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CSIRO

Intelligent Extrusion Product

From idea to validated design prototype

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Acknowledgement of Country

Digital Village wishes to acknowledge the traditional custodians of the land on which our office stands, the Gadigal people of the Eora Nation. We extend this respect to all Aboriginal and Torres Strait Islander peoples — to Elders past, present, and emerging — and acknowledge the important role First Nations people continue to play within the global business community.

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Welcome to Digital Village

Get connected to a network of digital experts who love to collaborate and build products that will delight your customers.

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Executive Summary

CSIRO is Australia's leading scientific research agency with coverage across multiple industries.

Over the course of FY23, the scientific research team within the Agriculture & Food sector, have explored the needs of academics, food governing bodies and corporates alike, to understand data usage and needs within the food extrusion process.

Across the varying customer segments, it was clear there were 6 areas of opportunities to explore developing a platform that could utilise existing complex data to provide and enhance both the decision making and extrusion processes.

This included:

- Extrusion Expert System
- Literature database (+ AI tool for automatic article addition)
- Concept map of food extrusion – Digital learning tool
- Ingredient property database
- Formulation & Process Builder – AI tool for prediction of product quality
- Company & Product Map – food extrusion industry
- Computational (surrogate) modelling tools + Digital Twin visualisation

The team at CSIRO, partnered with Data61, have approached Digital Village to understand how they can realise this product vision for an initial high profile customer segment. This document represents the outcome of this process, developing an Intelligent Extrusion Platform.

01

The Design Sprint Process

Removing the ambiguity of the extrusion process

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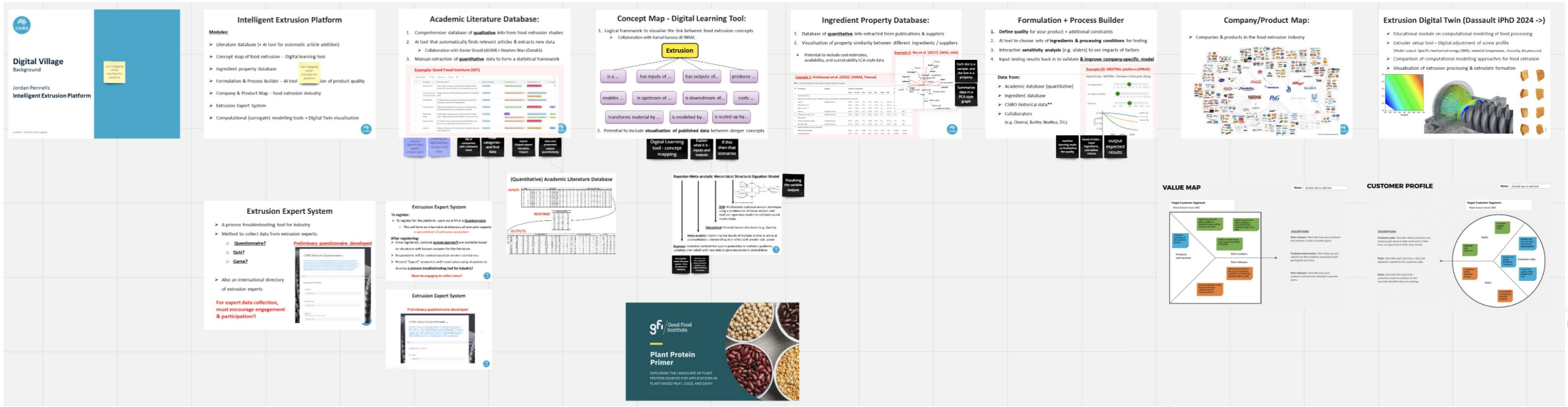
Overview of the Design Sprint

Period	Week 1 - IMMERSION		Week 2 - Design Sprint				Week 3-4 TEST & PLAN	
	Day 1-3	Day 4	Day 1	Day 2	Day 3	Day 4	Wk 3	Wk 4
	Immersion	Synthesis	Align & Ideate	Solutioning	Prototyping	Test	Iterate	Roadmap
Outcomes	Collated customer research, exploring	Consolidation of business outcomes Identified core opportunities	Defined business objectives and opportunities Prioritised product opportunities (through the Salesforce lens)	A product idea defined and sketched, ready for prototyping Customers prepared for validation on day 4	Single mid-fidelity prototype developed in Figma ready for testing Customer interview questions, stories and flows	Understanding if the idea is development ready.	Refined product idea 2nd phase project validation	Product delivery roadmap

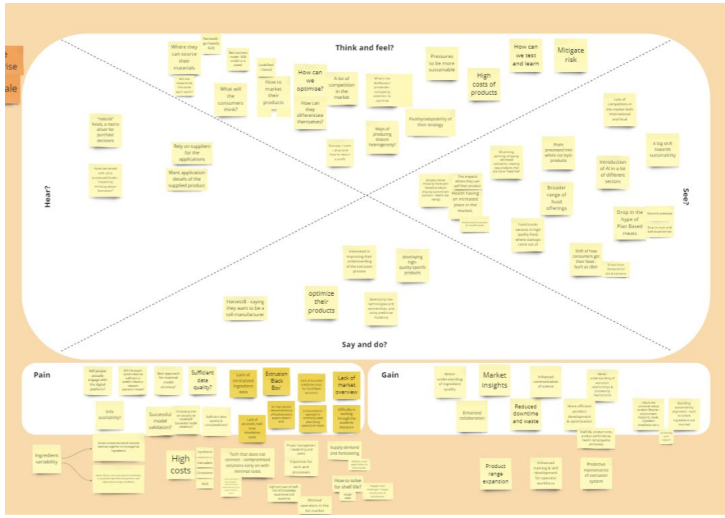
Detailed Market & Customer Research

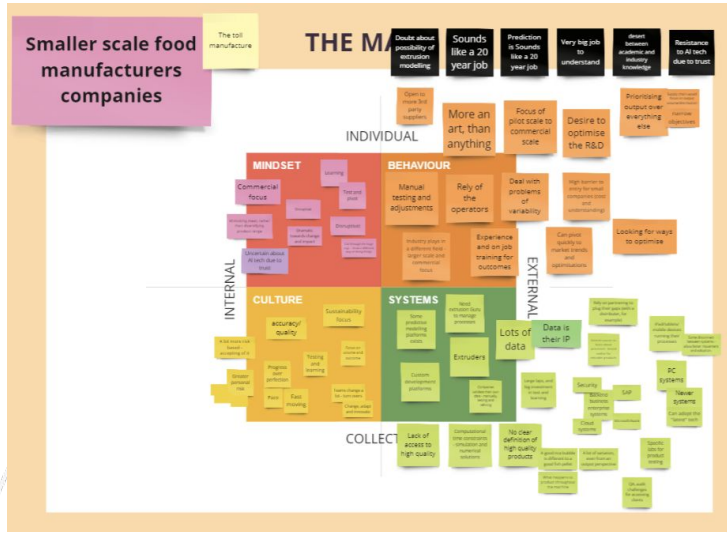
CSIRO teams conducted in-depth research with 50 customers across multiple sectors who utilise extrusion including researchers/scientists to manufacturers of products, ingredients and the extruders themselves.



Focus: Smaller scale food manufacturing companies

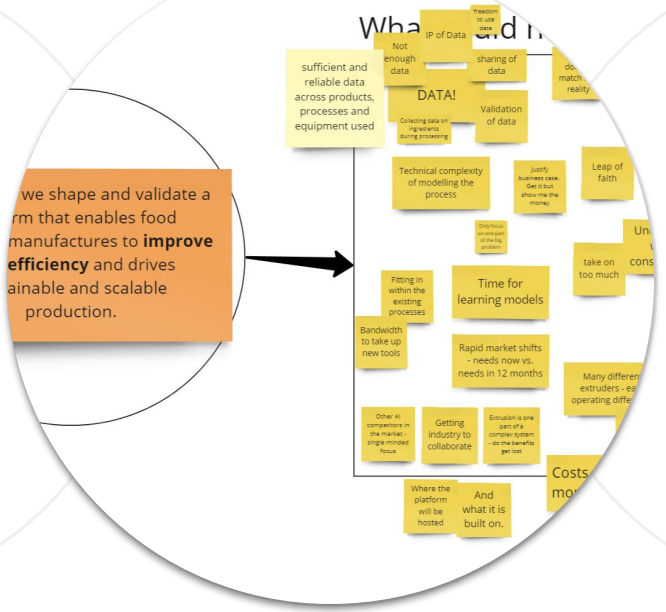
- **Adaptable Yet Cautious:** Eager to innovate and optimize but wary of data quality and new technologies like AI.
- **Commercially Driven:** Primarily focused on B2B models, with an intense emphasis on output and scalability and very cautious about their IP.
- **Sustainability & Health Focus:** Aware of the shifting consumer preference towards sustainable and health-conscious foods.
- **Tech-Ready but Skeptical:** Open to adopting predictive modeling and other advanced technologies, yet concerned about their reliability.
- **Operational Hurdles:** Face challenges in supply chain management, high staff turnover, and cost-efficiency.
- **Market-Sensitive:** Keenly attuned to market trends, competitive landscape, and the need to differentiate their offerings.



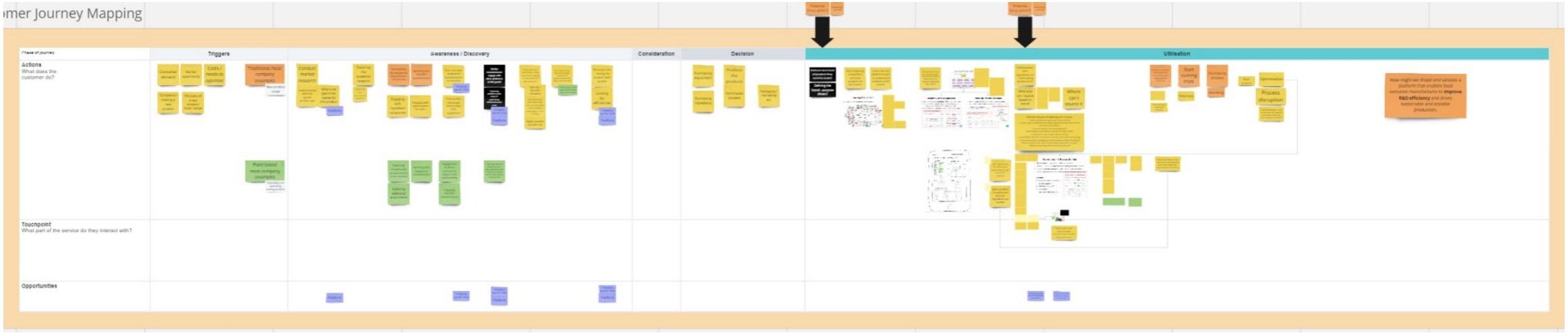


North star!

How might we shape and validate a platform that enables food extrusion manufacturers to improve R&D efficiency and drives sustainable and scalable production?



The Customer



Triggers

Factors like consumer demand, market opportunity, or competitive moves, exploring new or optimize existing products.

Awareness - Discovery

Customer is deeply engaged in market and academic research, exploring equipment needs, and considering third-party consults or partnerships for specialized support.

Decision

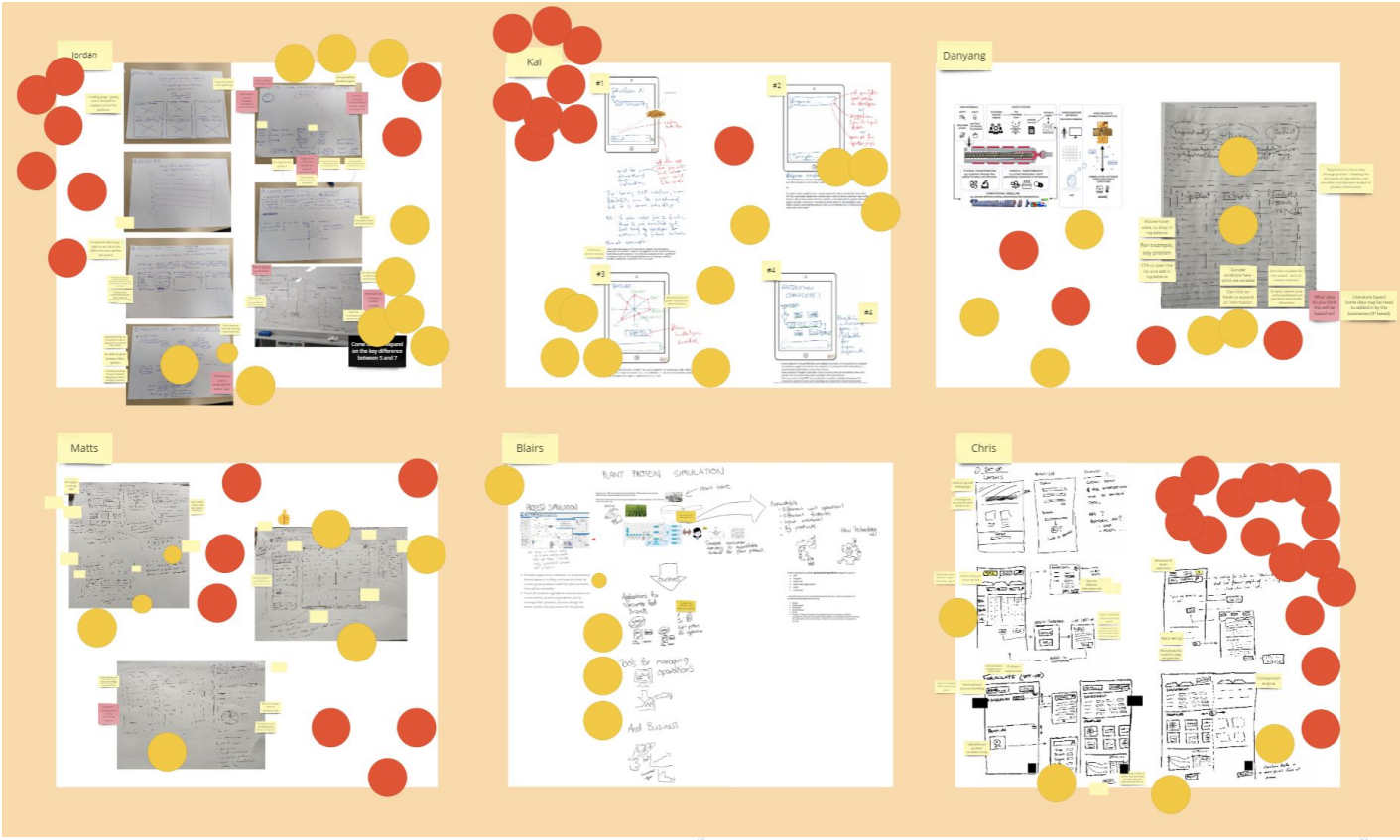
Defining product briefs, engaging with suppliers, and initiate trials.
Dive into databases and platforms to better understand the market landscape and possibilities for optimisations.

Utilisation

- **Product definition:** Companies articulate the product's brand identity, considering elements like sourcing, price point and sustainability.
- **Business Model/Costs:** Deep dive into cost considerations, including supply chain economics and sustainability factors.
- **Output:** Companies look at the end-product quality and variables, including nutritional breakdown, shelf life, and overall cost, fine-tuning these parameters for market readiness.

Ideate Product Design

1. What might the product look like?
2. What features could support the customer needs and pain points?
3. How can we simplify the journey, focussing on the outcome?

