



Quantum

Design of an enterprise manufacturing data analytics tool

BACKGROUND

Team & the project

Team (Manufacturing Software Systems)

- Program manager
- Google material design team
- UX researcher from Google Cloud team
- Frontend developers
- Offshore design team members

Users

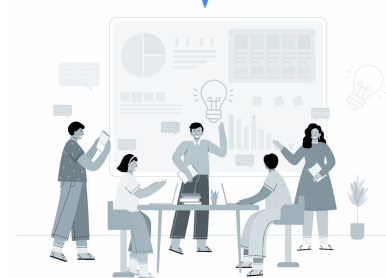
- Program managers
- Test engineers



Test stations &
production lines

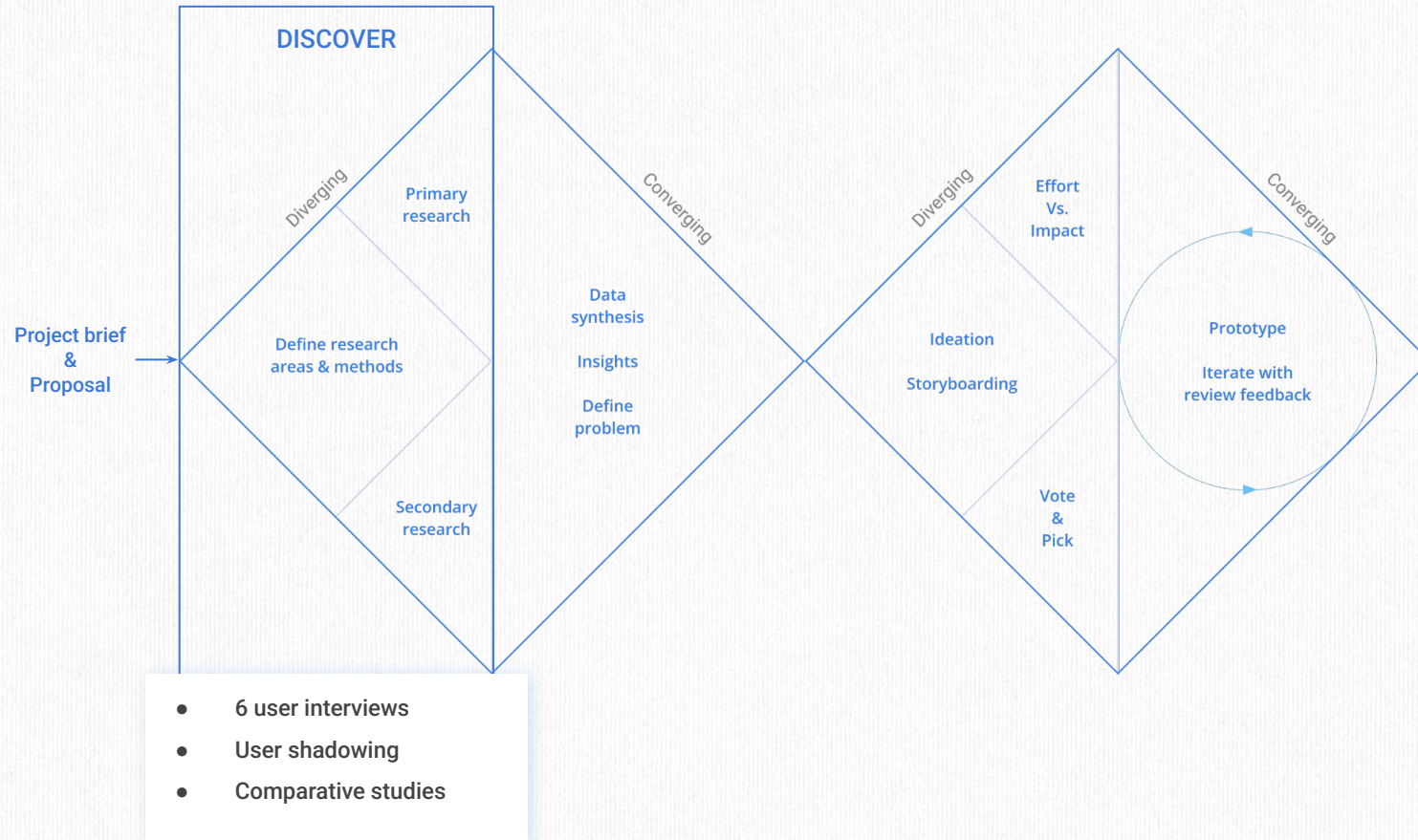


Cloud servers

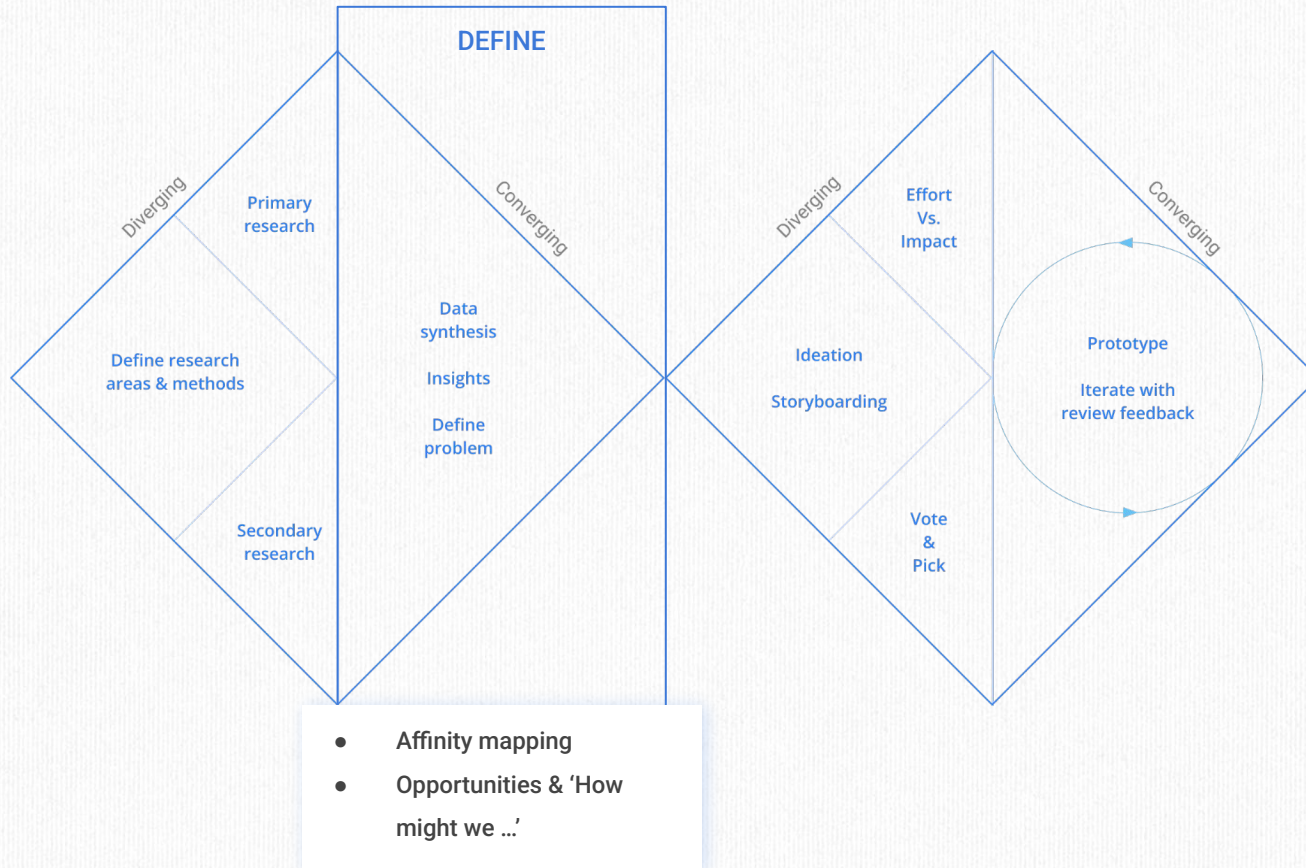


Program managers &
test engineers
exploring insights

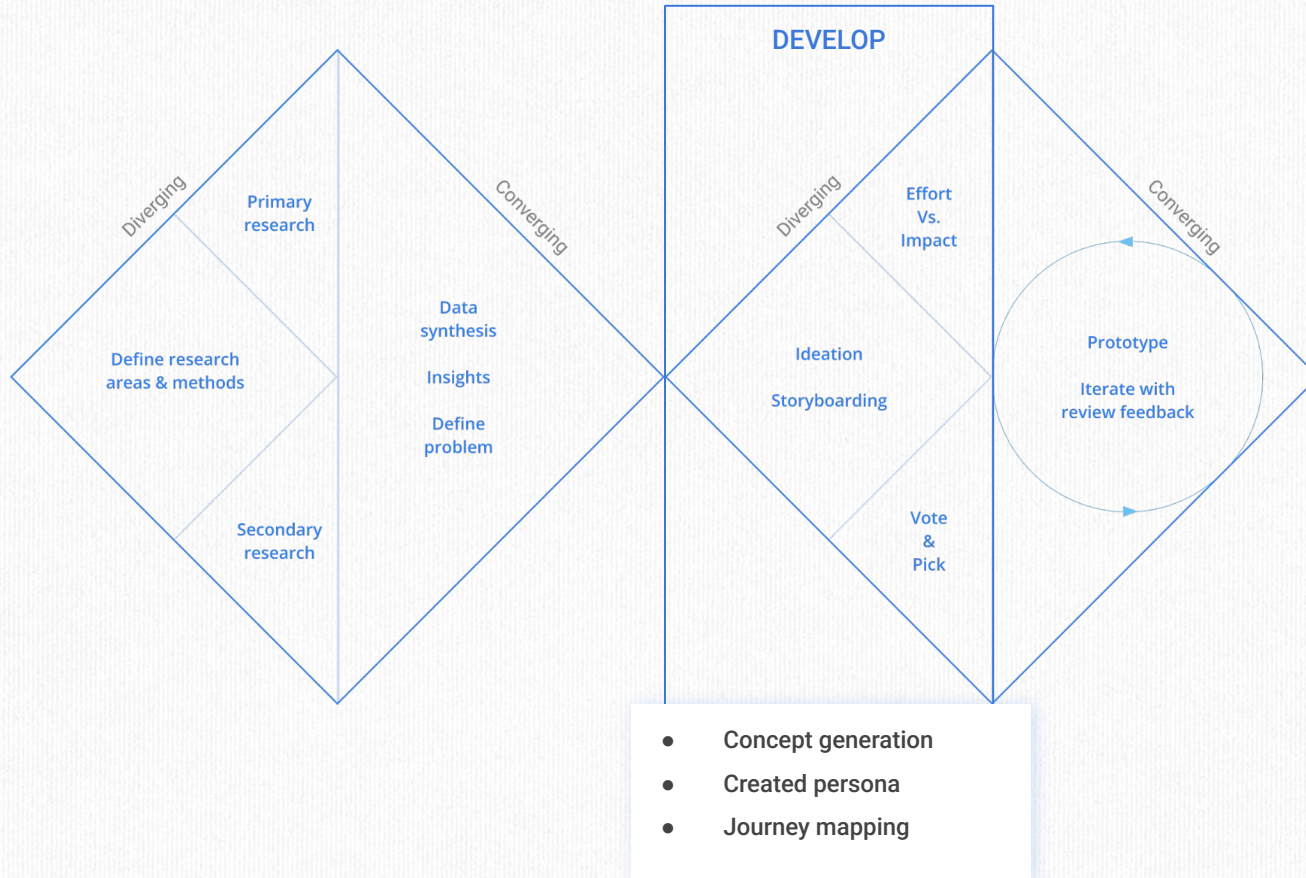
My contributions



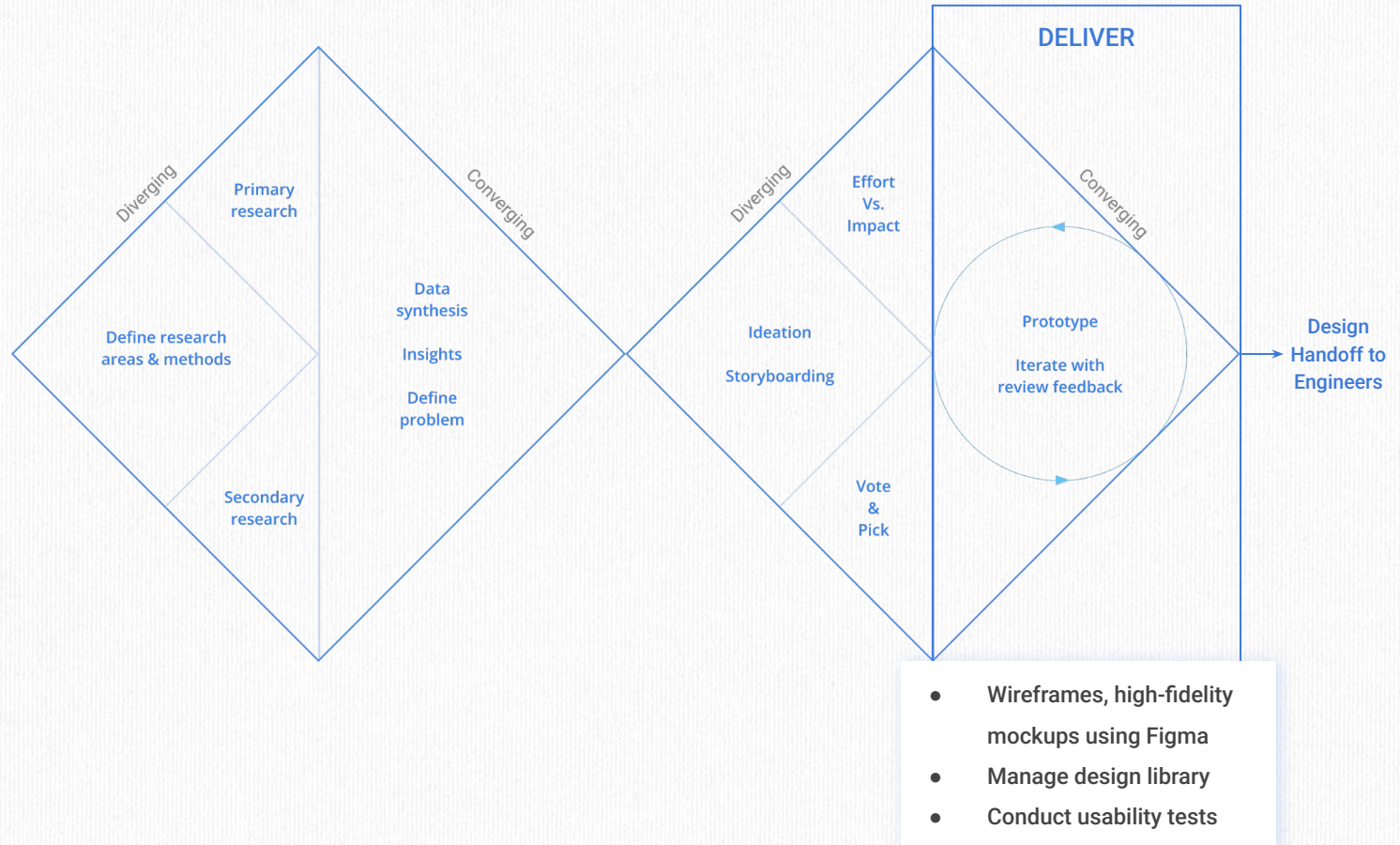
My contributions



My contributions



My contributions



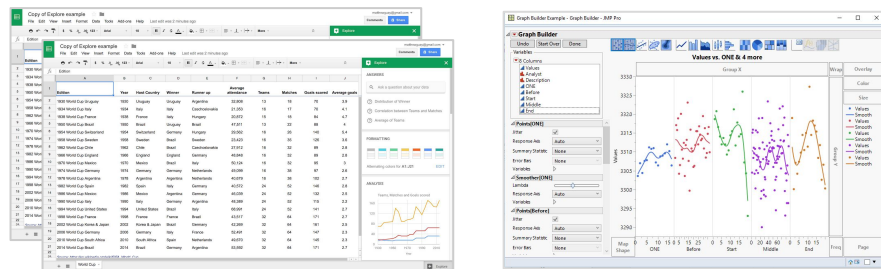
THE PROBLEM

What led to pursuing this project?

Huge amount of complex manufacturing data that gets generated during mass production of Google products at the factory. It was crucial to explore and understand the patterns in data but it presented challenges in terms of:

