cutout. Each branch gets merged back into the main workspace and updates the model at different times.”

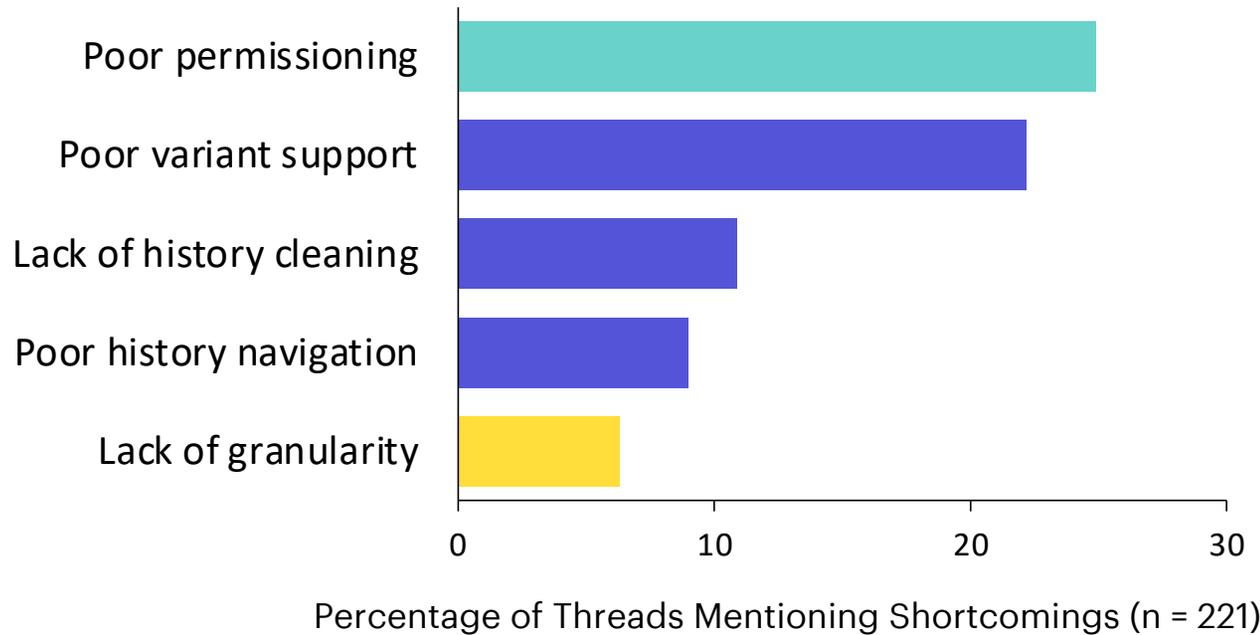
CAD Forum (2022)



# RQ1: Use Cases for Branching



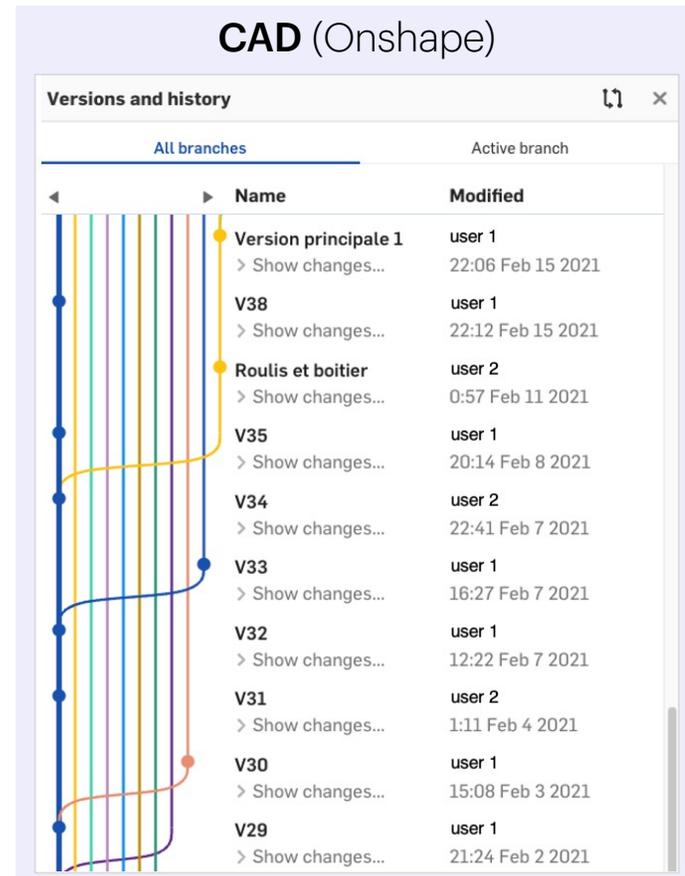
# RQ2: Shortcomings of CAD Branching Tools