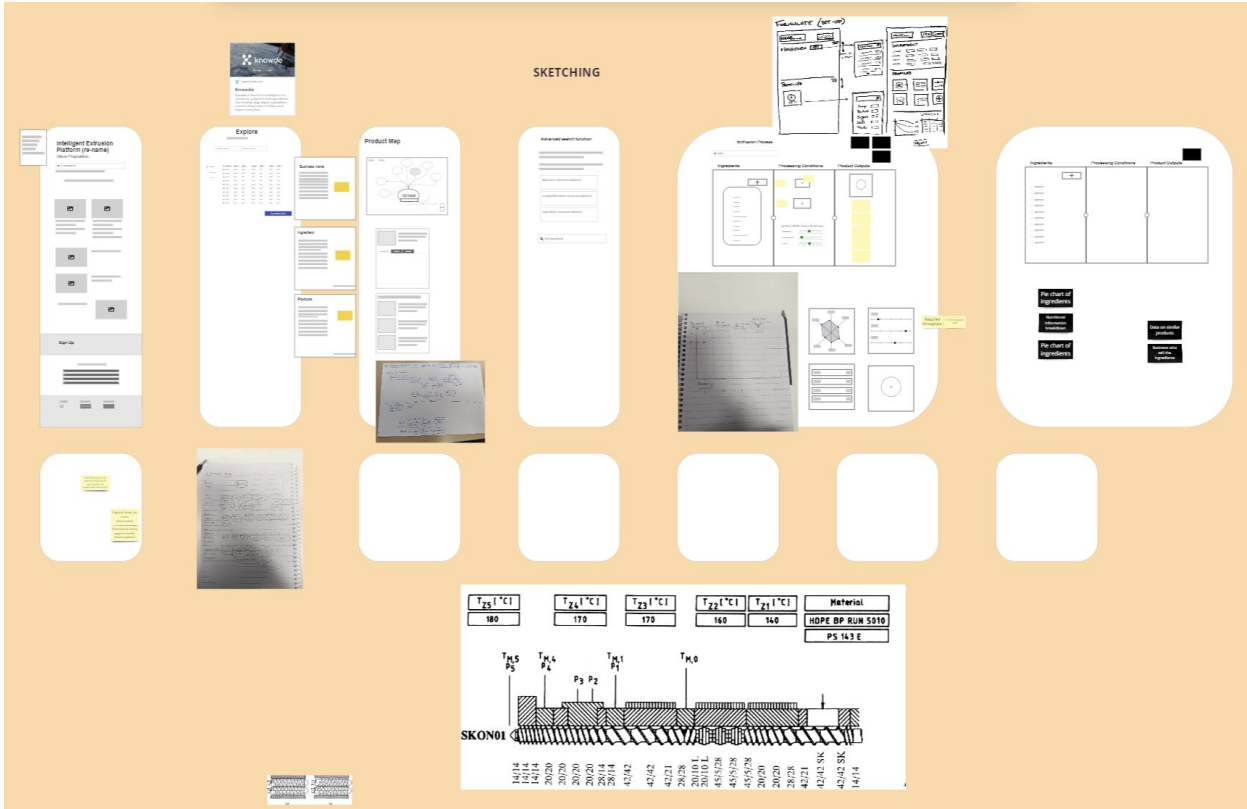


Shape Our Blueprint

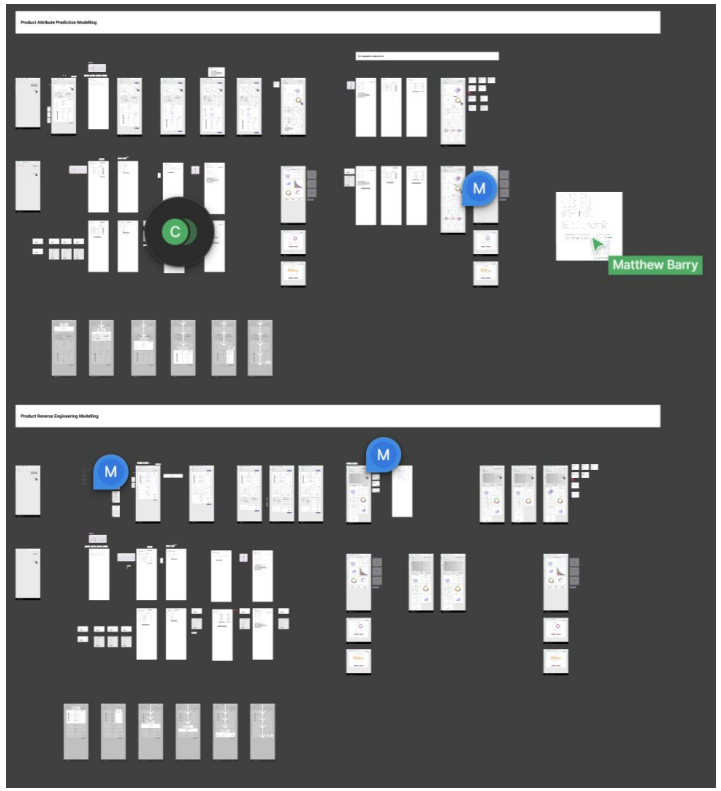
A 6 step journey was mapped out as visually as possible utilising design decisions made to become the foundations of the prototype.

Covering:

1. Landing page
2. Explore pages - research data
3. Supporting AI tools
4. Extrusion builder:
    a. Set up product/builder
    b. Adjust conditions
    c. Output and analysis



Clickable Design Prototype In Figma

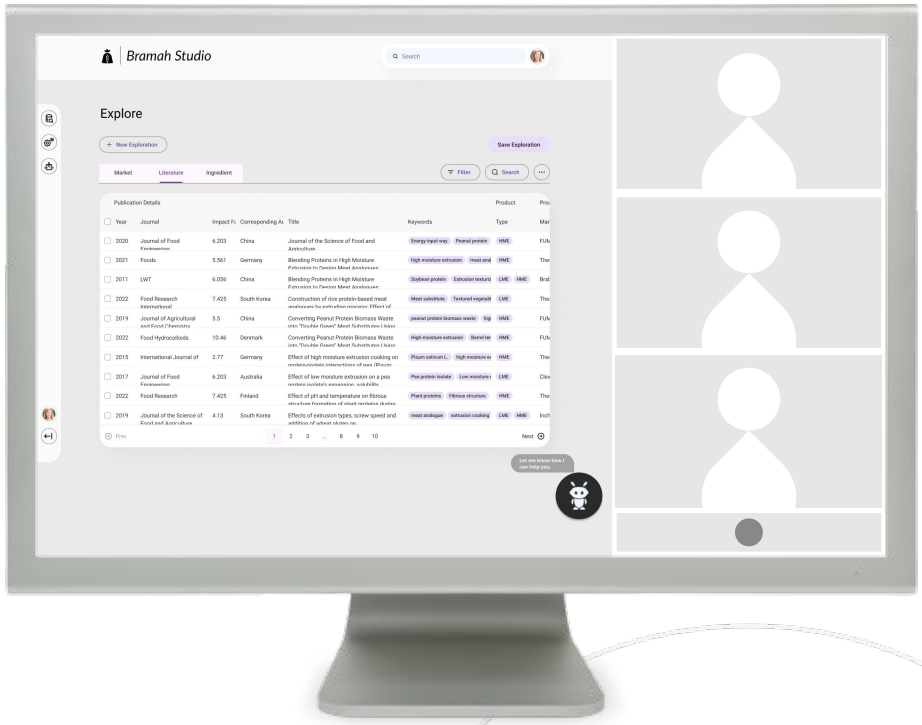


Access the Figma File [Here](#).

Customer Validation - What We Learnt

- IP is king, how we can we cater for the extrusion process for unknown extruders?
- Clear call to actions and a need for clear definitions at each point
- Search and AI tools are of greatest interest - allowing the user to test up front and provide trust in the tool
- General optimisations and flows to make it easier to get through the platform

Consensus: if we can pull off the automation and have trust in the data, we have a winner of a product!



02

Extruder Modeling Platform

Removing the ambiguity of the extrusion process

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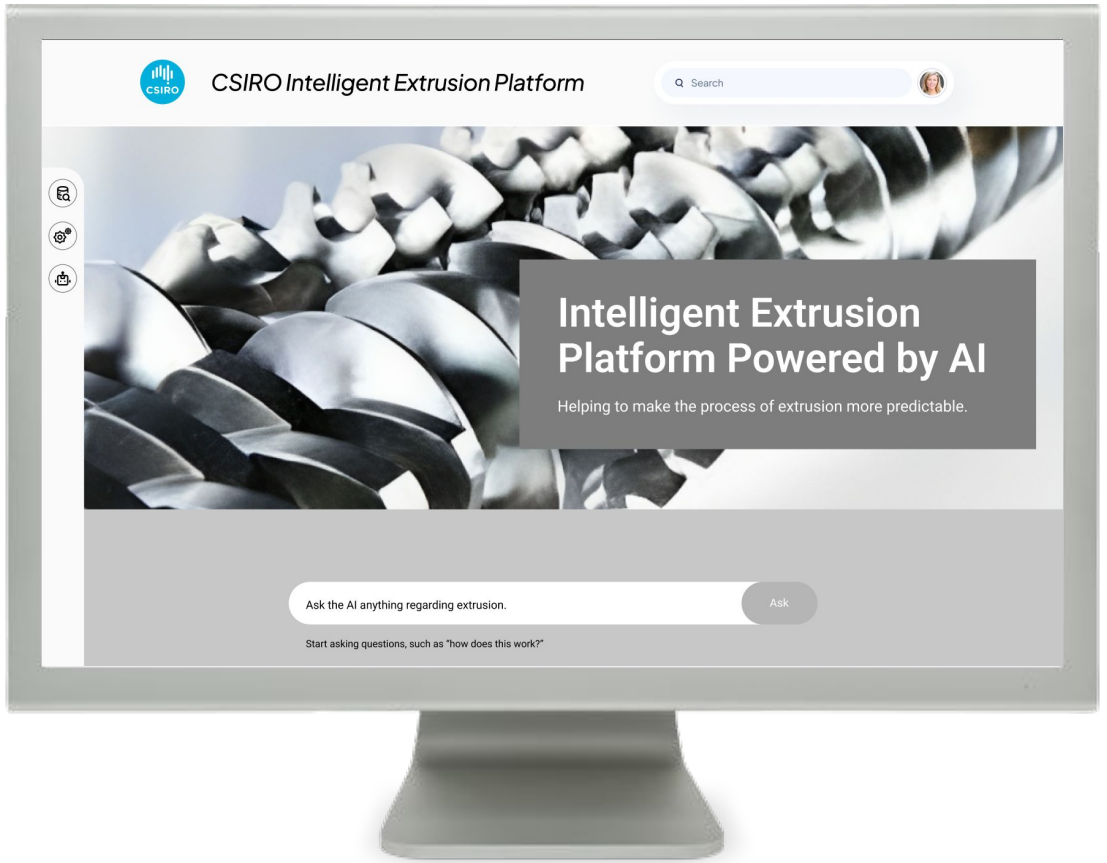
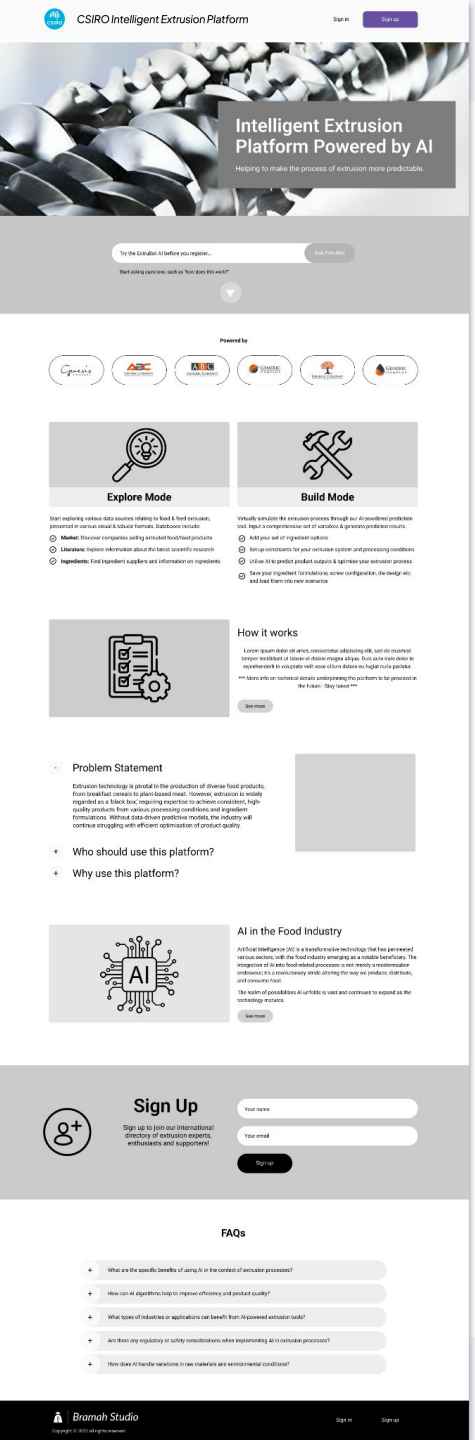
Homepage & Profile Management





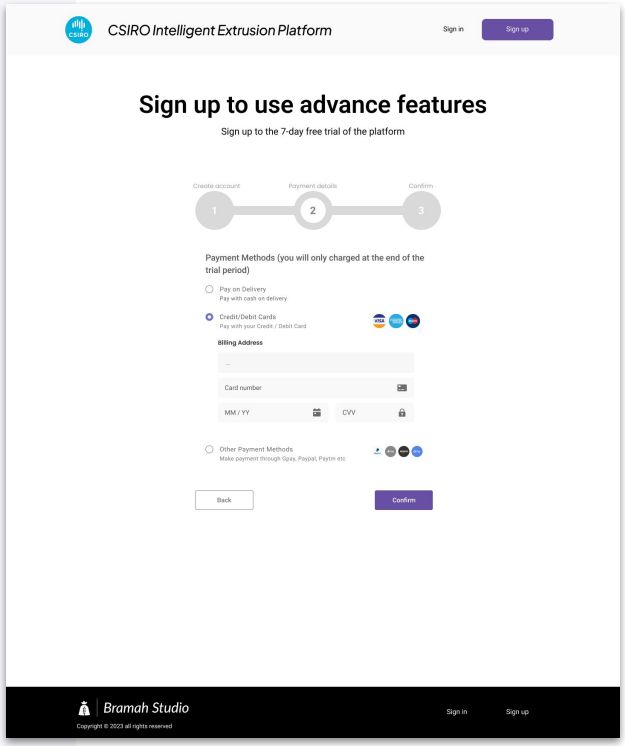
Homepage - Logged Out

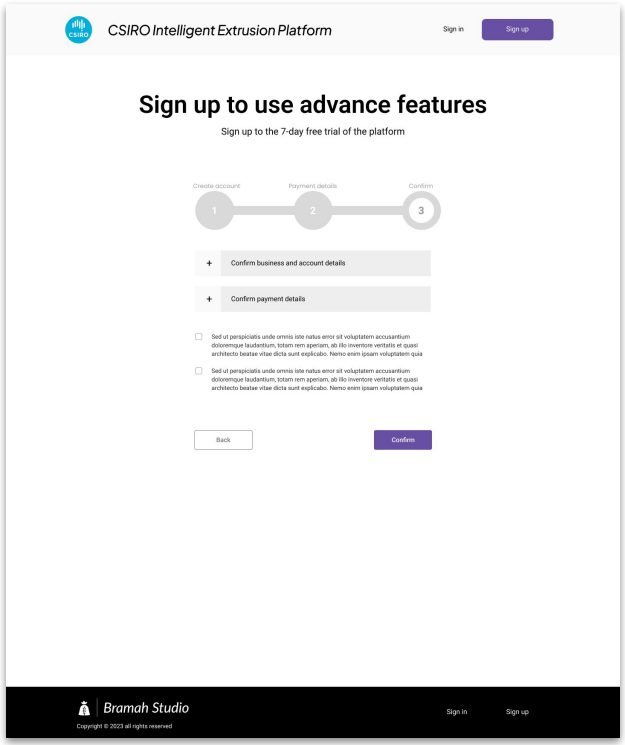
As a customer, I need a homepage that can assist in understanding what the platform is about and allow exploration of the product.