- Data inconsistencies
- Inefficient access modes
- Data security barriers

Use of several google sheets & visualization tools (JMP, tableau)



Auto-reloading results with way too many dropdown filters

Build phase ▼ Mode ▼ Factory name ▼ Test name ▼ Station ▼ Station ID ▼

Phase name ▼ Measurement name ▼ Device IDs ▼ ERS ▼ Line ▼ Line ID ▼

Line type ▼ SCOF ▼ Live data ▼ Device config ▼

Test name	Station name	Station ID	Phase name	Measurement name	Device config
New func-screen	FATP-01	FATP-01-034838	LED-Test-01	LED-Test-01-sample-meas01	FATP-Dev01
New func-screen	FATP-02	FATP-02-939499	Heat-test-039	Heat-test-039-sample-meas-02	FATP-Dev02
New func-screen	FATP-01	FATP-01-034838	LED-Test-01	LED-Test-01-sample-meas01	FATP-Dev01
New func-screen	FATP-02	FATP-02-939499	Heat-test-039	Heat-test-039-sample-meas-02	FATP-Dev02

Research findings

KEY INSIGHTS

Lack of consistent data specifications

As new cross functional teams collaborated, there were different tools in use for similar needs.

Diverse data definition and specifications often caused teams to conflicting scenarios.



“During reporting, I aggregate all the build data but the tool from the Logistics team does not follow the data specification we use internally in team.. It’s always challenging...”

Julie, 28, Technical Program Manager

KEY INSIGHTS

Data intensive & engineering centric experience is not always preferred

Most senior executives and product managers preferred glanceable content with primary issues, yield trends than data-busy and complex visualizations.



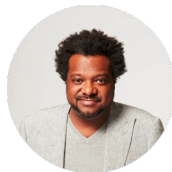
“It’s essential to have details ongoing top issues a click away... but I end up having to contact several team members to compile these insights.. ”

Dave, 47, Lead Product Specialist

KEY INSIGHTS

Fragmented experience to answer feature-based questions

While users frame queries based using 'if ... else ...' and other connectors, this involved numerous filters and conditions. This presented inefficient and difficult ways to get answers for feature-focussed questions.



