**Appendix to the manuscript: “Idea evaluation as a design process: Understanding how experts develop ideas and manage fixations”**

Below is an explanation of the steps made to identify experts’ idea development activities during idea evaluation.

1. The expert was presented with an idea (see description of Idea 2 below) and asked to think aloud while evaluating it from a Short Term and Long Term perspectives.

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| ***Idea 2: Customer Services – Remote diagnostic information***  *Provide the customer support and service by using the remote tools and virtual mechnics/technicans to: Diagnose the vehicle and inform customer of the health of the vehicle. The intention would be to investigate enhanced diagnostic solution in order to provide as early as possible information on vehicle status to Customer Services. The goal is for [the company] to know about any anomaly before the customers knows and thus become a pro-active service provider.* |

1. The idea and the transcribed audio-recording of the expert’s evaluation, were analyzed using the framework by Sukhov et al. (2019) in order to identify different fragments of an idea and to characterize different idea development activities. The breakdown of an idea (Idea 2) is provided in Table A1.

**Table A1:** Breakdown of Idea 2 using the framework of an Idea for Innovation by Sukhov et al., (2019)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Components of an idea for innovation** | **Context** | **Problem** | | **Solution** | |
|  | *Where/when does the idea occur?* | *What situation does the idea address? (Situation)* | *Why/to whom is the idea important? (Importance/dissatisfaction)* | *How can the idea be resolved? (Procedure)* | *What resources are used/required? (Resources)* |
| **Breakdown of Idea 2** | Customer Service [department] | Provide early information on vehicle status. | Help [the company] to become a proactive service provider and know about anomalies before the customer. | Provide support and service. Diagnose the vehicle. Inform the customer. Investigate enhanced diagnostic solution. | Remote tools.  Virtual mechanics/technicians. |

Based on this breakdown, the initial idea concept suggests to provide remote technical support in order to improve customer service. The breakdown of the idea development activities by Expert 1 for this idea is provided in Table A2.

**Table A2:** Breakdown of idea development activities of Idea 2 by Expert 1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Identification of Idea development activities** | | **Components of an idea for innovation (Sukhov et al., 2019)** | | | | |
| **Context** | **Problem** | | **Solution** | |
| Activity | Empirical example | *Where/when does the idea occur?* | *What situation does the idea address? (Situation)* | *Why/to whom is the idea important? (Importance/dissatisfaction)* | *How can the idea be resolved? (Procedure)* | *What resources are used/required? (Resources)* |
| 1 | *“this is [the division’s name] capability”* |  |  | Elaboration of the actor to whom this idea is important |  |  |
| 2 | *“…for me with the NV assist solutions […] it's a Sheraton project…”* |  | Elaboration of another situation that the idea can address. |  |  |  |
| 3 | *“…we want to connect the dealer, the back office and the customer, to be able to monitor for codes and to be able to connecting to the…”* |  |  |  | Elaboration of how the solution can work. |  |
| 4 | *“…when you go to a customer and you say to him, “hey, be careful”, you are going to have an issue in … I don't know, 1,000 miles, or…”* |  | Transformation on what situation can the idea address |  |  |  |
| 5 | *”You should go to a place to repair, we have booked the space for your truck.”* |  |  |  | Elaboration of how the solution can work |  |
| 6 | *“Your guy can stop, we will stop him two hours, but we will secure that you will be able to deliver end to end, just a two hours stop to secure your end to end delivery could be really valuable to the customer”* |  |  | Elaborating why this idea is important and to whom |  |  |
| 7 | *“And the other point is to be able to have, I would say, a daily contact with your customer. Not only when it's breakdown […]. You are the partner of a customer, and you can also make him send to your customer reports, saying “everything is going well”.”* |  |  |  | Elaboration of how the solution can work |  |
| 8 | *“I mean, the … in the aircraft industries, where they are monitoring engines”* | Transformation of the idea to a different context |  |  |  |  |
| 9 | *“…and they can say to the air company, like Air France, say “warning, on this plane you should make a maintenance. We have this alert on the airplane, on the engine. Please plan specific maintenance.” And this is how to do it”* |  |  |  | Elaboration of how the transformed solution can work |  |
| 10 | *“And I would also say, we have all the technical means”* |  |  |  |  | Elaboration acknowledging existing resources |
| 11 | *“…so now it's more working on make it sellable instead of make it possible. This is possible, and we have to transform it. So it's more about, well, use your assets”* |  | Elaboration on what situation does the idea address. |  |  |  |

1. The breakdown of the idea development activities enabled us to identify different types of activities such as elaborations and transformations of different idea fragments.

The example in Table A2 shows the gradual development of the idea through elaboration of its fragments until the expert forms a new layer of information leading to idea’s transformation (the activities in Table A2 are listed chronologically). In this example we were able to group the activities and identify three versions of the initial idea.

The initial idea was to provide remote diagnostics without direct involvement of the customer to improve customer service. Expert 1 elaborates on this (Activities 1-3), and then transforms the idea and elaborates on a solution that would instead involve the customer (Activities 4-7). After doing that, the expert transforms the context of the idea by drawing parallels with the Aircraft industry, where the expert has prior professional experience, and finally reiterates what situation should the idea address giving the idea a new meaning (Activities 8-11).