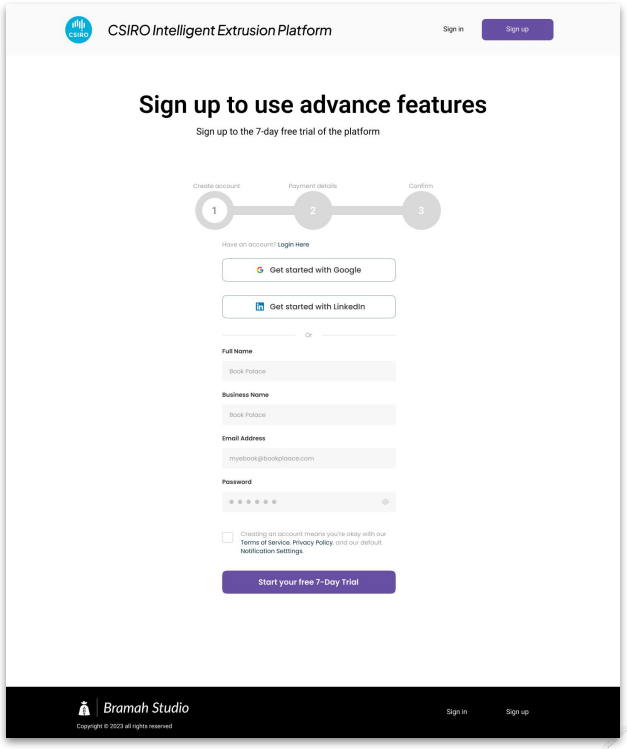
This includes a:

1. Quick access to login/register to the platform
2. Access to the AI tool integration
3. Details about the ‘Explore and Build’ capability modes
4. Messaging and information to build trust on the capabilities of the platform
5. Information on how the platform works and what AI capabilities are all about
6. Ability to sign up to CRM options

Sign Up Process



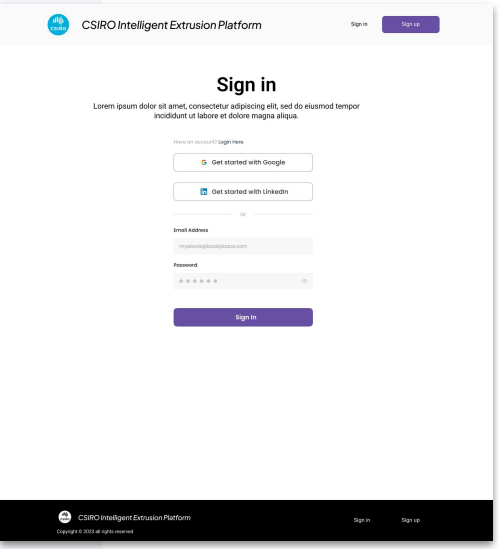


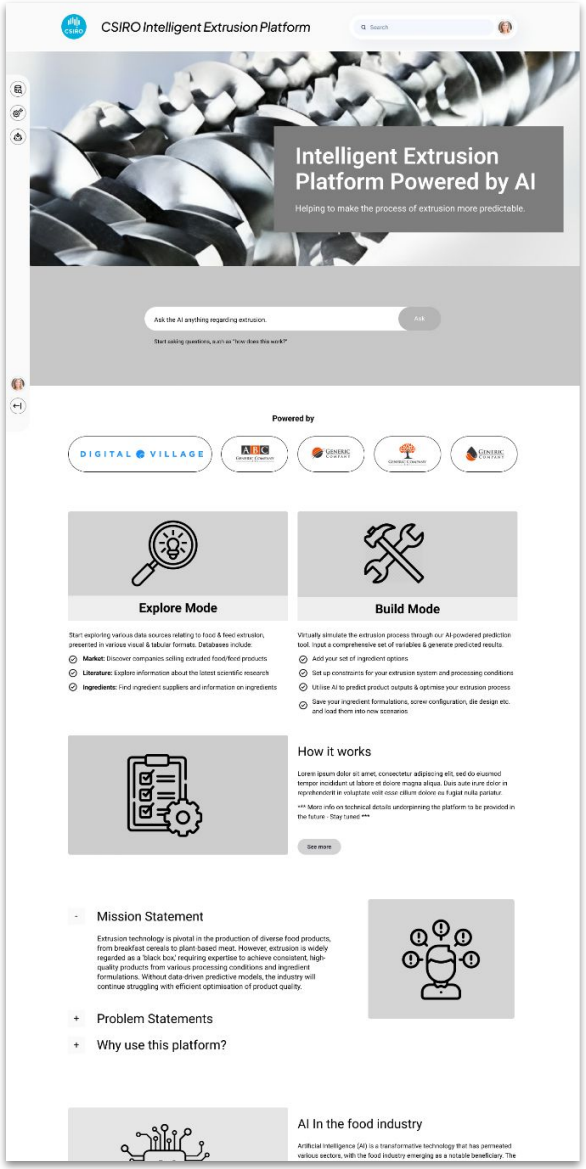


As a user, when signing up, I'd like to be given the option to access a trial version of the platform for a limited time.

Once the trial is over, I would then be charged to maintain complete access of the platform.

I would like the option to be able to register utilising common one-click options, such as Google, and pay with alternate credit card credentials.



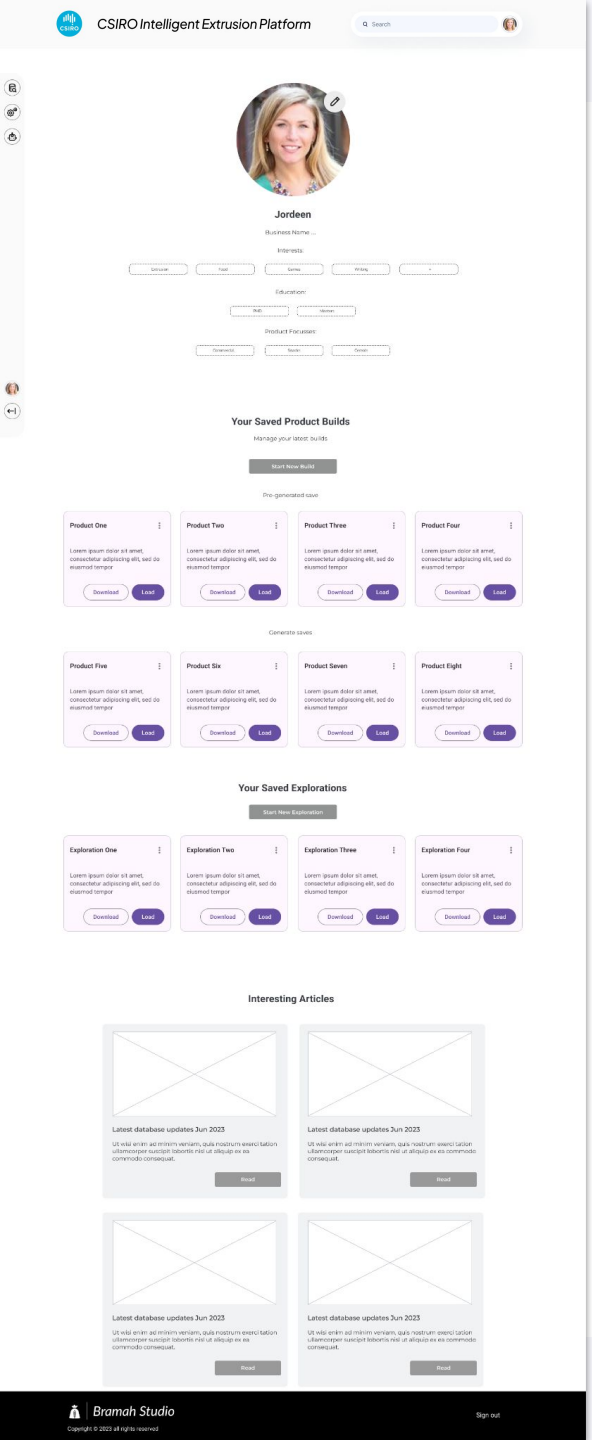


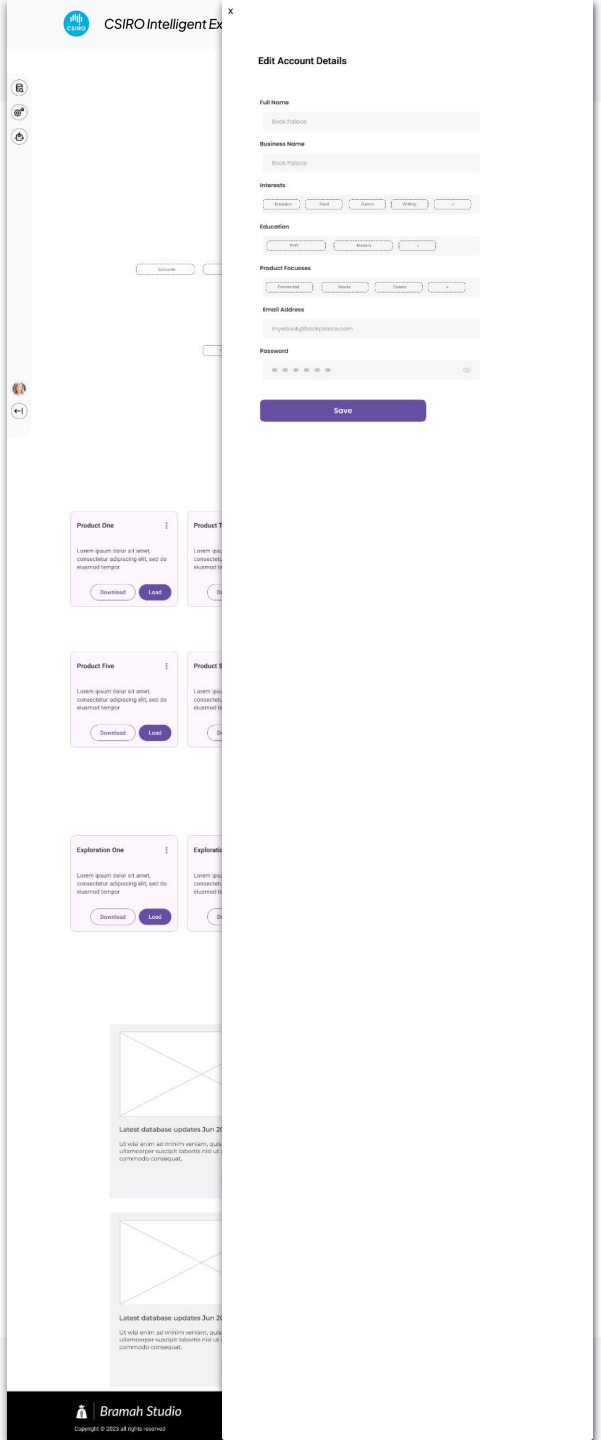
Homepage - Logged-In

As a user, I would like to be able to login utilise no password options such as Google or other social services.

When I am logged in, I would like easy and quick access to the tools on the site, including:

- The builder
- The explorer
- My profile
- The AI tools





Advanced Profiles

As a customer, I will need a profile that is able to show me customised information and insights that are available on the platform (such as research and other articles).

To get this information, I will need to be able to easily provide insights into the type of work I do and the interest I have relating to food production/extrusion/research.

I will need to have access to all of my saved projects (builder), including saved segments within the project, to allow me to quickly load and/or continue testing with ideas and ingredients.

I will be able to also access saved search results from within the explorer pages. This will be saved filtered results - so I go straight to terms I had previously wanted to “favourite”.

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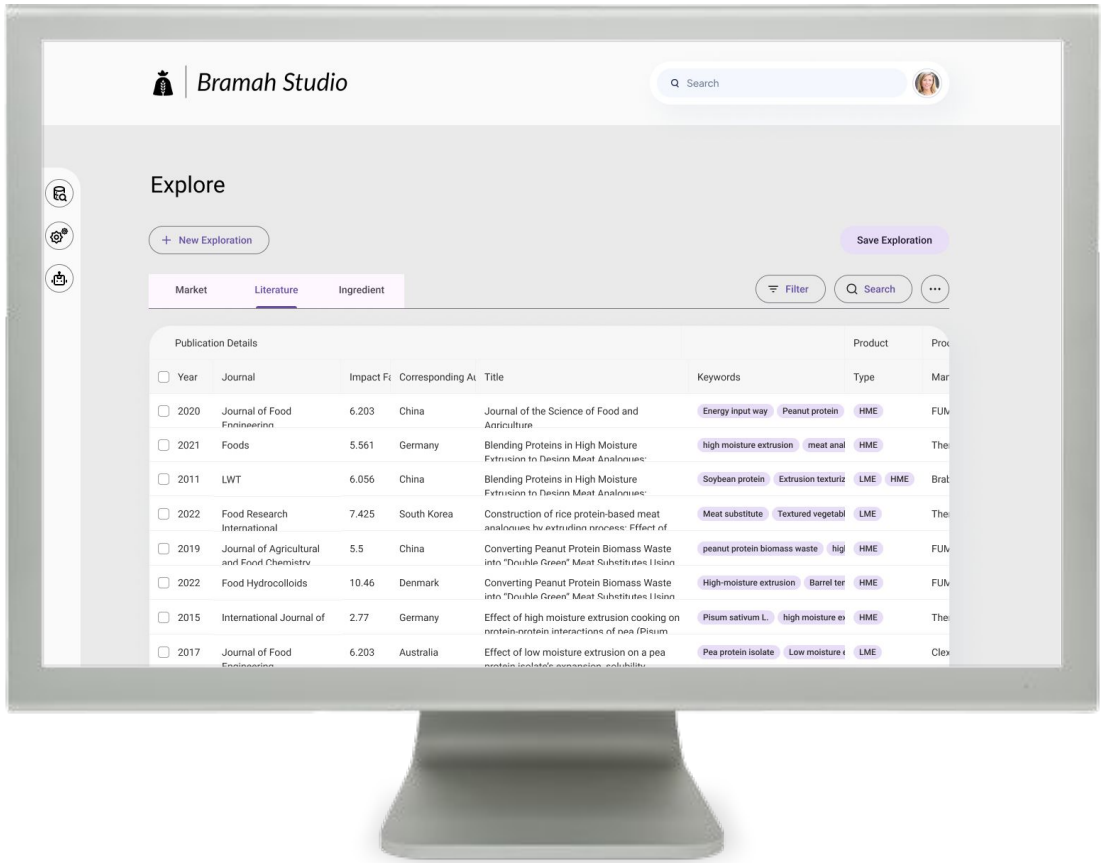
Explore