"It's hard to create these complex queries and it is challenging for me everytime... I prefer to ask a human instead..."

Philip, 27, Equipment staff, Sony (Vendor)

User persona & journey mapping



Maya
AGE 27
OCCUPATION Test Engineer

"Whenever I notice any patterns in data, I tend to associate my past experiences to make new conclusions"

GOALS

Efficiently debug issues with manufacturing test data.
Minimize product quality issues proactively.
Ensure factory yield goals and product build target are met.

NEEDS

I want to analyze factory data efficiently.
I want to derive important insights by visualizing manufacturing test data.
I want to discover test failures at the earlier stages of product builds.

PAIN POINTS

Does not understand acronyms that are manufacturing specific, slow performing data dashboards frustrates most often.

TECHNOLOGY EXPERIENCE

Uses wide variety of software applications, computer programming tools to synthesize data insights - JMP tool, Python, SQL programming, Tableau.



Sam
AGE 35
OCCUPATION Product Manager

"Being proactive is crucial to me. I want to understand what is the problem, how we solved it and an indication that it is no more a problem"

GOALS

Proactively identify and address factory issues.
Collaborate with necessary stakeholders to achieve team's goals.
Ensure cost effective solutions meanwhile making sure efficient manufacturing process.

NEEDS

I want to be able to take the data and solve problems on-time.
I want to understand overall status in factory and drill-down into data when necessary.
I want to export insights from dashboards to outside applications for communicating with stakeholders.

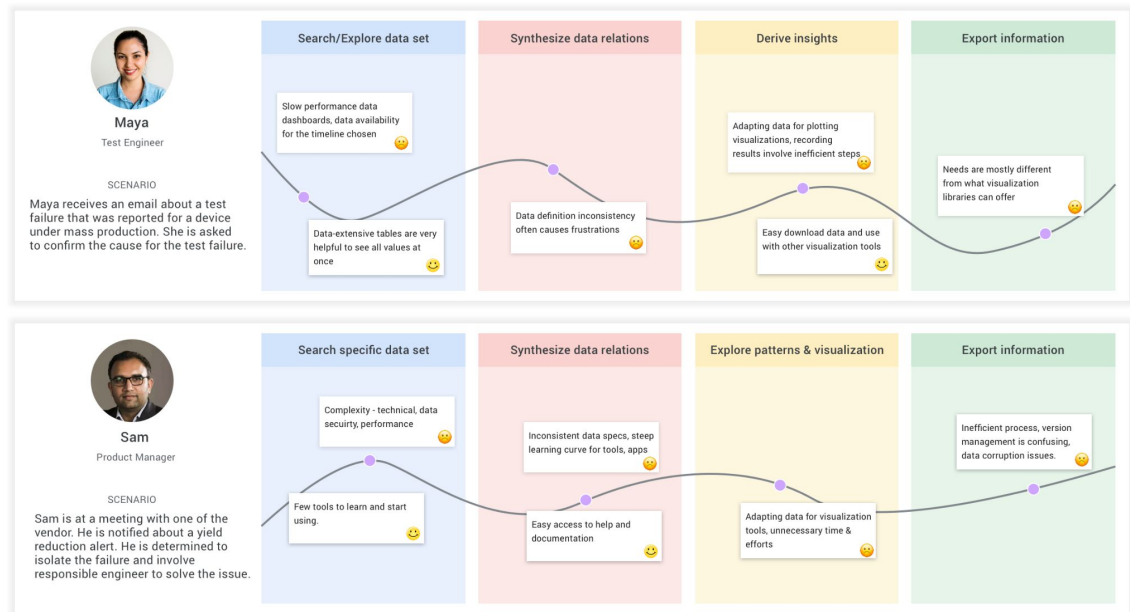
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TECHNOLOGY EXPERIENCE

Uses wide variety of software applications, computer programming tools to synthesize data insights - JMP tool, Python, SQL programming, Tableau.

With the help of analyzed research data, we arrived at user personas that facilitated storytelling & internal communication. Further, we articulated journey map detailing opportunities at each step.



The Challenge

How might we design for efficient **feature-based insight exploration** with **centralized data specification** and support **glanceable experience** alongside data-intensive dashboard?

CRITICAL USER JOURNEYS

Connecting users with their deeper need - Goals



User



Tasks



Goals

#1

As a **Program manager**, I want to **understand failure insights** efficiently so that I can take **proactive measures to avoid/detect them at latent stage**

#2

As a **Program manager**, I need to **quickly obtain factory yield** data so that I can estimate **factory infrastructure procurement needs effectively**

