Designing Pen-based Interactions for Productivity and Creativity

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How to leverage the pen capabilities to design interactions tailored to productivity and creativity?

Productivity and creativity support tools on desktop are often strongly structured, enabling users to perform advanced manipulations. This structure, however, bears constraints which become a liability when these tools are adapted to interactive surfaces. We explore how the pen can be used to benefit from the structure while mitigating the constraints in the cases of spreadsheet work and music score writing.


Context

The spreadsheet's powerful structure resides in its grid. But on interactive surfaces, this grid forms a layer above the values that intercepts most of our actions. When we want to interact with the grid (b), navigate above (a), reach the cell values underneath (c), and go back and forth between these layers, our misinterpreted actions slow down the workflow.

a — Navigation layer
b — Grid layer
c — Value layer
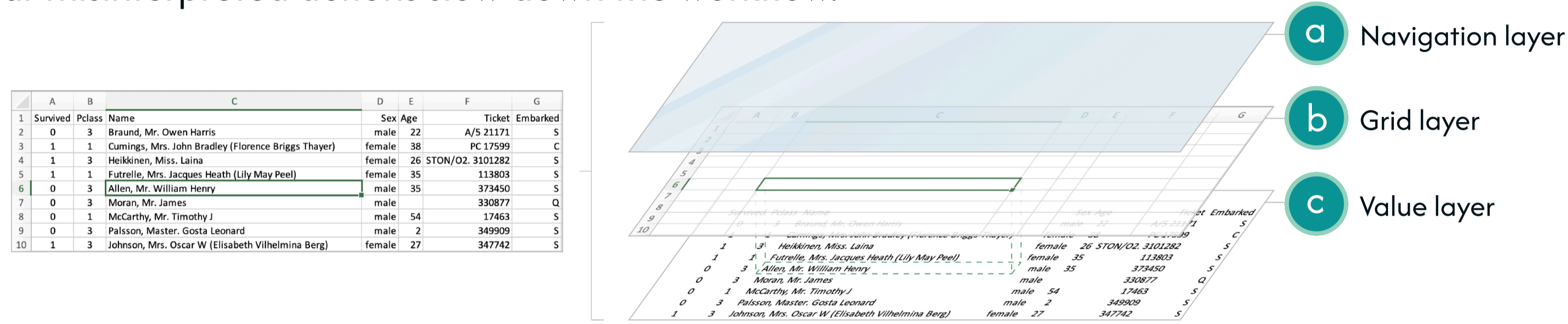
Design

What users can do - Review of commercial spreadsheet programs

We looked into what users can currently do with popular spreadsheet programs on various interactive surfaces and showed a lack of consistency between configurations. For instance, a double tap with the pen might put a cursor at the end of a value (a), or in the middle of it (b), or select the whole value (c).
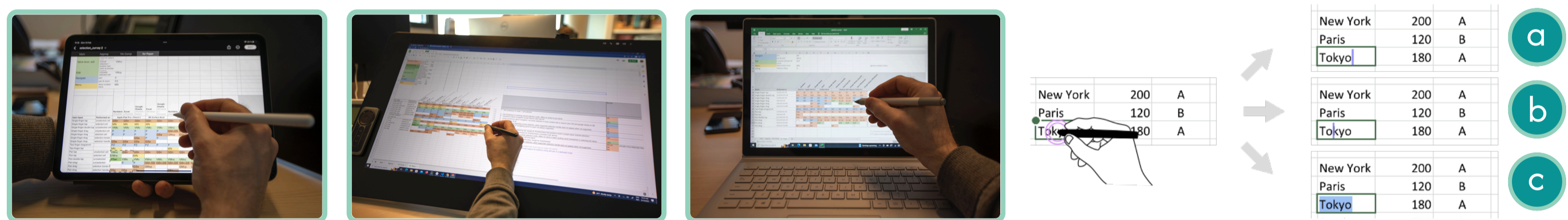
What users could do - Elicitation study