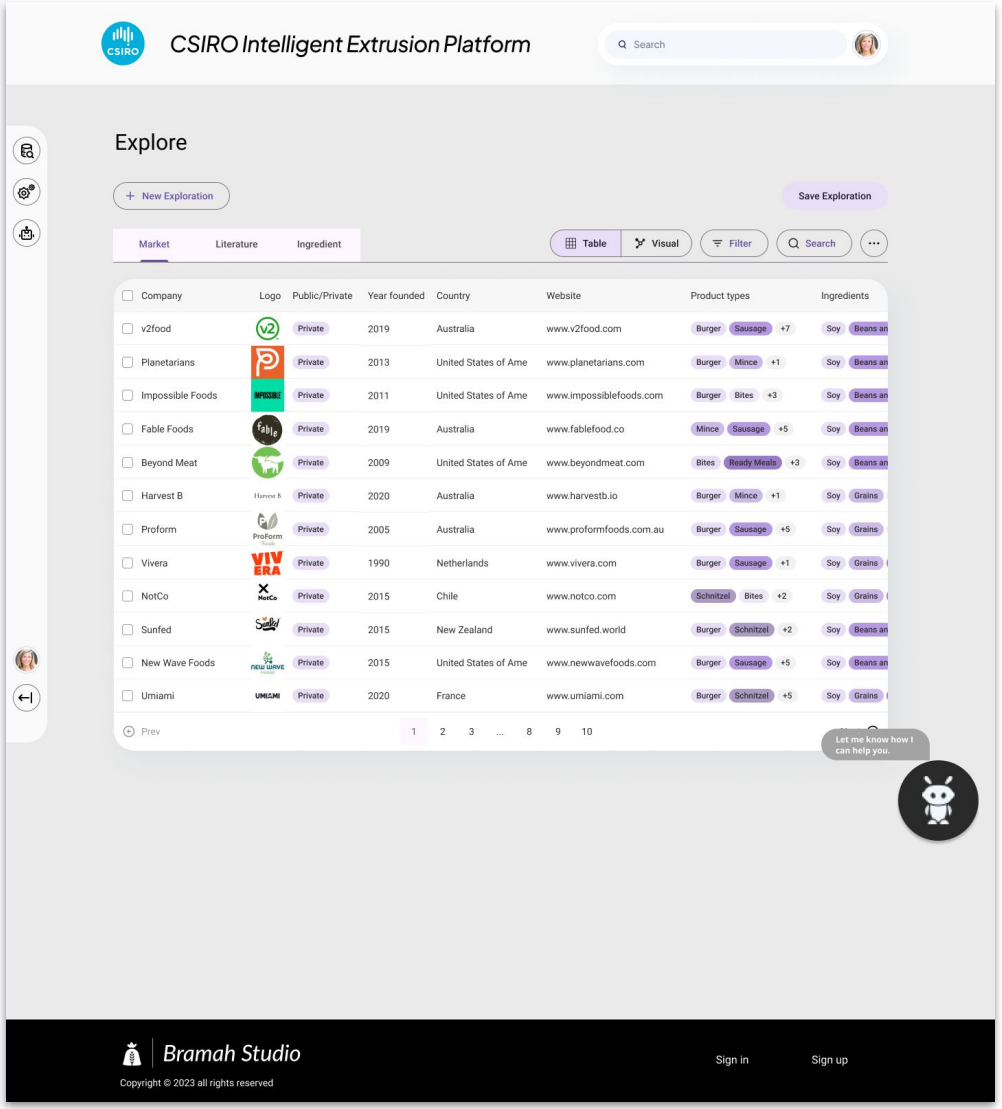


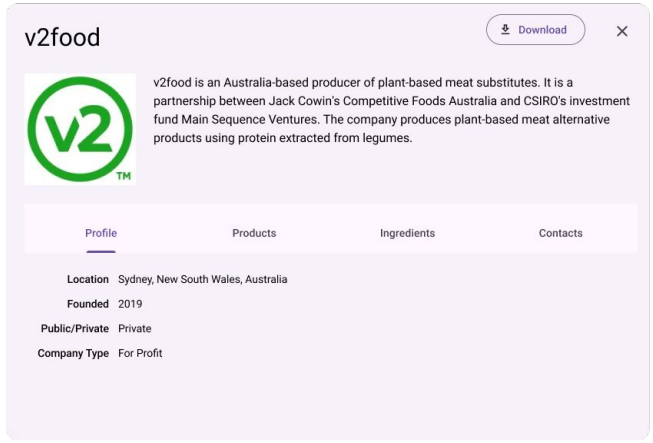
Research - Market

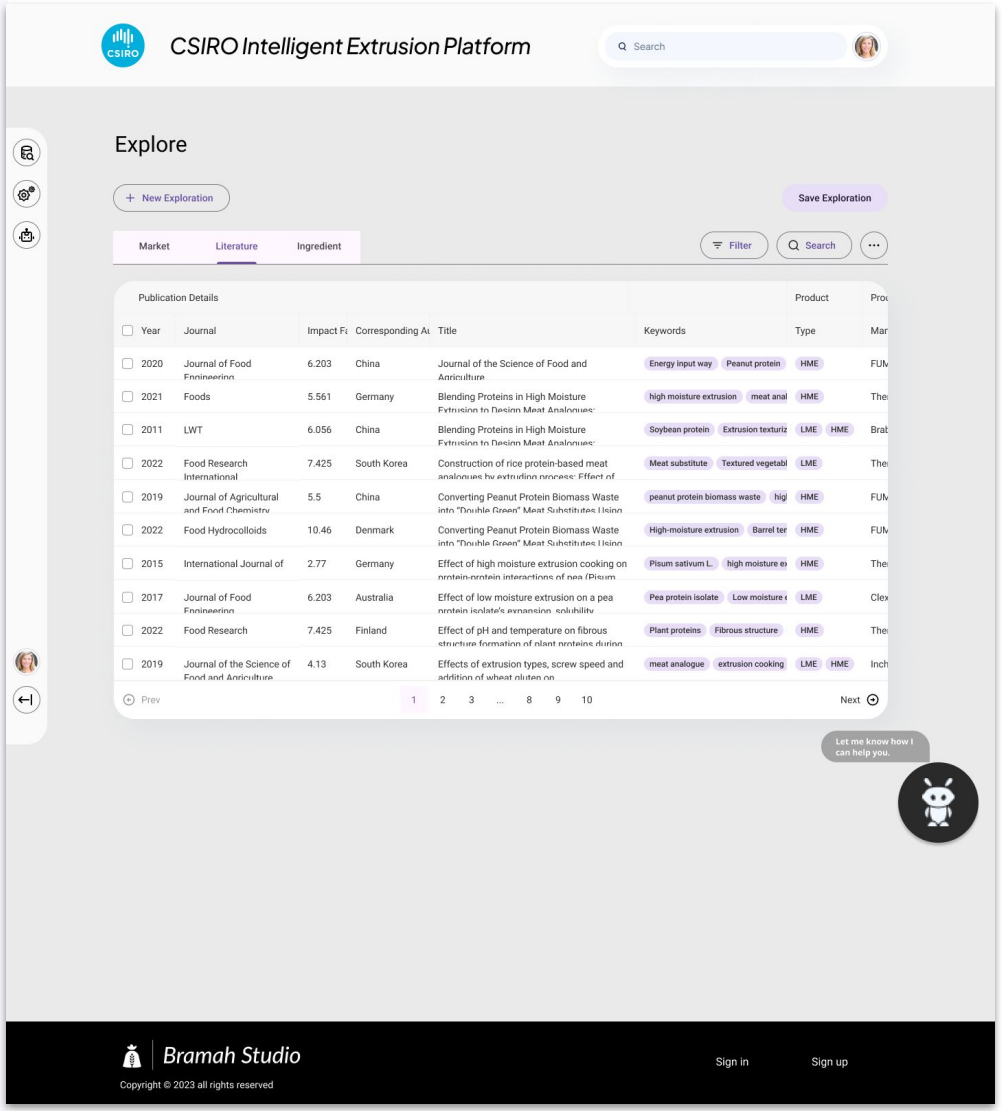
As a customer, I would like to be able to explore all of the market information about any ingredients or products.

This includes:

- Organisational information and contacts within them
- What products, ingredients or services they offer



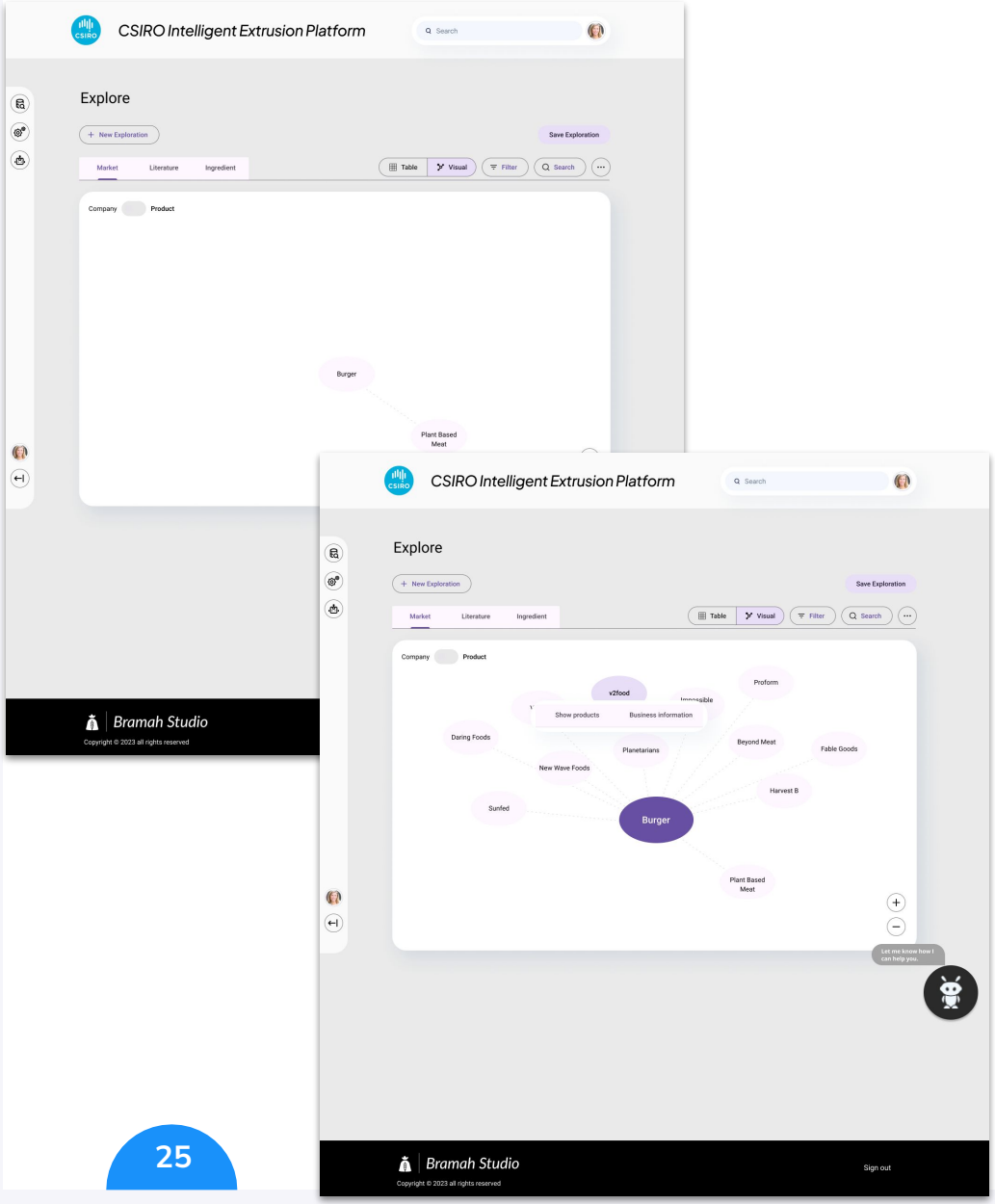




Research - Literature

As a customer, I need to be able to explore what research and other literatures is available.

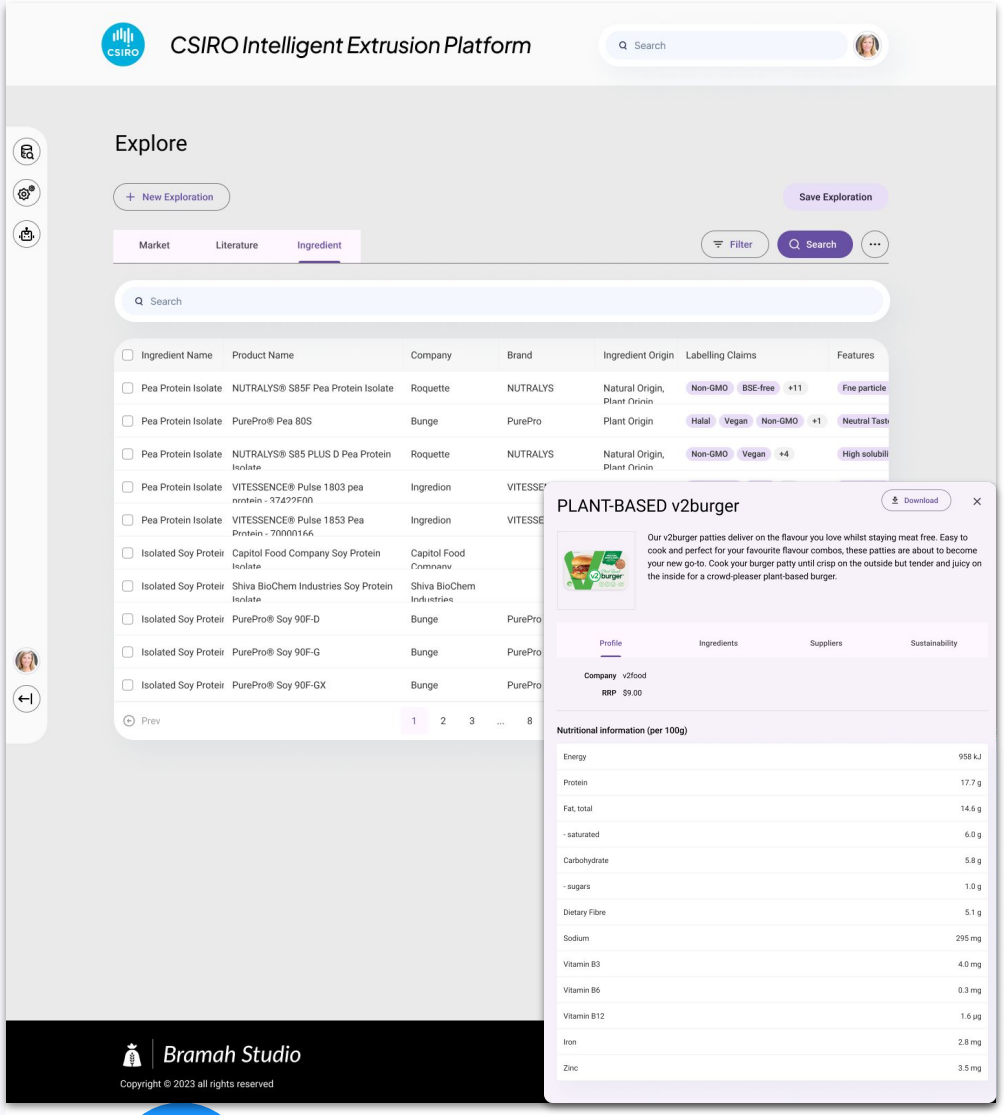
I would like to be able to download and read the documentation, or have the option to click through to the platform where the information may be available to download separately and/or purchase, should it not be accessible directly within the CSIRO platform.



Research - Market

As a customer, I would like a visual tool to be able to deep dive into organisations, product types, services and ingredients, utilising mind maps.

I can alternate the mind map between organisations and products, and get a complete visual picture of what is available within each category.



Research - Ingredients

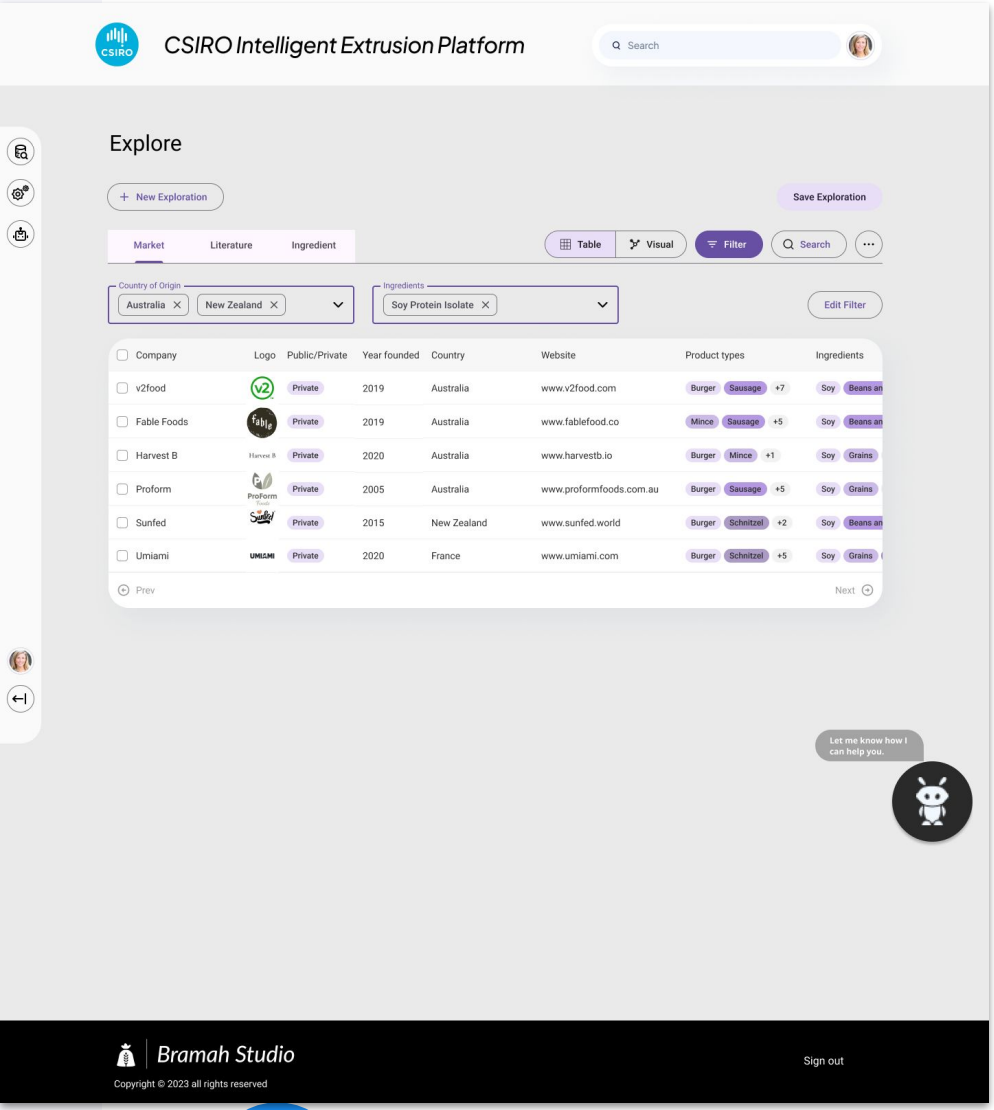
As a customer, I would like to be able to explore ingredients that available to be used within food/extrusion processes.