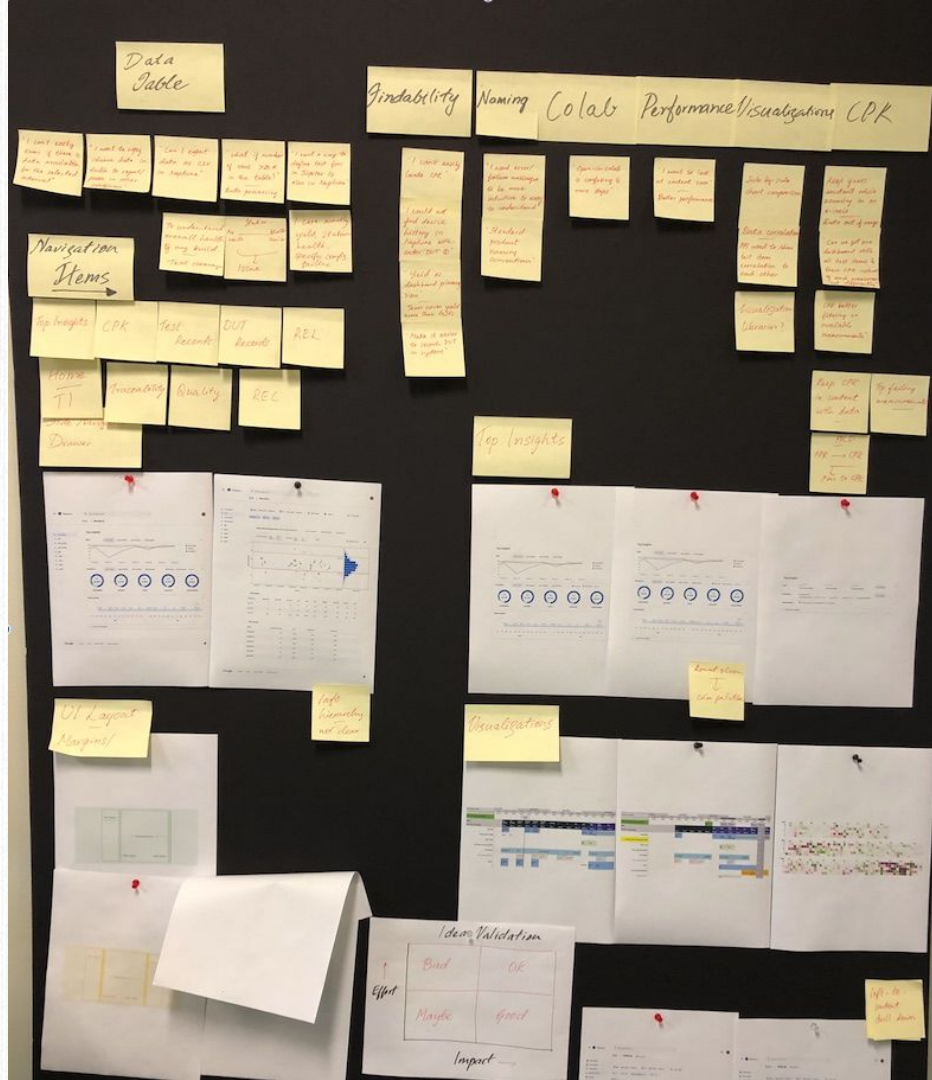
#3

As a **Test engineer**, I want to **explore & debug failures** efficiently so that I can ensure **factory daily yield needs are met**

Brainstorming session

Within a group comprised of all our stakeholder representatives - **test engineers, PMs, executive members, vendor company team**, we generated concepts.

These concepts were later voted and split based on **'Impact Vs. Effort'**. We picked the top three concepts to prototype further.



Prototyping & design iterations

Progressive content disclosure

Finding a balance between 'engineering centric' view and 'glanceable insight view'

Quantum

Search by 'Device ID, Station name ...'

Headphones > Mario foxconn-vn

From May 3, 2019 09:30 pm To May 9, 2019 10:30 pm Past 7 days Station Station ID Build stage

Line stage Line SN Configuration Device SN Order By

Explore

Date (Factory time GMT+8)	Device SN	Station name	Initial Qty	Fail Qty	Yield	Retest rate
2019-05-28 18:57:24	96011FFBA000AA	PRESSMON	322	23	92.31	15.03
2019-05-28 18:57:13	96011FFBA000B5	FUNC20	288	19	92.45	12.5
2019-05-28 18:57:24	96011FFBA000AA	AIRMEAS	165	12	95.60	9.69
2019-05-28 18:57:13	96011FFBA000B5	BTRYCHK	84	8	92.31	5.88
2019-05-28 18:57:24	96011FFBA000AA	PCCHK	28	3	92.45	3.42
2019-05-28 18:57:13	96011FFBA000B5	TEMP54	684	14	95.60	22.01
2019-05-28 18:57:24	96011FFBA000AA	TRANS_24	288	19	92.31	12.5
2019-05-28 18:57:13	96011FFBA000B5	ACCMTR	165	12	92.45	9.69
2019-05-28 18:57:24	96011FFBA000AA	KYBRDCHK	84	8	95.60	5.88
2019-05-28 18:57:13	96011FFBA000B5	WRLSS	28	3	92.45	3.42
2019-05-28 18:57:24	96011FFBA000AA	PCCHK	188	12	95.60	4.31

Total 2500 records found

Quantum

Search by 'Device ID, Station name ...'

Headphones > Mario foxconn-vn

Line type Last 2 days Last 7 days Aggregate yield (%)

FUNCPROD

Station name	Initial qty	Pass qty	Failed qty	Retest qty	Retest rate (%)	Yield (%)
PRESSMON	322	267	25	23	15.03	92.31
FUNC20	288	252	21	19	12.5	92.45
AIRMEAS	165	135	15	12	9.69	95.60
BTRYCHK	84	68	11	8	5.88	99.88
PCCHK	28	24	6	3	3.42	99.92

Load 20 more records

Line type Last 2 days Last 7 days Aggregate yield (%)

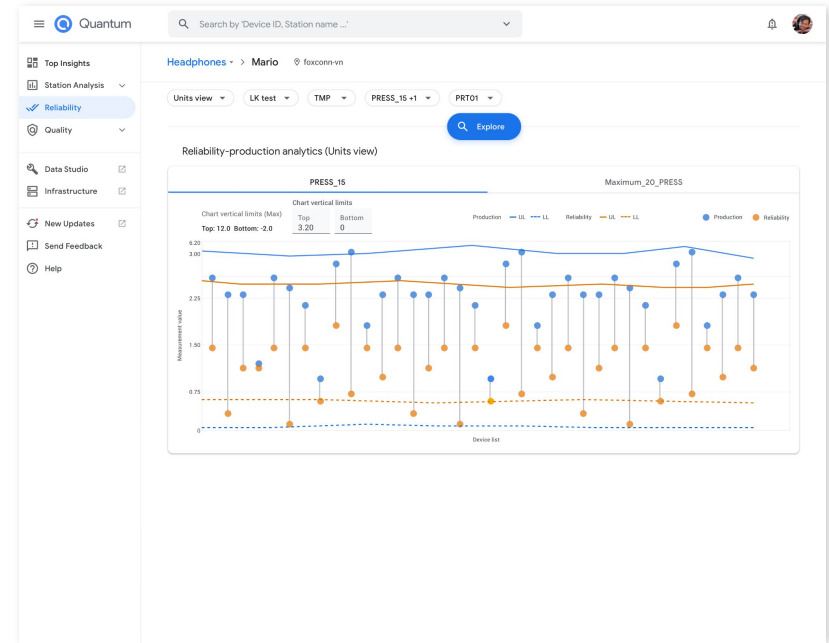
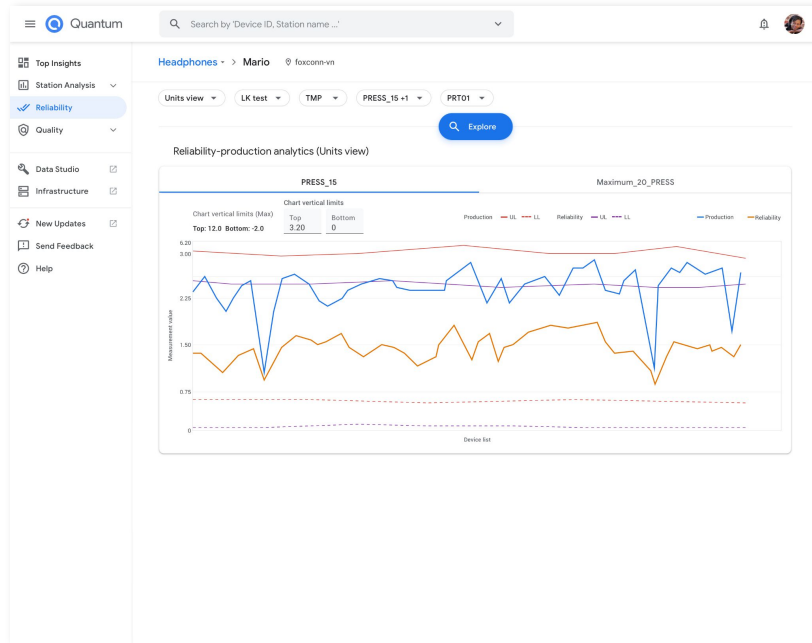
RELPAC