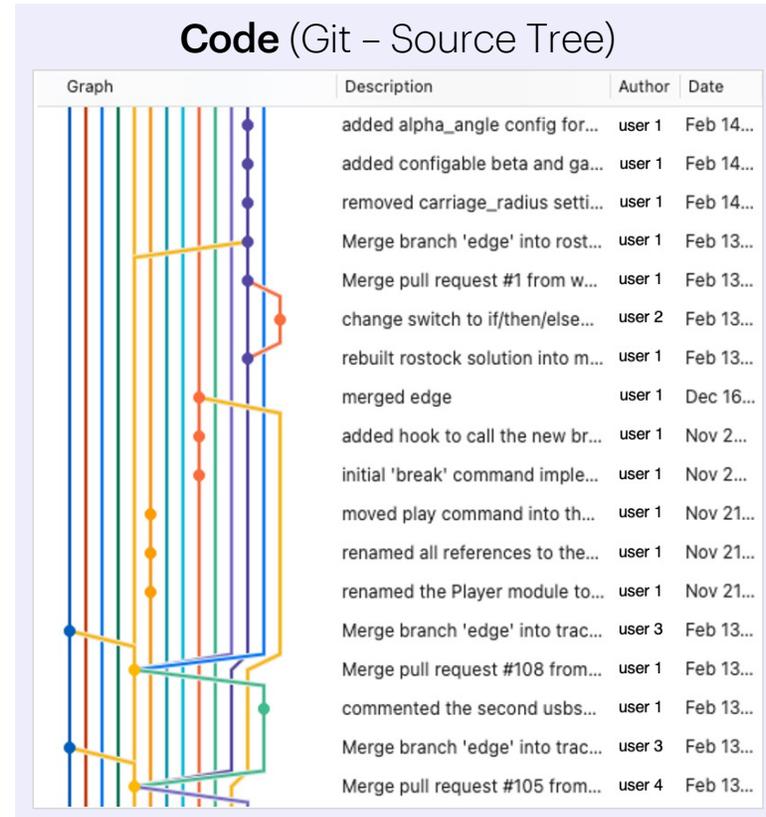
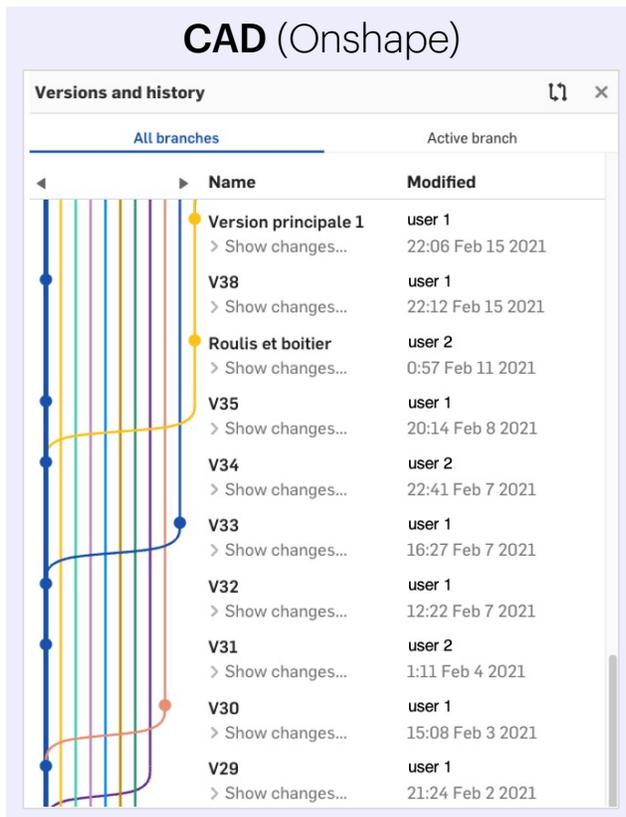
# Branch history is messy and hard to navigate

“The animation displayed is like a personal nightmare, complete with a sensation of vertigo while viewing. It jumps off the screen almost. I hope to comprehend this tree and its long vine-like branches eventually.”