I'd like to have access to the detail profile of the ingredient, organisations/suppliers that it can be purchased from, and an understanding of what foods it is commonly used in.

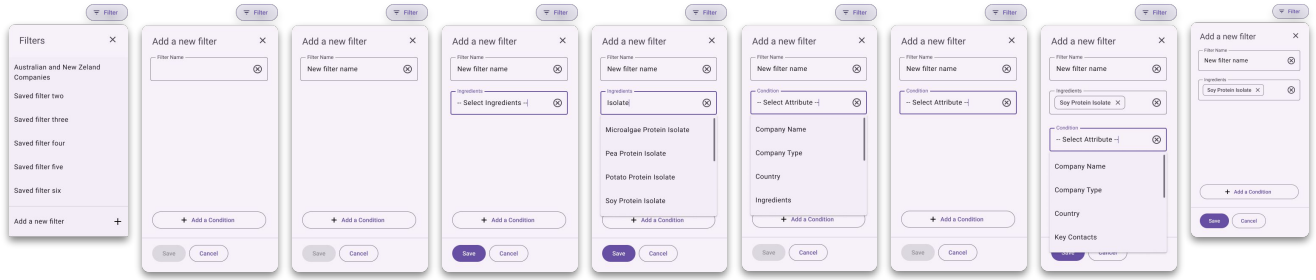
I would like to be able to also:

1. Download the information into an excel or pdf document

2. Select to be able to add the ingredient into a pre-existing and/or knew builder process within the CSIRO platform.



Research - Filter Features



As a user, I would like to be able to create custom filters to search and find the information I am looking for within Market, Literature and Ingredients.

The filters should be relevant to keyword search terms and allow me to drill down into specific content I am interested in.

I can then save these filters to my profile to come back to review/read at a future date.

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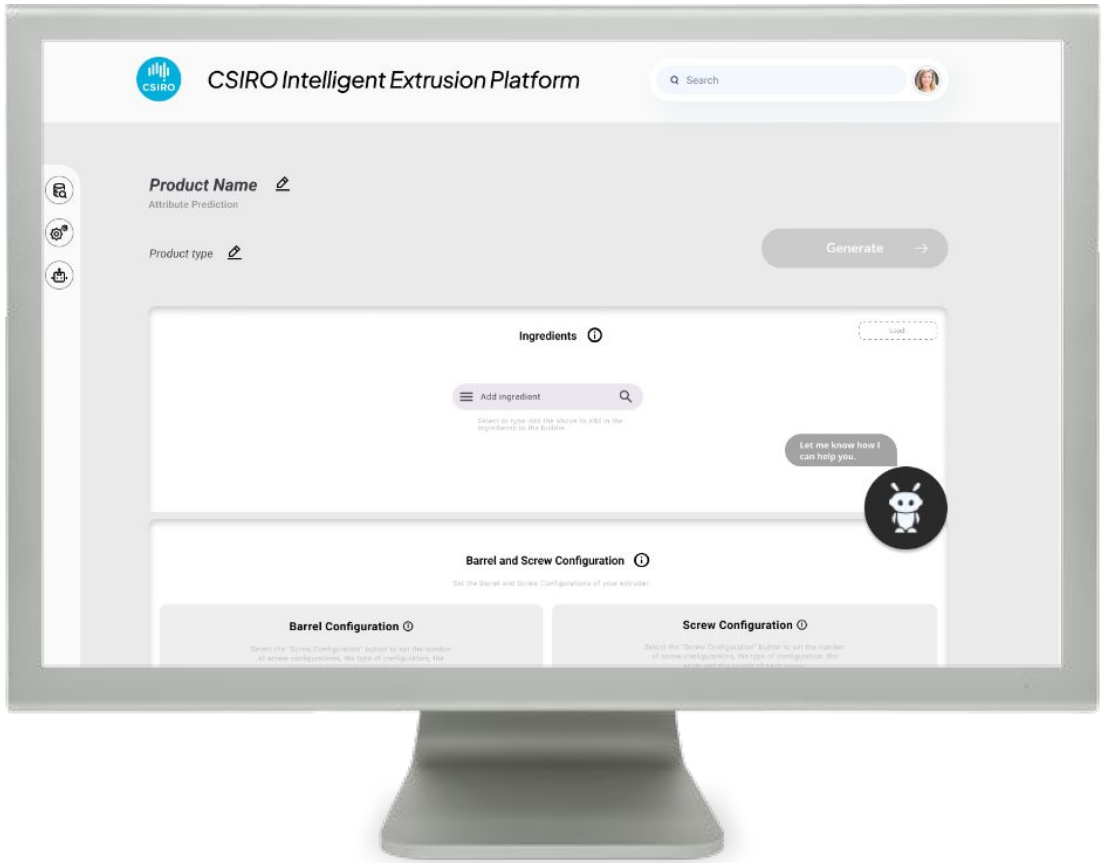
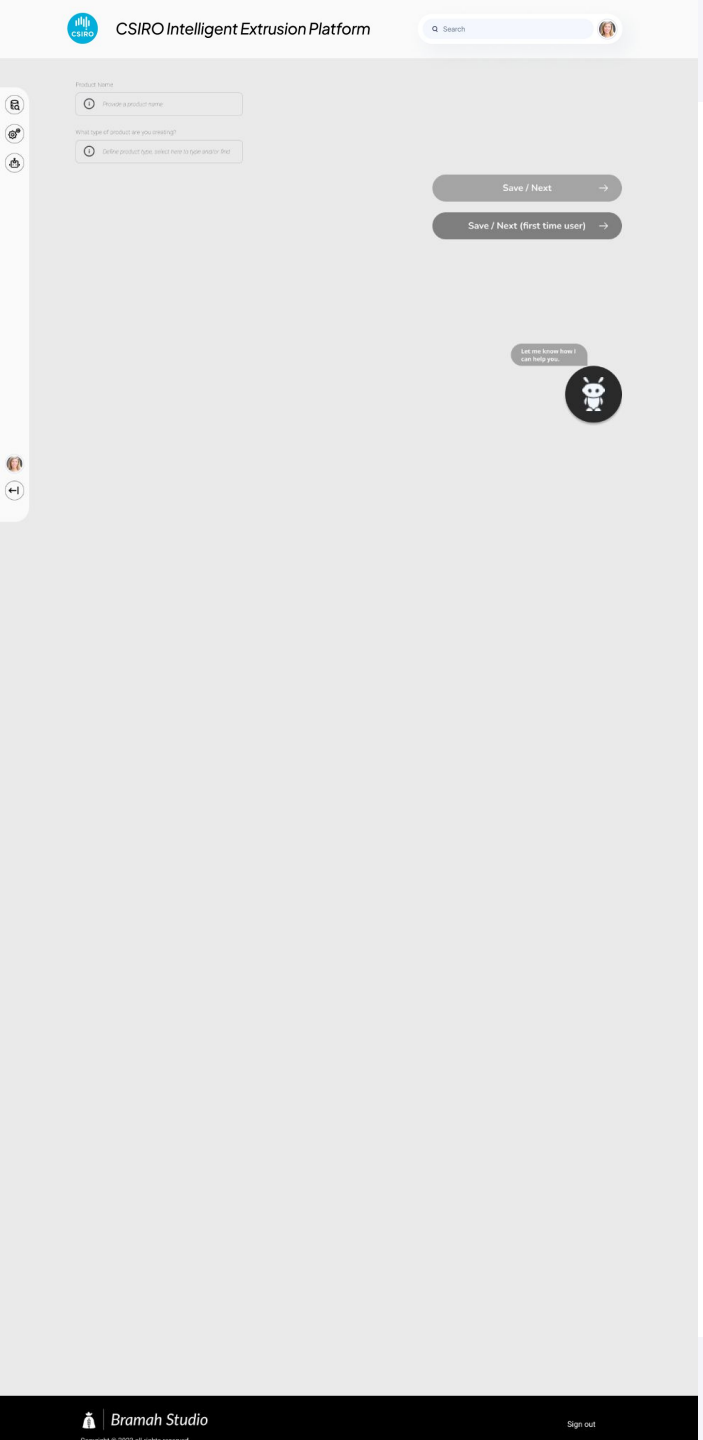
Builder: Prediction Modeling



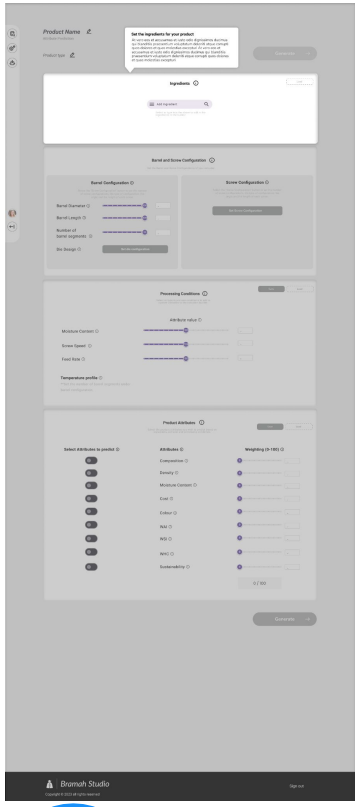
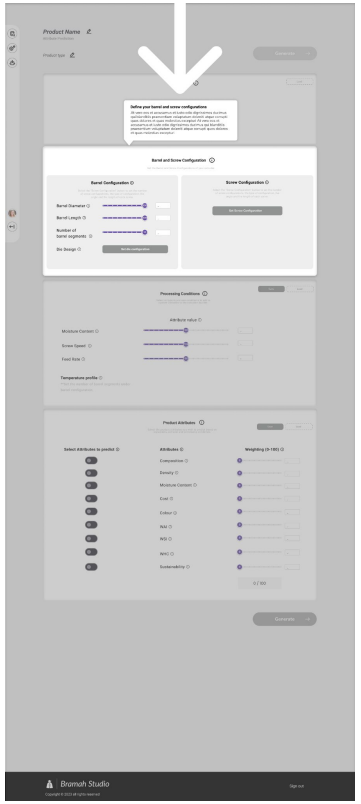
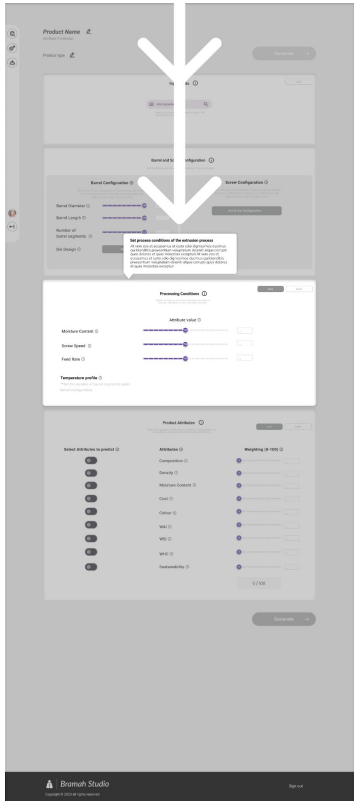
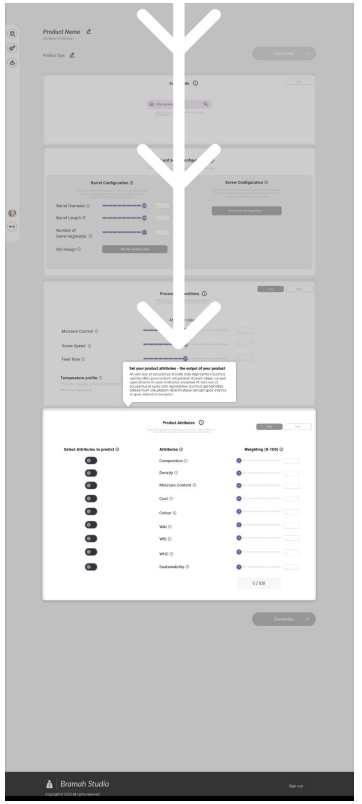
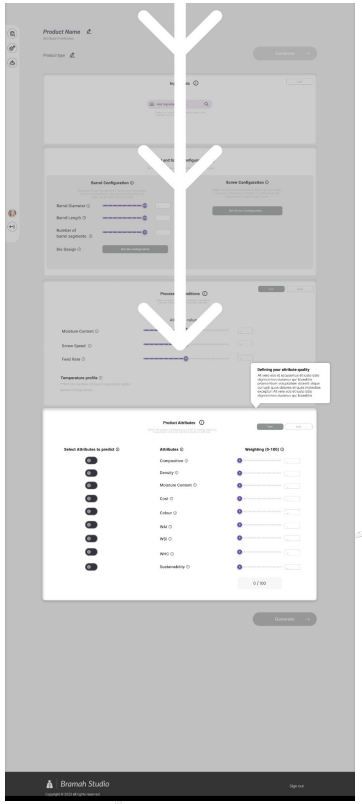


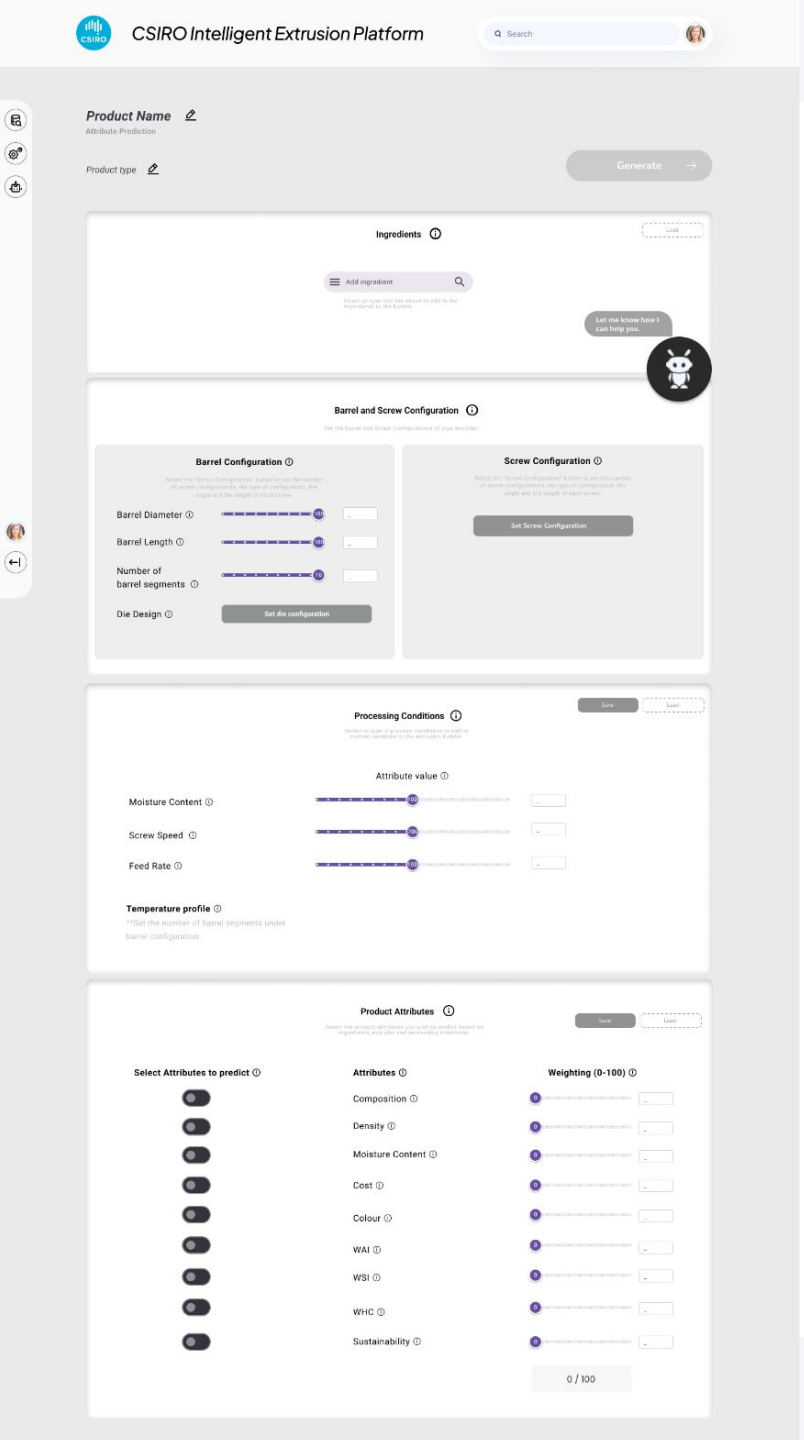
Step 1: Setting the name and product type

As a user, I need to the give the product that I am building a name, and define the type of product category, so the AI knows what and how it assisting the predictive modelling.