Station name	Initial qty	Pass qty	Failed qty	Retest qty	Retest rate (%)	Yield (%)
TEMP54	684	656	15	14	22.01	94.32
TRANS_24	288	252	21	19	12.5	92.45
ACCMTR	165	135	15	12	9.69	95.60
KYBRDCHK	84	68	9	8	5.88	99.88
WRLSS	28	24	3	3	3.42	99.92

Load 12 more records

How best to represent relative aspects of data?

Moving away from conventional charts to explore effective ways to achieve intended outcome

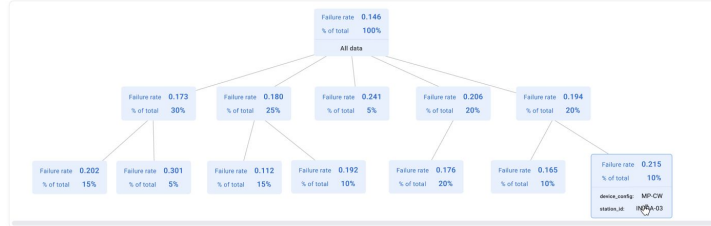


Efficient way to analyze multi-dimensional data insights

Facilitating efficient way to analyze multi-dimensional data (Tree view Vs. Icicle diagram)

0.1226944667201283	frozenset((571_B3_L1_FATP-LED-CAL_...	1.0704905182239381e	2.9159412810838512e-06	0.2030848329048843	0.04578984540532057
0.06335204490777867	frozenset((2116120005))	9.76174481736057e-07	3.6735377025347195e-13	0.18035694490632967	0.35395963633367337
0.43491045175086873	frozenset((2116120007))	4.621033340268166e-2	2.6990549093722096e-11	0.18035694490632967	0.04578984540532057

Tree chart



Itemset chart view

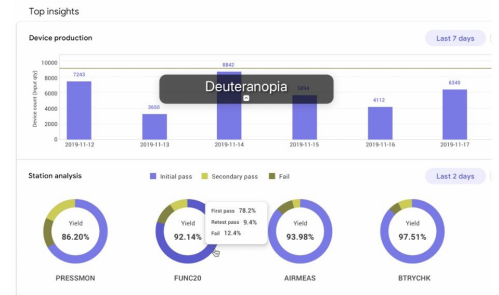
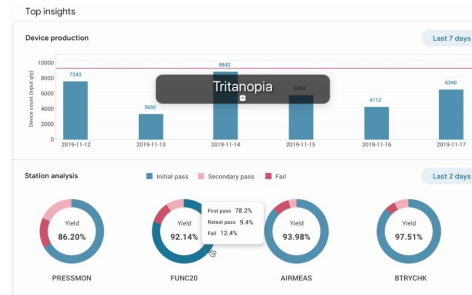
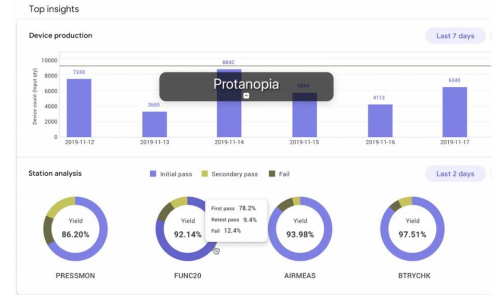


Testing for accessibility

Validating with a11y recommendations for 'voice-over' , contrast ratio checks & vision test