Onshape user (2016)



# This problem exists in both CAD and code



# Branching helps CAD designers with the 3Cs of collaboration

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## coordination

“the management of people, their activities, and resources”

Branches can organize personnel, timelines, resources, and tasks

## communication

“the exchange of messages and information among people”

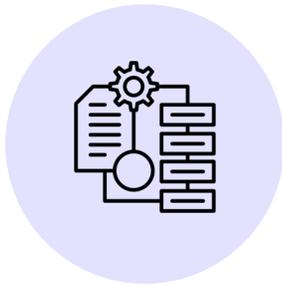
Branches allow a CAD model to act as a shared artifact

## cooperation

“the joint production of members of a group within a shared space”

Branches enable collaboration in a separate, yet linked space

# Our work can benefit branching in the broader CSCW community



Scientific workflow  
management  
systems

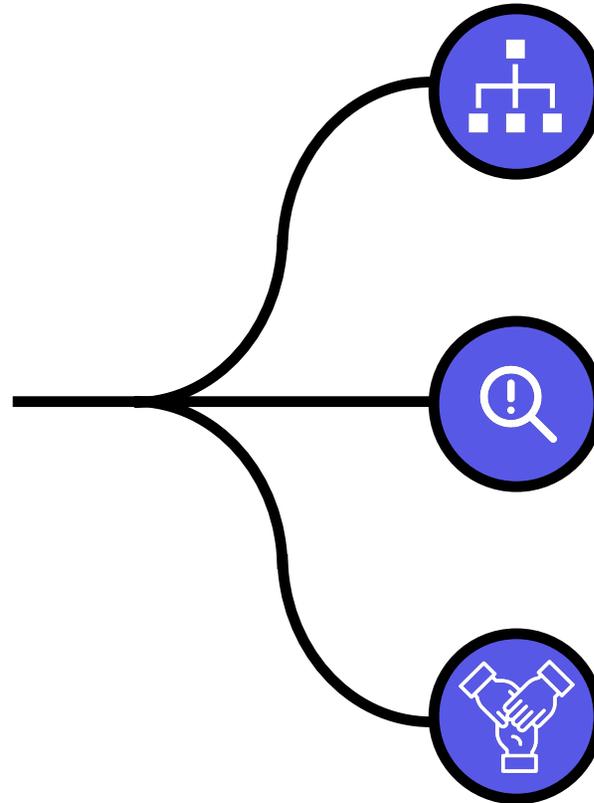


Open  
collaborative  
writing



Creative  
practice

# Key Takeaways



First-ever **taxonomy** of CAD branching use cases

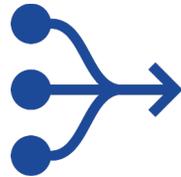
**Future work** to target shortcomings of CAD branching tools

Contributing to fundamental **theory** (3C model) in CSCW

# Future work

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Merging in CAD



Branching practices in  
real-life design projects



Further parallels with  
software & CAD



... multi-user  
synchronicity

# Interested in learning more?

Session

## Collaboration II

Wednesday, Oct 18

9:00AM – 10:30AM

Kathy Cheng

**In the Age of Collaboration,  
the Computer-Aided Design  
Ecosystem is Behind:  
An Interview Study of  
Distributed CAD Practice**