Walk through process

As a first time user, I should be walked through the process of utilising the platform, with detail outlining the actions and capabilities.

Step 2.1: Product build page

Ingredients: As a user, I will define what products I would like to add to the extrusion model. I expect to see all of the information about all the ingredients, just as I would within the explorer pages. I would then define the ratio of each ingredient within the product.

Barrel Configuration: As a user I would like to define the barrel configuration of the extruder, setting:

1. Diameter of the barrel
2. Length of the barrel
3. The number of barrel segments (to then define the temperature within the process conditions)
4. And the design of the die

Screw Configuration: As a user I would like to be able to set the screw configuration, to define:

1. Number of screw segments
2. Type of screw for each segment
3. Angle and direction of the segments
4. Length of each element

Processing Conditions: As a user I would like to be able to define the Processing Conditions (variables), that impact the end product. This includes:

1. Moisture content
2. Screw speed
3. Feed rate
4. Temperature profile for each of the barrel segments

Product Attributes: As a user, I would like define the attributes for the product that comes out of the extruder at the end of the process. This would define attributes such as what my product looks, feels and tastes like.

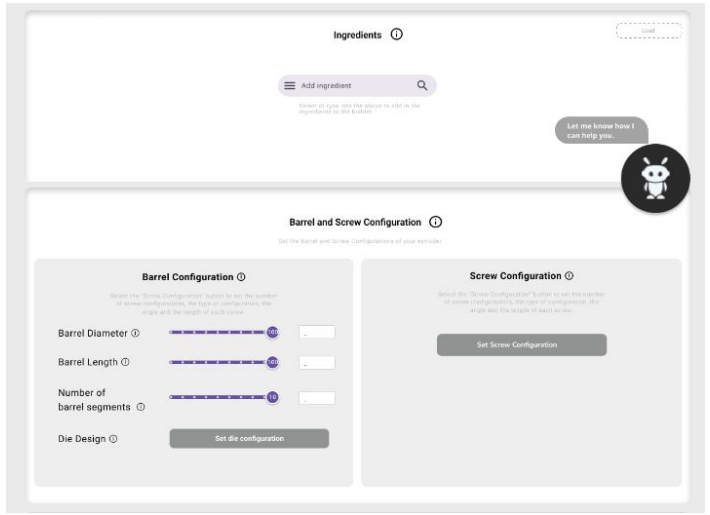
I would select out of each attribute, which of the 3 main attributes I would like the AI model to predict, and then define the weighting of importance for these attributes.

Example, if I select 3 attributes:

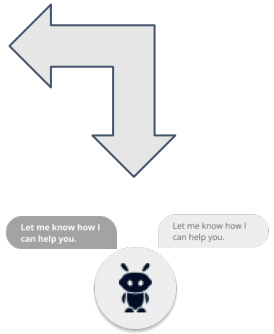
- Density
- Moisture, and
- Cost

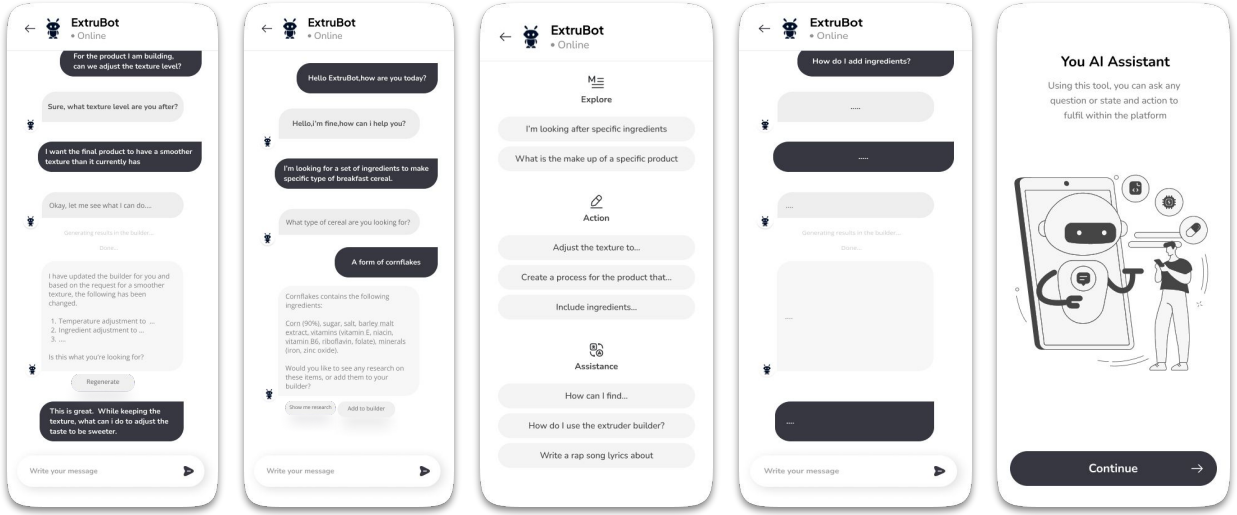
I then define Density as 50%, Moisture as 25% and Cost as 25%.
By doing this, I am telling the AI, that Density is the most important component of the end product, and thus it will prioritise to get the “best” density value possible.

Step 3: Maybe use the AI tool?



Left or right positions





As a user, I would like to be able to have a conversation with an AI, and ask it to update the product builder with setting based on discussion points.

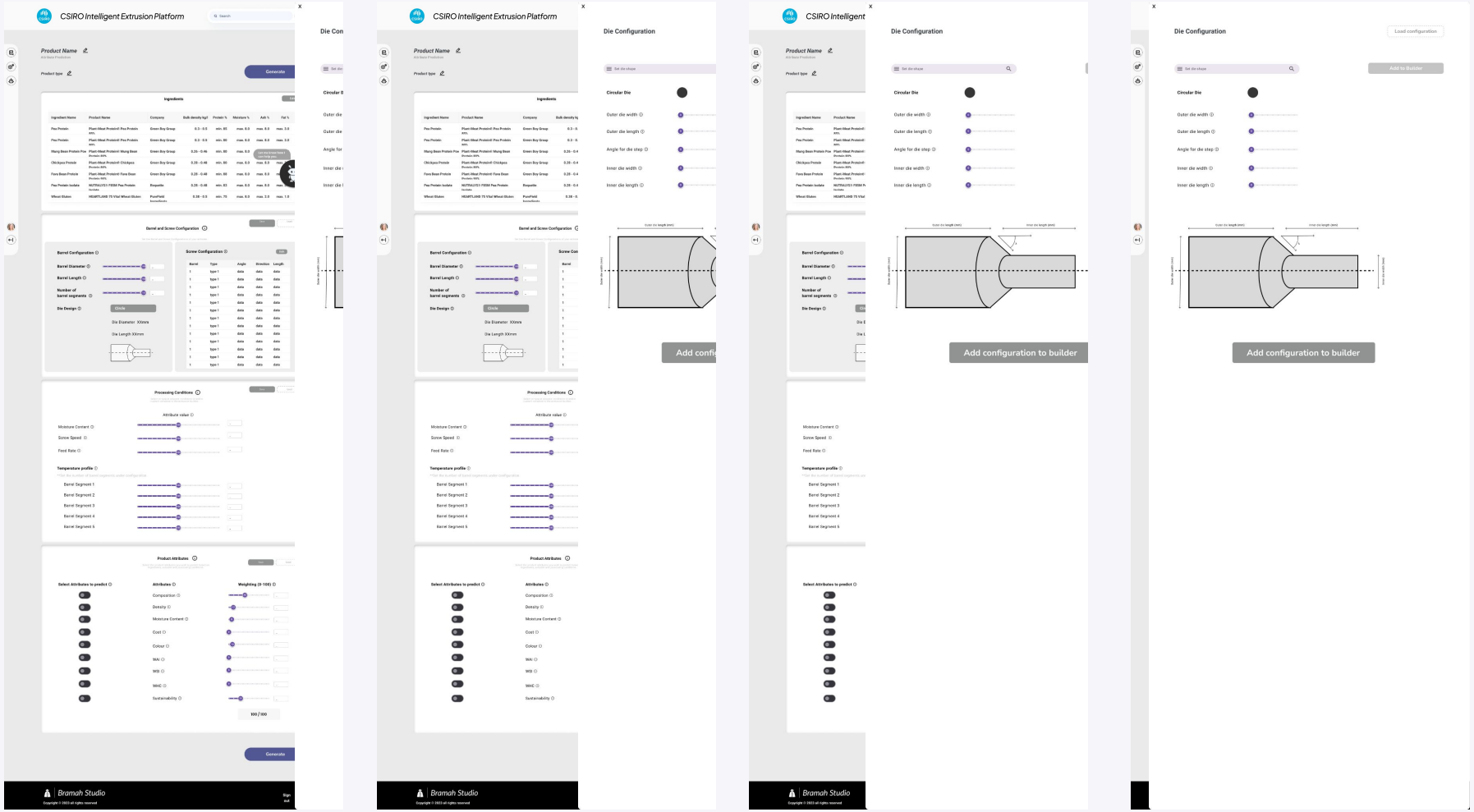
I would like the AI tool to be available wherever I am within the process, to quickly ask it questions and/or for assistance.

This could include reverse engineering input, such as: could you set up the page to create a cornflake cereal.

Example conversations:

- Update the ingredients with ....
- Set up the builder to create a ....
- Show me research related to ....
- What ingredients are required for ....
- How does .... work within the builder?

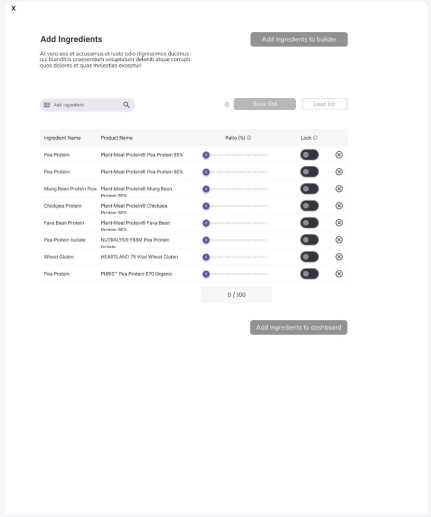
Editing advanced fields

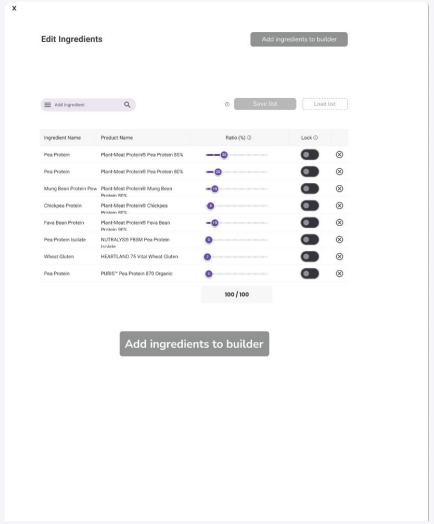


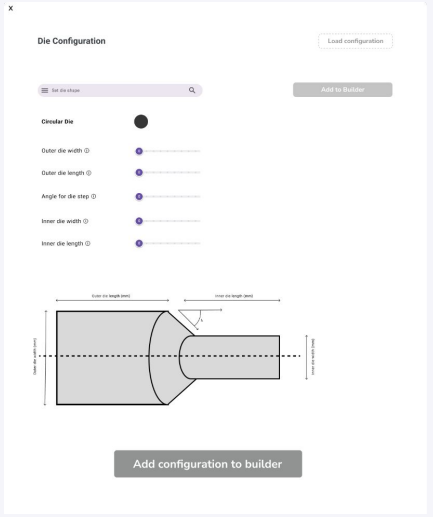
As a user, making sure it's clear how, where and what components I'm editing.

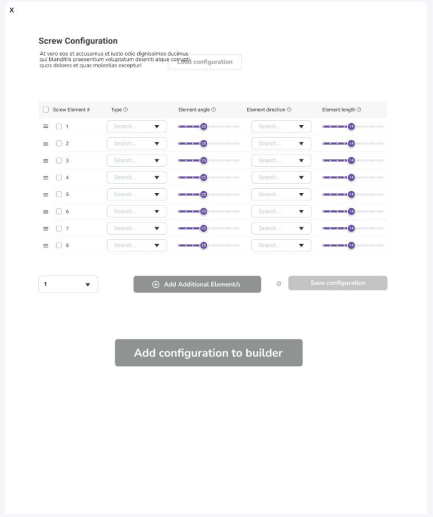
Selecting editable features, that requires me to adjust further information should appear as sliding overlays. This makes it responsive and accessible on desktop and tablet devices.

Editable sections









Ingredients prt1

As a user, I need to be able easily search and add ingredients to the ingredients component.

For each ingredient I would then define what the ratio of the ingredient is for the final product, and define if the AI is allowed to adjust this ration.

Locking the ingredient will prevent the AI from adjusting ratios.

Ingredients prt2

As a user, it needs to be clear if the ratio I have defined is equal to 100%. There should be an indicator showing me to the total.

There should also be an easy way to delete/remove ingredients from the list, should I need to change it.

Die configuration

As a user, I would need to be able to search for different die shapes.

I would then need to configure:

- Outer and inner die widths
- Outer and inner die lengths
- And the angle of the die step

As a user, it would be helpful to have a diagram demonstrating the die configuration selected/defined.

Screw configuration

As a user, I would need to be able to set the number of screw elements.

For each element, I would then to be able to define:

1. Type of screw
2. Elements angle
3. Direction
4. Element length

As a user, it would be helpful to have a diagram, which demonstrates the screw configuration selected/defined.

As a user, I would like to make sure I can save and load in the configurations I set, so I don't have to repeat the process each time.

Features

As a user, I want to make sure it's easy for me to define the values for every item and component. On tablet, it is easier to use the touch screen, and consequently move sliders to define values. The slider needs clearly show the value that is being moved/defined.

Alternatively, I may prefer to type in values, which would be possible with a text box next to the slider component.

Sometimes I will need to define the range for a product attribute. This allows me to set two values, and the AI can make predictions for the best result, utilising values between the selected range.

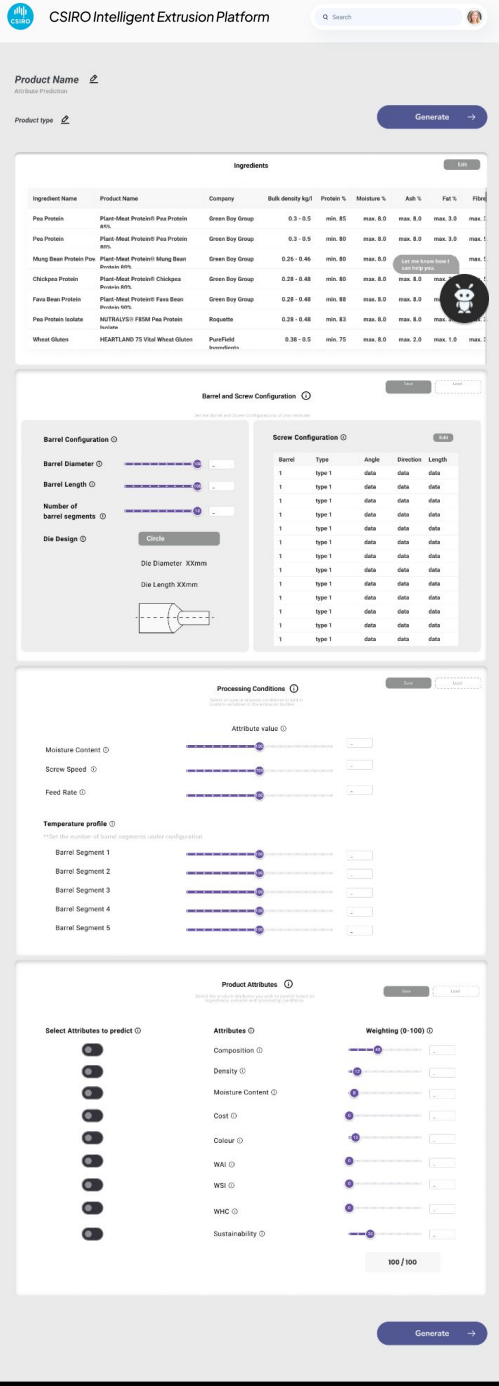
As a user, I won't always get things right. As such, I to be able to edit items after I have added in information (such as product names). This is the edit icon.