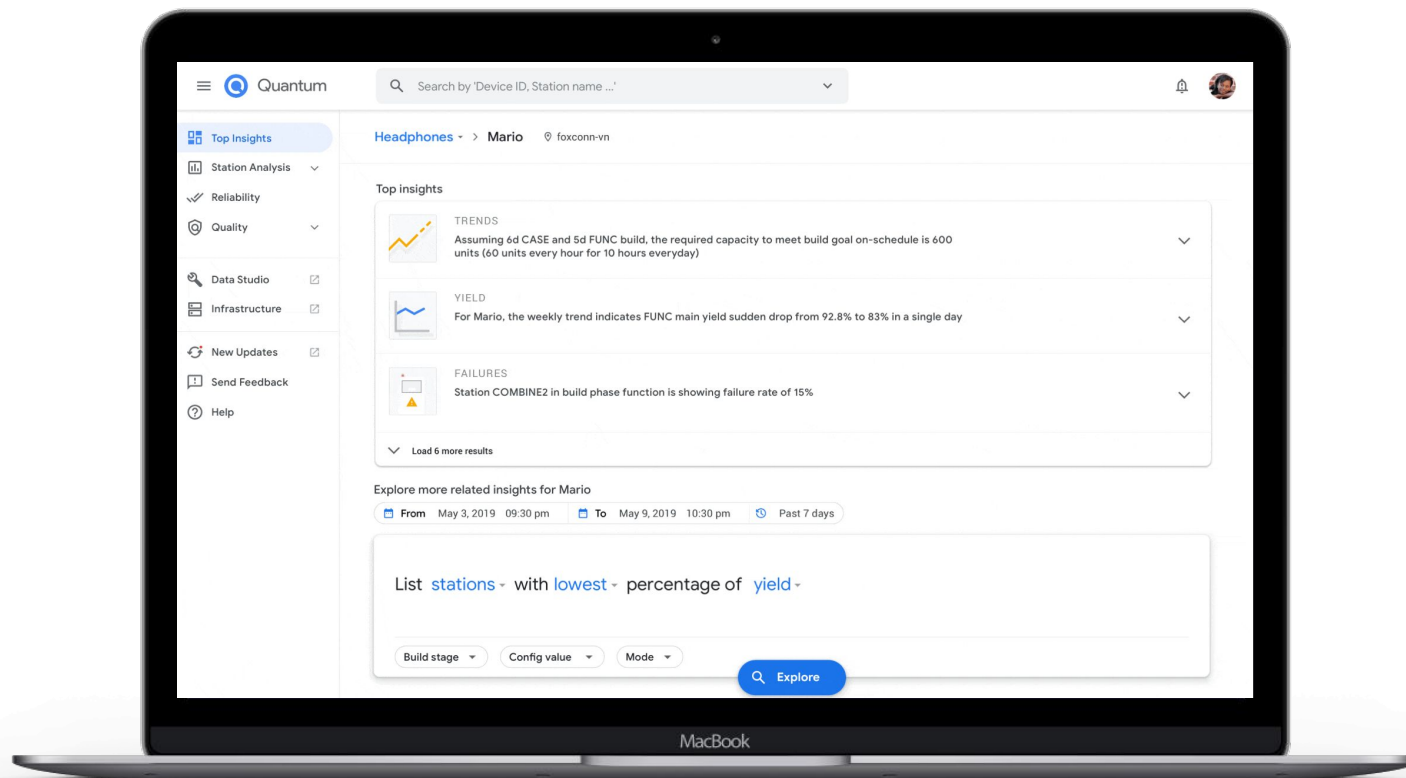
Global code	
A11Y accessibility recommendations	Additional details
lang attribute:	
1 <html lang="en">	
title attribute:	
2 <head>	
<title>Quantum top insights</title>	
</head>	
Side navigation:	
3 <div role="navigation" aria-label="Primary"> ...	
headings:	
Top insights	
4 Top yield records by line type	
Product selection:	Dynamically update aria-label after users selects a different product & location:
5 <div role="Product selection menu" aria-label="Product far document.getElementById('main-product-selection').setAttribute('aria-label', 'Product family-Headphones, product selected-Mario and location selection-Side nav Expand/Collapse button:	
6 <div role="Expand/Collapse button" aria-label="Expand or collapse side navigation"> ... </div>	

Data Tables																											
Sample table <table> <tr> <th>Line</th><th>Yield</th><th>First pass</th><th>Second pass</th><th>Fail</th></tr> <tr> <td>1</td><td>86.20%</td><td>78.2%</td><td>9.4%</td><td>12.4%</td></tr> <tr> <td>2</td><td>92.14%</td><td>9.4%</td><td>12.4%</td><td></td></tr> <tr> <td>3</td><td>93.98%</td><td></td><td></td><td></td></tr> <tr> <td>4</td><td>97.51%</td><td></td><td></td><td></td></tr> </table> 1	Line	Yield	First pass	Second pass	Fail	1	86.20%	78.2%	9.4%	12.4%	2	92.14%	9.4%	12.4%		3	93.98%				4	97.51%				A11Y accessibility recommendations Screen readers scan line-by-line within tables. 1. Add table caption 2. Add scope markup for columns and rows	Sample table accessibility changes <pre> <table> <caption>Yield records</caption> <thead> <tr> <th class="Zhuome">scope="col">Date</th> <th class="Yield1">scope="col">Input Qty</th> </thead> <tbody> <tr> <td class="YieldTotal">scope="row">2019-12-16</td> <td class="YieldTotal">34224</td> </tr> </tbody> </table> </pre>
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4	97.51%																										
Buttons/Chips																											
Sample assist chips Last 7 days Last 2 weeks 1 2 	A11Y accessibility recommendations Include focus state for button/chip Add descriptive aria-label attribute Icon-based button to contain 48dp click target space	Sample table accessibility changes Date interval assist chip buttons: <div role="button" aria-label="Show data visualization for the last 7 days"> ... </div>																									