We repeated these steps and performed the same analysis on other experts’ activities. We found that Expert 3 engaged in 9 idea development activities containing eight idea elaborations and one transformation (the illustration of this is provided in the main manuscript). The expert quickly realized that the initial idea is focusing on the wrong area, stating that *“The problem is that when you have the […] codes it’s not enough to diagnose.”*, and then engaging in elaboration activities, gradually reiterating the idea into identifying a new problem that needs to be resolved, namely being able to *“ask good questions to the customer”.*

When looking into how Expert 4 developed the same idea, we found that the expert only engaged in idea elaboration activities extending the solution part of the initial concept by identifying resources in terms of technology that can be used to perform wireless diagnostics and specifying a more technical solution that is currently used by the company (see Table A3). Thus the idea is never transformed into a different concept, but rather is being more elaborated in terms of detailing its solution.

**Table A3:** Breakdown of idea development activities of Idea 2 by Expert 4

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Identification of Idea development activities** | | **Components of an idea for innovation (Sukhov et al., 2019)** | | | | |
| **Context** | **Problem** | | **Solution** | |
| Activity | Empirical example | *Where/when does the idea occur?* | *What situation does the idea address? (Situation)* | *Why/to whom is the idea important? (Importance/dissatisfaction)* | *How can the idea be resolved? (Procedure)* | *What resources are used/required? (Resources)* |
| 1 | *“today we have this kind of services but with … I don’t know what we can say, but we use a diagnostic box”* |  |  |  |  | Elaboration on the resources that are currently used. |
| 2 | *“that we plug in in the vehicle and we have all information about … the diagnostic information”* |  |  |  | Elaboration of how the solution currently works. |  |
| 3 | *“Today the technology is available I think thanks to wireless communication, smartphone or this kind of technology”* |  |  |  |  | Elaboration on the potential resources that can be used |
| 4 | *so I think this idea is an amelioration* |  |  |  | Elaboration of what the solution is about. |  |

1. Using this categorization of the idea development activities we then plotted all of the activities performed by experts on a graph with two axis in order to make a visual comparison.

In Figure A1, X-axis represented the total number of identified activities and Y-axis represented the number of idea transformations. The plot is shown for Idea 2 based on Expert 1 (11 activities, 3 transformations), Expert 3 (9 activities, 1 transformation), and Expert 4 (4 activities, 0 transformations). The Short and Long term idea evaluation scores are also provided in the figure.

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Insert Figure A1 about here

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1. The C-K theory framework was then applied on the idea development activities in order to understand the design process performed by each expert.

Doing this step allowed us to categorize activities that related to the Concept-space and activities that related to the Knowledge space, and helped us to understand the design process that the experts engage in. Figure A2 provides an example of how Idea 2 is designed by Expert 1, involving 11 idea development activities (the activities and their numbering correspond to the idea breakdown provided in table A2). By doing this, we could identify: *i)* an easy path that was generated by mobilizing knowledge about existing solutions related to the initial idea, and *ii)* a difficult path, where the expert mobilized knowledge from a different sector, the aircraft industry.

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Insert Figure A2 about here

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1. The C-K plots were compared across all cases in order to examine reoccurring patterns.

Performing the C-K coding on all experts and on all ideas (64 cases) allowed us to trace different patterns of the Experts’ concept development process. If we look at how Expert 1 engaged with different ideas we can observe different patterns. For instance, in the case of Idea 3, titled “Workshop planning tool”, the expert acknowledged the initial solution (C0), but quickly realized an alternative path (see Figure A3). This transformation of the idea occurred in 5 activities and shows a different C-K pattern compared to Idea 2 presented above. All the concepts in the case of Idea 3 are generated on easy paths since they mobilize restrictive knowledge directly related to the idea.

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Insert Figure A3 about here

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A different pattern in Expert 1’s reasoning can be seen in Idea 7 (see Figure A4). There, the expert elaborates on the initial idea concept (C0) realizing that a similar idea is already in the pipeline. This is another short development of the idea with only one easy path since the knowledge corresponds to an already existing idea in this field.

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Insert Figure A4 about here

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When comparing the C-K plots, the number, and the type of idea development activities, we could clearly see that the same expert could engage in a variety of different behaviors. Figure A5 gives an overview of how Expert 1 engaged with 15 different ideas based on the range of idea development activities.

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Insert Figure A5 about here

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Doing this for all experts helped us to finally identify six distinct types of reasoning that the experts experienced when evaluating ideas. A more detailed explanation of the different types and the discussion on how experts develop ideas is provided in the manuscript.

**Figure A1.** Number of idea development and transformation activities of Expert 1, Expert 3, and Expert 4 in relation to Idea 2 and the idea’s evaluation scores

**Figure A2.** C-K plot of Idea 2 by Expert 1

**Figure A3.** C-K plot of Idea 3 by Expert 1

**Figure A4.** C-K plot of Idea 7 by Expert 1

**Figure A5.** The range of idea development and transformation activities for different ideas provided by Expert 1