As a user, I would like to ensure that there is easy to access information throughout the page, that allows me to understand what the action requires and/or what it means. This should be an easy to access hover state on every headline feature.

As a user, I would like to be able to save different sections within the builder, to load them into other builder projects. This will save me from having to repeat inputting information, such as Barrel and Screw configurations, when they are the same each time.

I am saving sections individually, such as:

- Ingredients
- Barrel configurations
- Screw configurations
- Processing conditions
- Product attributes



Step 3: Ready to generate

As a user, it should be clear when I have shared enough information to be able to start generating the results.

Once enough information has been included, the “Generate” CTA should be colourful and clear that I can now select the action.

Prior to this, it should be greyed out. If I attempt to interact with it while it is greyed out, an information box (hover state) will appear and alert me to the requirement of completing the information on the page.

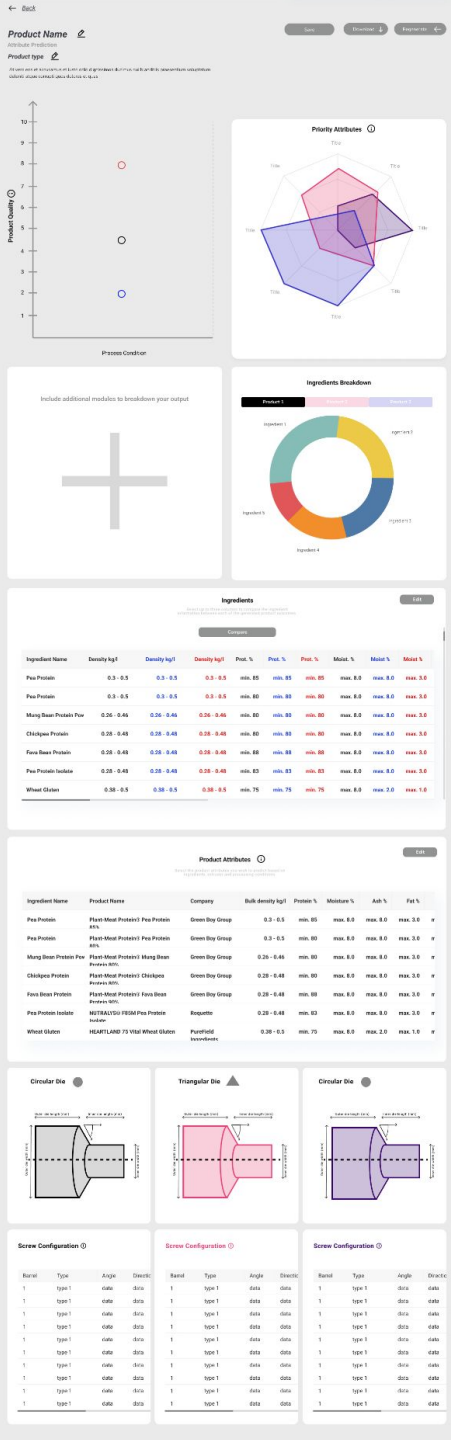
Step 4: AI initial results page

As a user, when I generate the output, I would be taken to a new page, which provides me detailed information about the product attributes.

I will see:

- A spider graph, with the breakdown of the attributes, as defined by the AI.
- A breakdown of the ingredients and a graph showing the ratio of each
  - Additional links to where to purchase
  - Additional links to further research and information
  - Select to show further information, per the research pages
- List of further attribute details
- Breakdown of the die and screw configuration

Most importantly, as a user, I would like to be able to adjust some of the configurations and see how this changes the attribute outcomes. To do this, I would like to be able to select edit within the appropriate configuration areas (ingredients/barrel/die etc). This will pop out the settings to adjust and regenerate the outcome.



Step 5: Compare and modify AI results

As a user, I would like to be able to see how the changes I just made to the configurations compare the previous configuration.

As I make further configurations, I can see the last 3 edits I made, and then compare the results across each of them.

This is managed by the graph at the top of the page, with the 3-pins, indicated by each of the last 3 adjustments.

***Once I've completed what I have set out to explore/build, I would like to be able to export these results as an EXCEL or PDF file to use for my own research at a later date.

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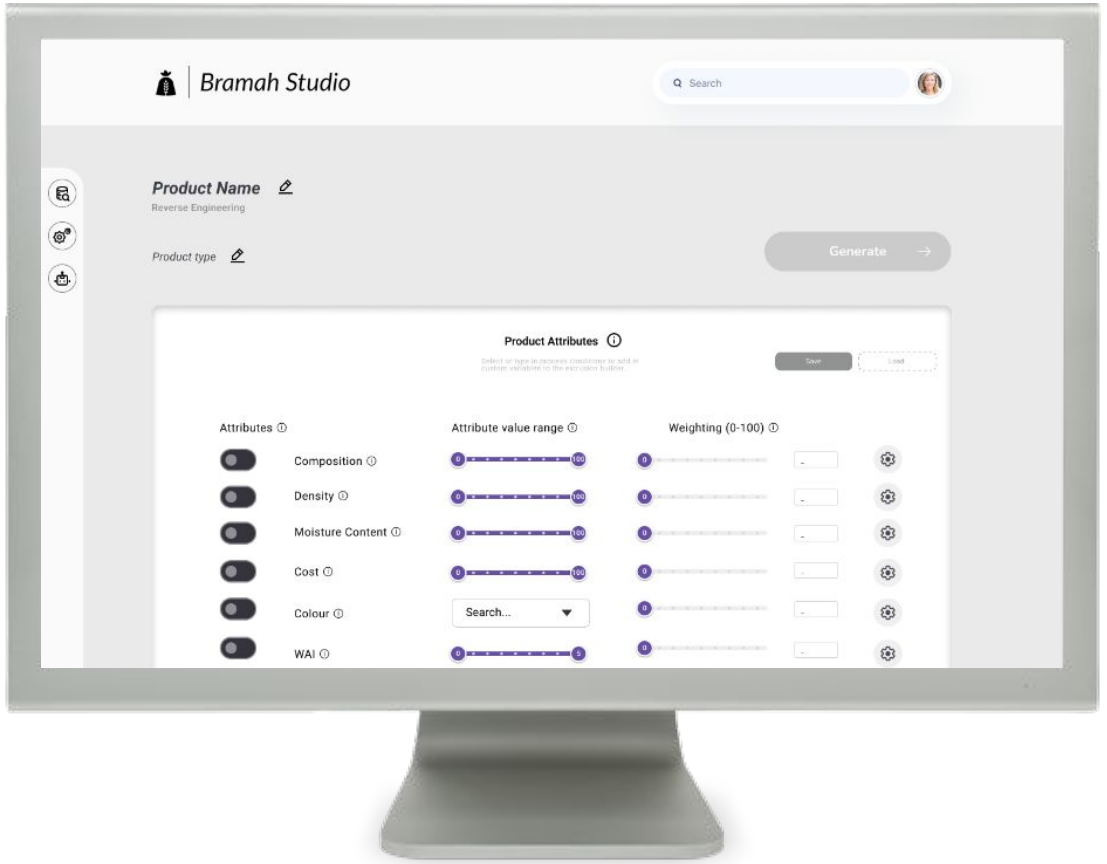
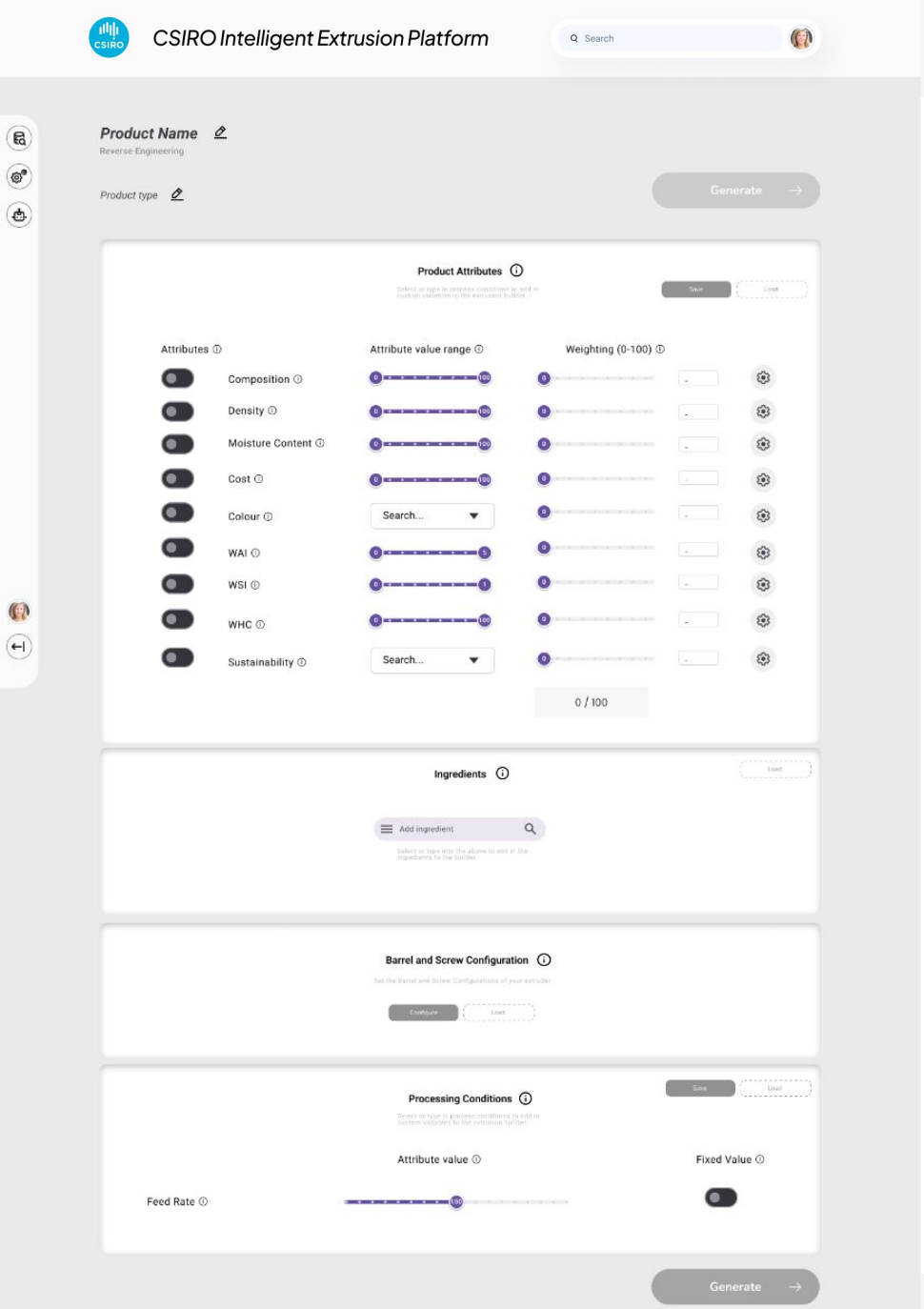
Builder:
Reverse Engineer





Step 1: Leading by attributes

As a user, I would like to define the attributes of a product first, and then generate the configurations I would need to create a product similar to the input set.

I firstly select which attributes are important for me to define, and allow the AI to predict the remaining attributes.

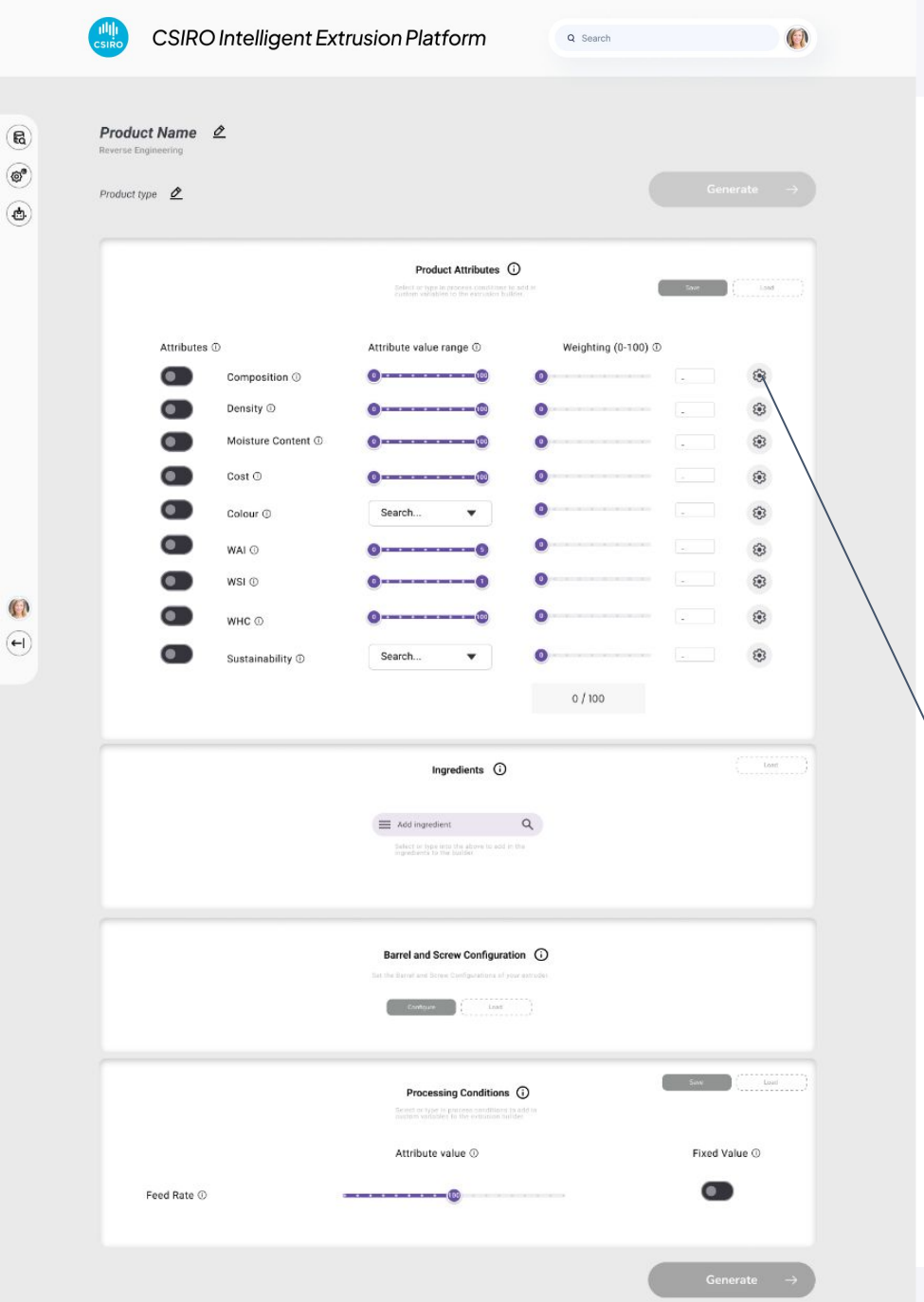
I would then set the value for each attribute.

Lastly, I would define the weighting of the attribute, which will define the overall quality of the product output.

Example: If I have all the attributes selected (there are 9 attributes in the design example), and I set the weighting of each attribute to be ~11% each, that would assume each attribute is considered of equal importance towards quality.

If I make 8 of the attributes 10%, and then a single one, say density to 19%, I am suggesting that density has the highest of importance towards quality.

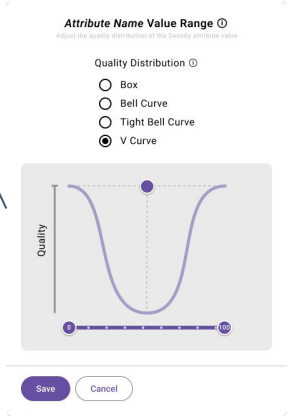
Once the results are generated, the quality of the output is defined by how closely the results relate to the attribute values and the weighting that attribute was set at.



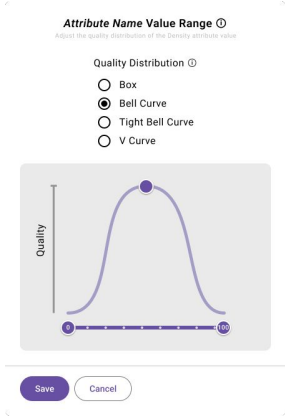
Step 2: Advanced attribute settings

I can further define what quality means to the AI, by selecting the settings cogs and choosing one of the following.