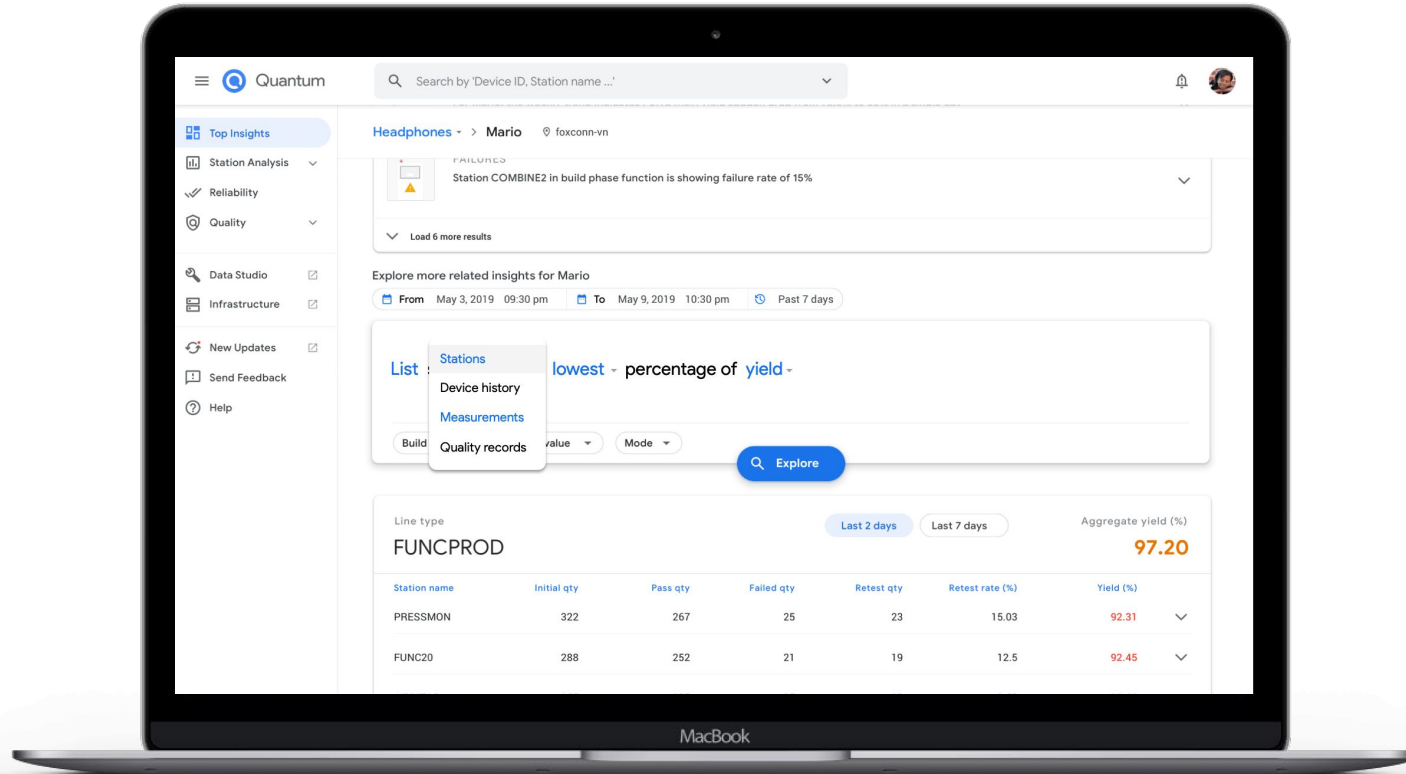
The Solution

Top Insights view



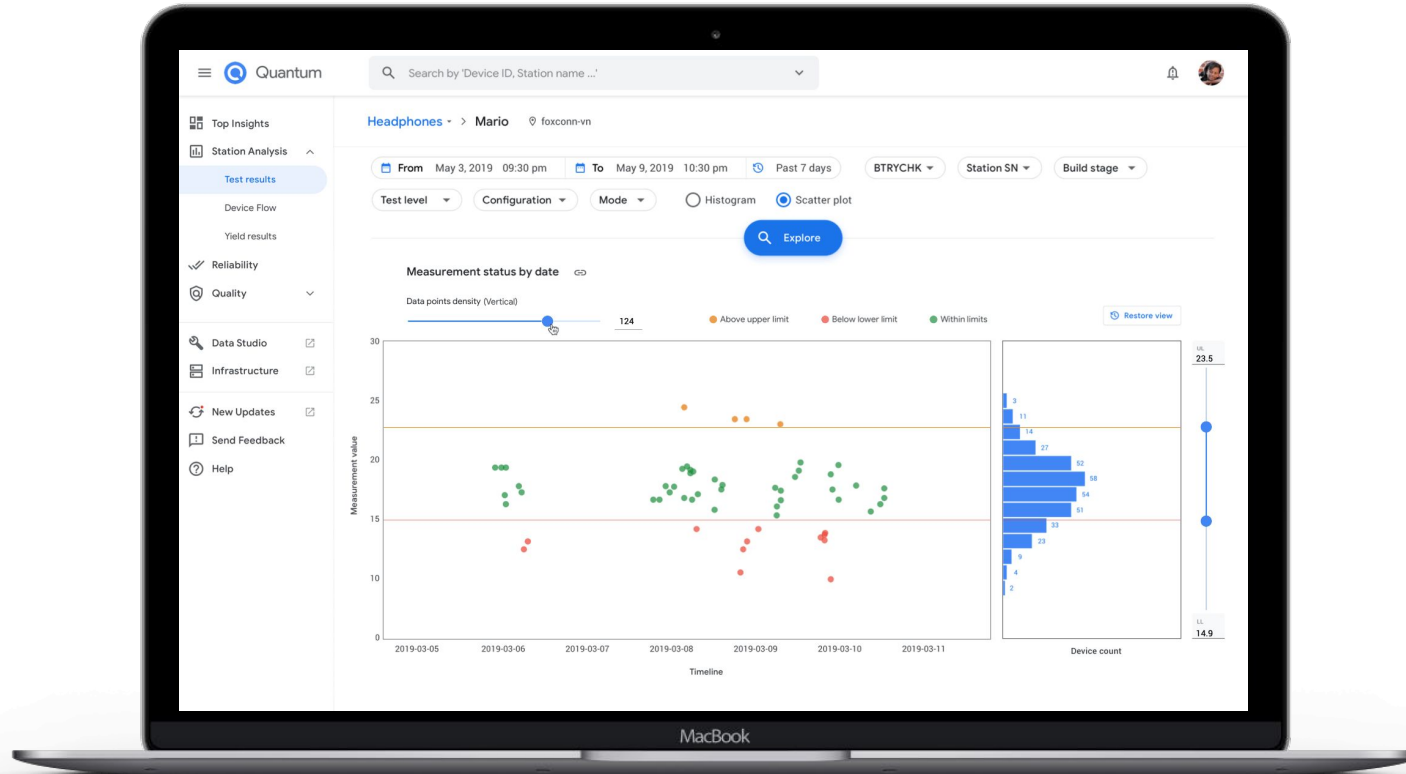
Leveraging the power of machine learning to synthesize high-level insights that are glanceable, quick and most-value added to users.

Feature-based data exploration



An intuitive, simple and conversational approach to explore manufacturing data insights. This minimized the need for complex query filters.

Centralized data specifications & analysis



With consensus across multiple cross functional teams, a single spec was applied to analyze and derive projections.

What did we accomplish?

- Daily yield (units produced) - increase by **18%** overall.
- **Adoption of 'Quantum'** by other cross functional teams internally at Google - **72%** increment in page visits per week after launch.
- Saved an **average of 1.5 hours** for test engineers troubleshooting station issues.
- Product returns from customers to 'Failure analysis' dropped by an average of **24% overall**.