**Kathy Cheng**, Michal K. Davis, Xiyue Zhang,  
Dr. Shurui Zhou, & Dr. Alison Olechowski



USER PERSPECTIVES ON BRANCHING IN COMPUTER-AIDED DESIGN

# Thank you! Questions?

**RQ1:** How do CAD designers use branching?

**RQ2:** What are the shortcomings of CAD branching tools?



**Kathy Cheng**



**Dr. Alison Olechowski**



**Dr. Shurui Zhou**

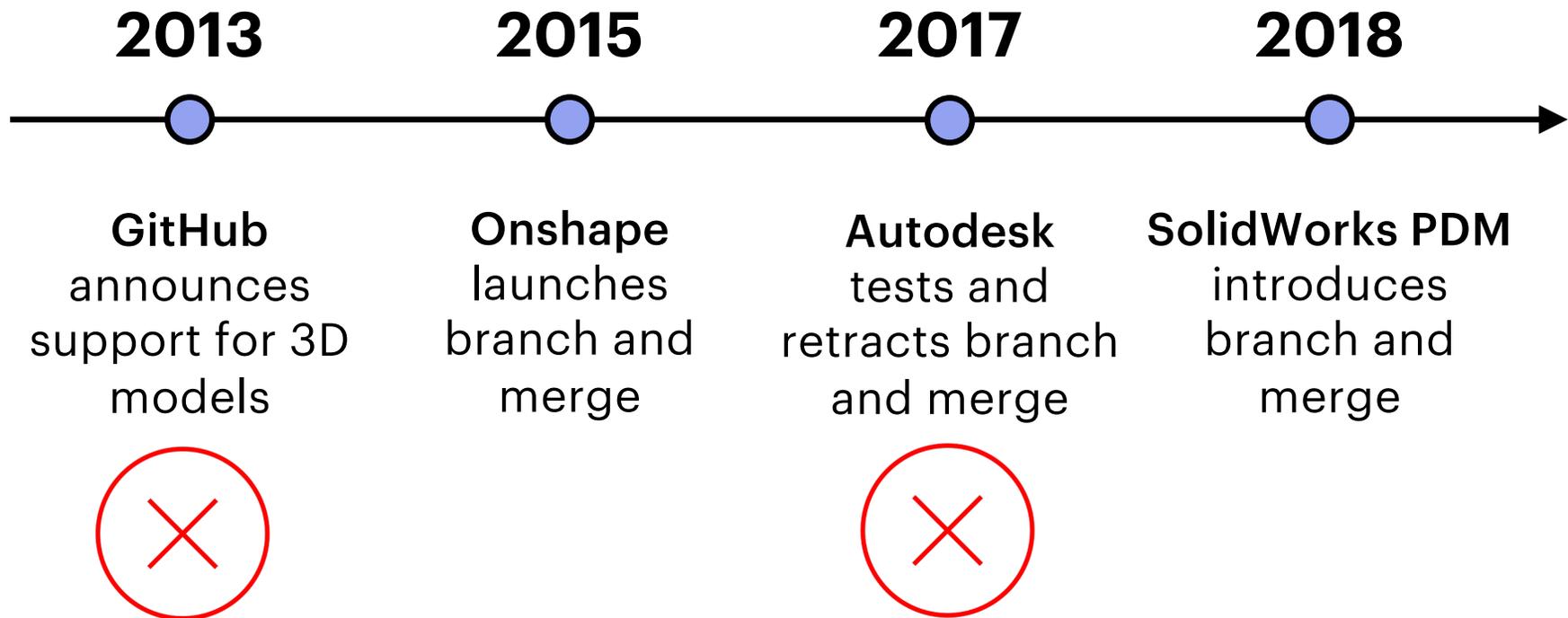
**FORCOLAB**

**READY  
LAB**

 UNIVERSITY OF TORONTO  
FACULTY OF APPLIED SCIENCE & ENGINEERING

CREDITS: This presentation includes icons by Flaticon, illustrations by Storyset, & images by Freepik.

# Branching is still new to CAD



# Previous releases of CAD branch & merge have failed



 **Spencer Wright**  
@pencerv

Replying to @hardi\_meybaum

@hardi\_meybaum Weird about that. Nobody designs in STL, so it's kind of inconvenient. Whoever does diffs for .ipt or .sldprt... that's cool.

10:25 PM · Sep 18, 2013 · TweetDeck



 **keqingsong** 1433 Views, 0 Replies

03-08-2017 05:08 PM

BRANCH & MERGE - Getting Started



## Branch & Merge Preview ending on July 15, 2017

- Based on feedback, how you're using it, how you expect it to work, and how we want to help you overcome challenges, we're ending the Branch & Merge Preview. We took a close look at what we've set out to solve, and instead of releasing the current experience it to the wild that doesn't really do the job quite right, we're going back to engineer a simpler and efficient solution. In the mean time, we're focusing on making sure that Fusion 360 has a robust set of **core data management tools**. Don't worry, it's not ending right away – you have till **July 15** to merge all your branches back to the master branch. If you're having trouble with it or are running into issue, feel free to reach out to us and we'll help you get it sorted out. Thank you for participating – together, we'll get to a better experience.

“Based on feedback,  
we’re ending the  
Branch and Merge  
preview”

“...the current  
experience doesn't do  
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