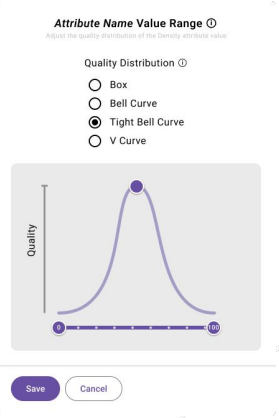
Here, I am defining where within the product value range, is the quality of the product/result being set.



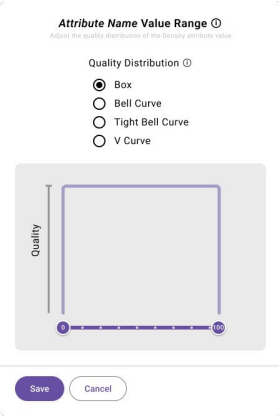
The V graph
Here quality is defined by the output being closest to the largest and smallest value in the range.



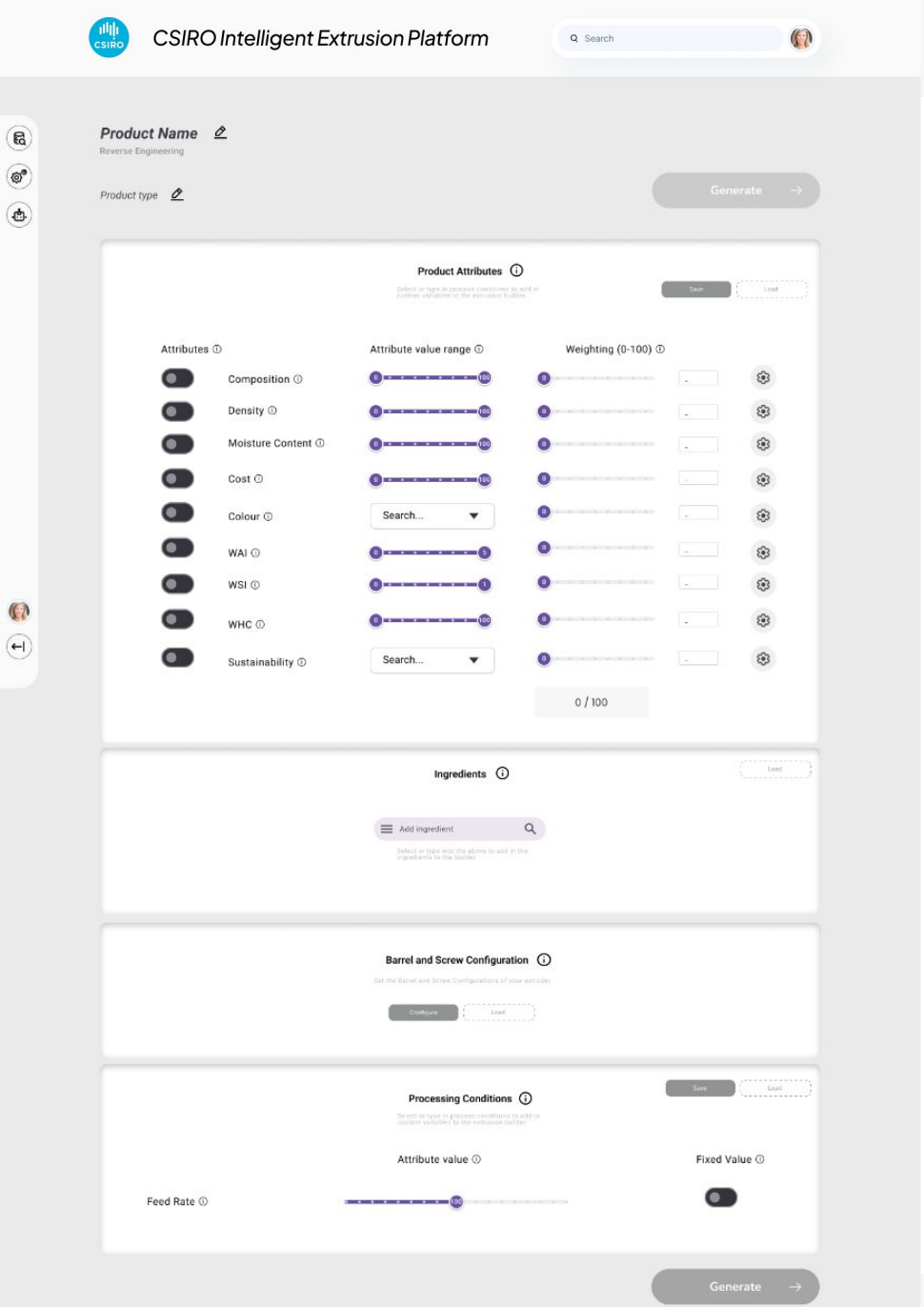
The bell graph
Here quality is defined by the output being closest to central point in the range.



You can similarly define where the central point of the bell graph is, and how tight the quality decision is.



The box graph
Here quality is defined by any value that sits within the defined range.



Step 3: Ingredients -> Process Conditions

Ingredients: As a user, I will define what products I would like to add to the extrusion model. I expect to see all of the information about all the ingredients, just as I would within the explorer pages. I would then define the ratio of each ingredient within the product.

Barrel Configuration: As a user I would like to define the barrel configuration of the extruder, setting:

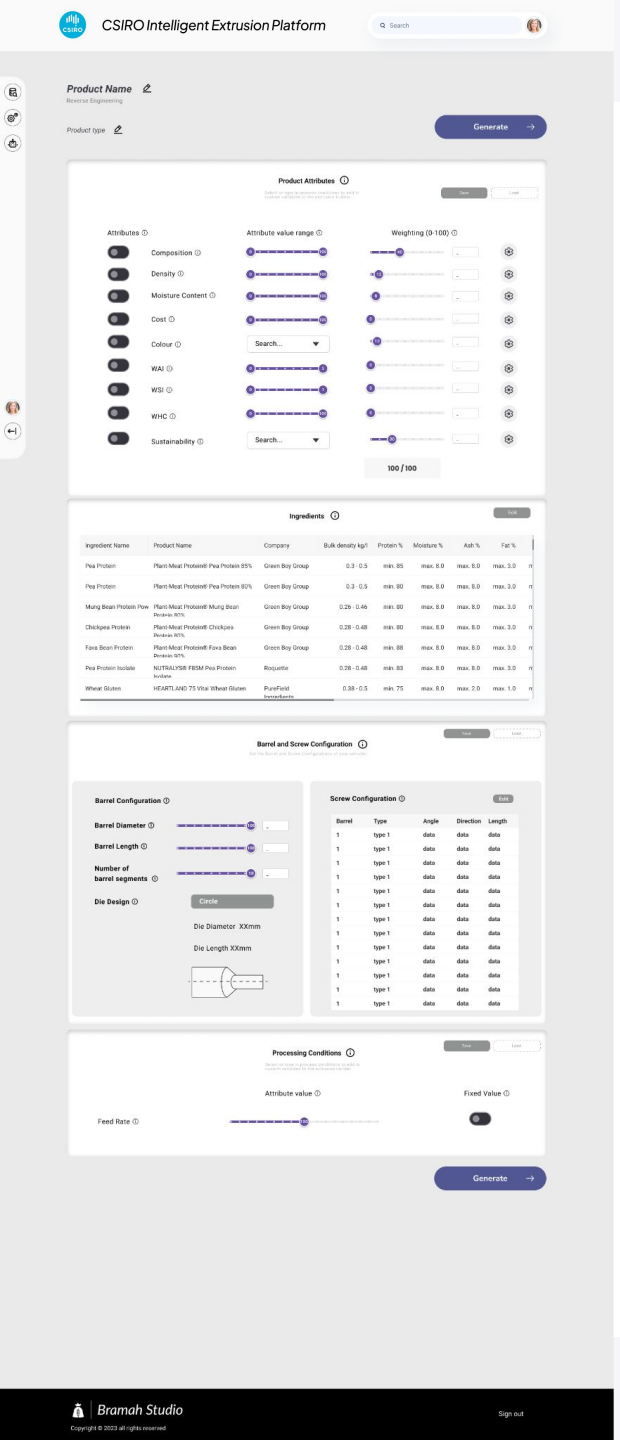
1. Diameter of the barrel
2. Length of the barrel
3. The number of barrel segments (to then define the temperature within the process conditions)
4. And the design of the die

Screw Configuration: As a user I would like to be able to set the screw configuration, to define:

1. Number of screw segments
2. Type of screw for each segment
3. Angle and direction of the segments
4. Length of each element

Processing Conditions: As a user I would like to be able to define the Processing Conditions (variables), that impact the end product. This includes:

1. Moisture content
2. Screw speed
3. Feed rate
4. Temperature profile for each of the barrel segments



Ready to generate results

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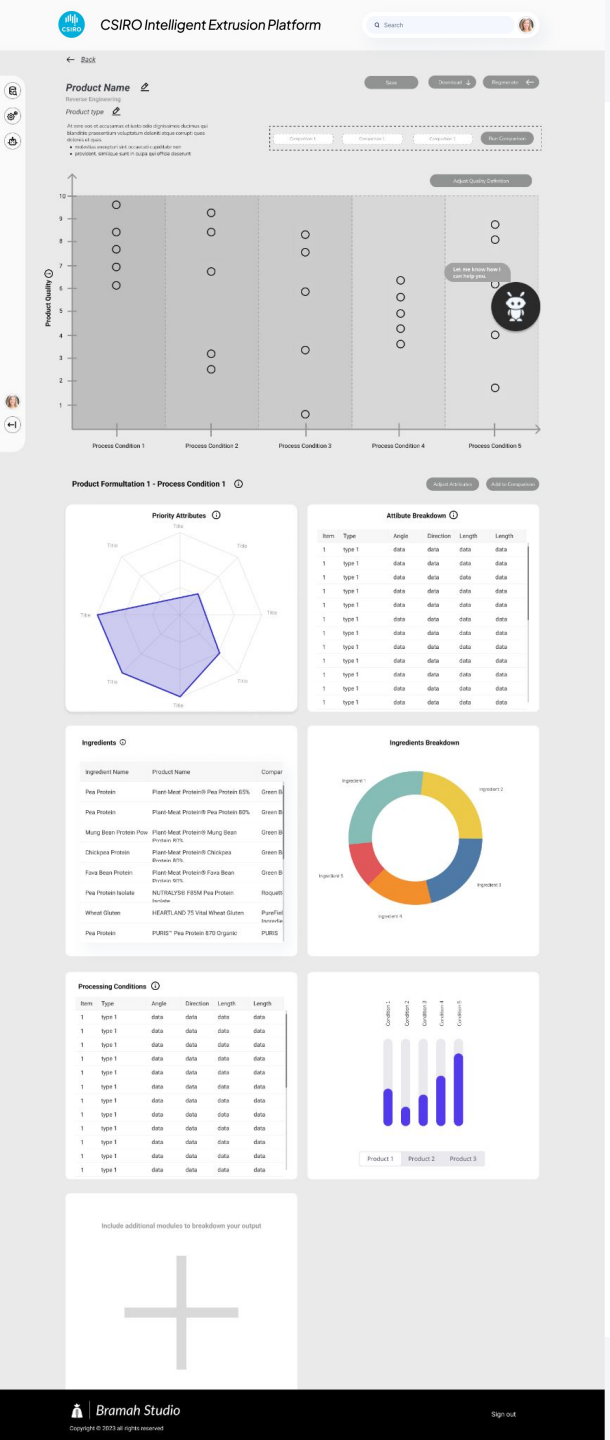

Multi-results to actions/compare

As a user, when going through the reverse engineering process, I expect to be able to see variations in the AI output, sharing multiple product results.

I would like to see, 5 different processing conditions, each with 5 varying qualities (as defined by the attribute selection).

I would also like to be able to compare up to 3 different AI conditions, by selecting the components in the graph and running a comparison engine.

03

Extruder Development Roadmap Recommendation

Removing the ambiguity of the extrusion process

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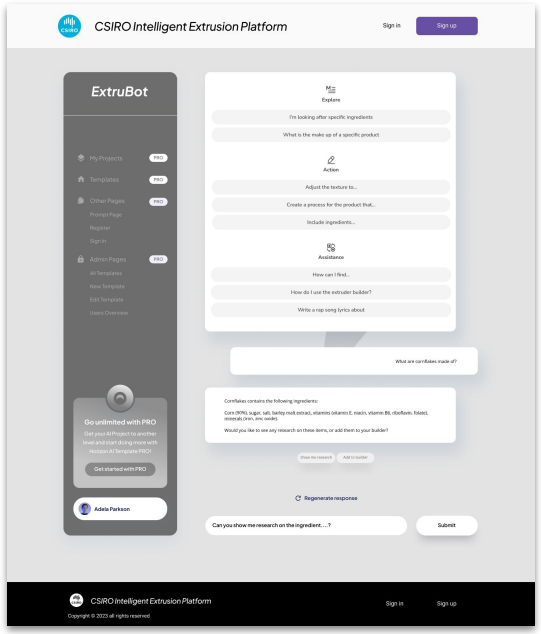
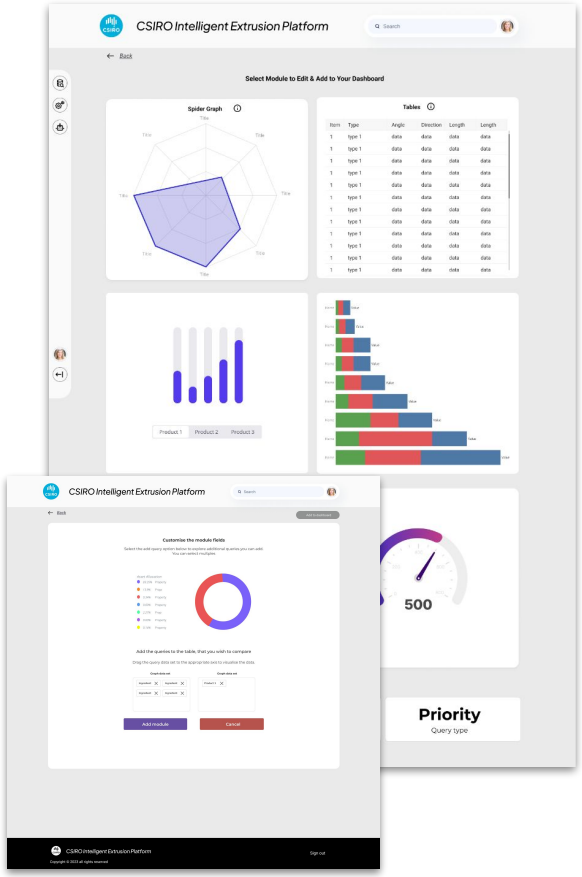
Recommended development roadmap

	Horizon 1: Beta (closed beta to test and learn)	Horizon 2: MVP (initial go to market with closed access)	Horizon 3: Research capabilities and payment gateways	Horizon 4: Advanced features
Include	• Product modeling builder + output • Utilising AI to generate results (only) • Registration (only, no payment gateway) • Save (whole product builds only) • Walk through process • Information hover states	• Basic product reverse engineering + output • Utilising AI to generate results (only) • Save by components (such as *screw profiles*)	• Research for market, ingredients and products • Fixed research filters • User profiles and configurations • Payment gateways • Blogs/articles • Advanced reverse engineer features	• AI bots (beta) + search capability • Comparison engines • Brain map research (visualisation tool) • Custom interest content - tailored to the user based on profile builder (link to blogs/research) • Custom research filters • Link research content into the builder -> ingredients
Exclude	• AI capability for chatbots etc. • Research capability • Comparison features • Payment gateways • User profiles • Blogs/articles • Custom graph building		• Research brain map visualisation • AI bots • Linking research to builders	

Items that should be parked and built at a later date

- Dedicated chatbot pages - arguably AI tools as well (excluding the builder)
- Custom graphs - recommend to initially define what information can be presented and build on this capability until further work as been done to complete the platform





04 Next Steps

Removing the ambiguity of the extrusion process

Recommended key next steps

1. Technical review with Digital Village - align with DigiV technical architect and CSIRO AI developer to build out delivery roadmap and understand timelines.

2. Prove AI capability/model.

3. Map out content, including support information, fields and branding. Understand data that should be displayed in predictive modelling and update accordingly.

4. Understand the data accessibility for the research, literature and market section. What is and isn't available, what can be hosted on the site, and what needs to be linked.

05

Assets/links

Links to all processes and documentation

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List of all assets, prototypes and workshops

- Initial customer research opportunities
- Sprint workshop
- Figma board
- Visual prototype

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Thank you