We asked 16 participants to show us strategies they could adopt to perform a list of operations. Overall, the results showed a lack of agreement between participants and a prevalence of pen use for the selection of values inside cells, revealing a fertile ground for new pen-based interactions.
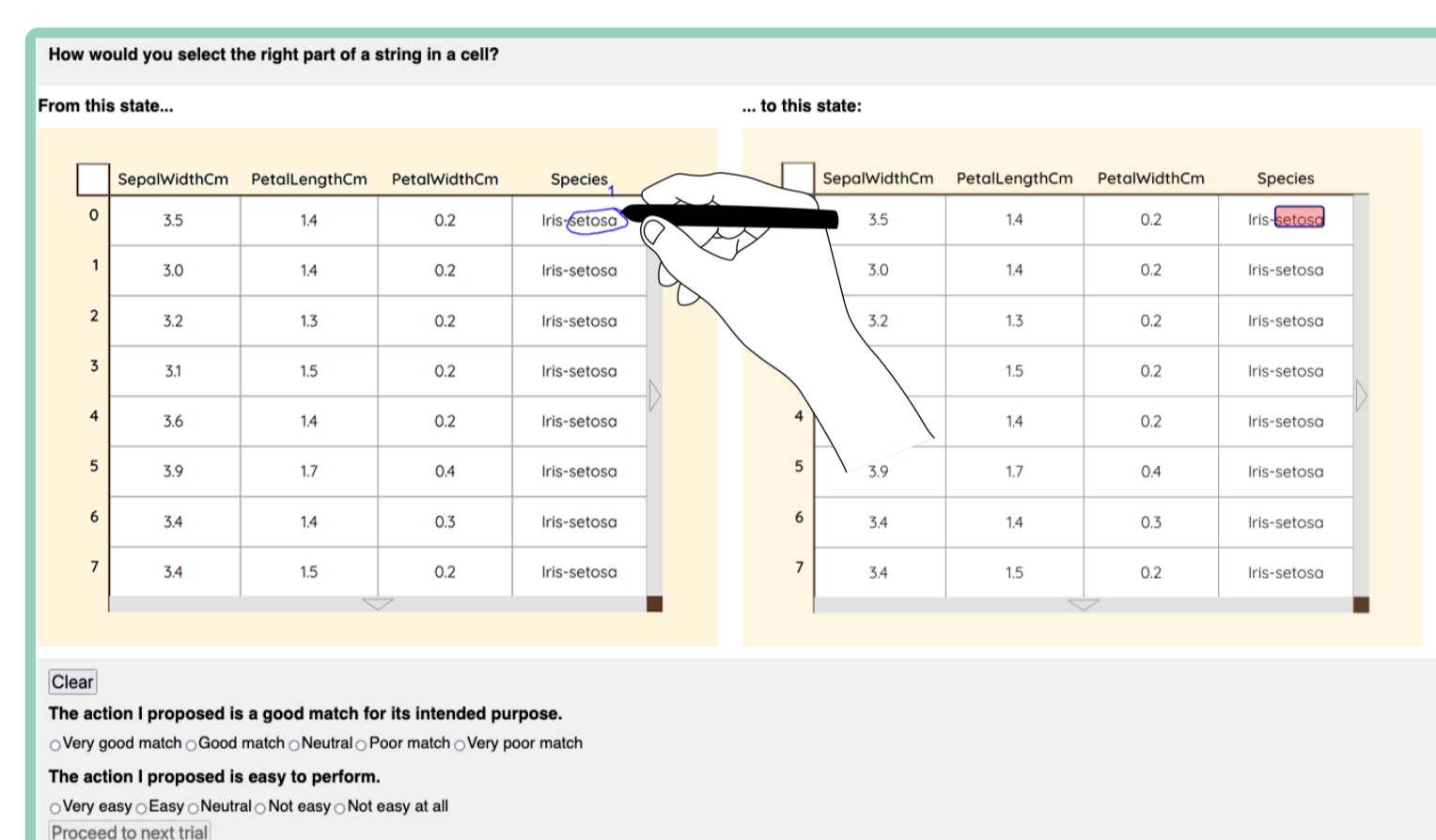

A trial in the elicitation study

Prototype

Breaking free from the navigation layer

To reduce the need to pan across the navigation layer and thus friction with the grid layer, we implemented widgets that rely on the precision of the pen. The *minitable* shows an overview of the dataset and lets users see and move beyond the viewport (a), but also select ranges of elements (b). *Minivis plots* can be bar charts, density plots or box plots and let users select rows based on values (c).
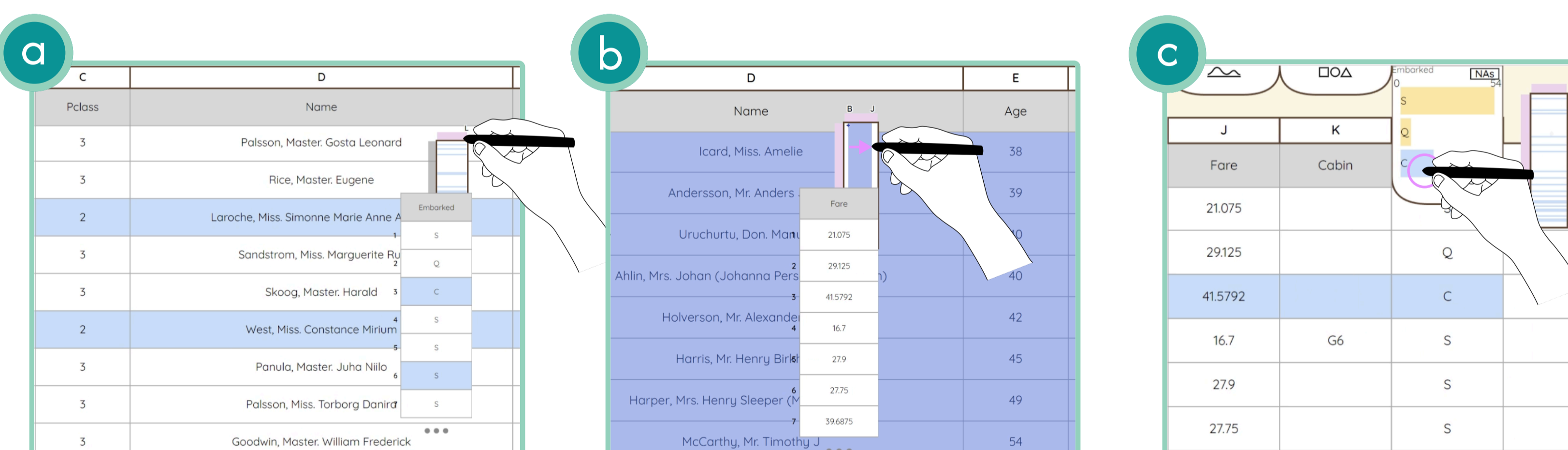

Breaking through the grid layer

To mitigate friction between the grid and value layer, we designed distinctive pen-based interactions to select elements. Tapping on a cell selects at grid-level (a), while drawing an unconstrained mark within the boundaries of a cell selects at value-level (b). Such a selection can then be used for advanced operations impossible without keyboard. For instance, to expand the selection rule (c).
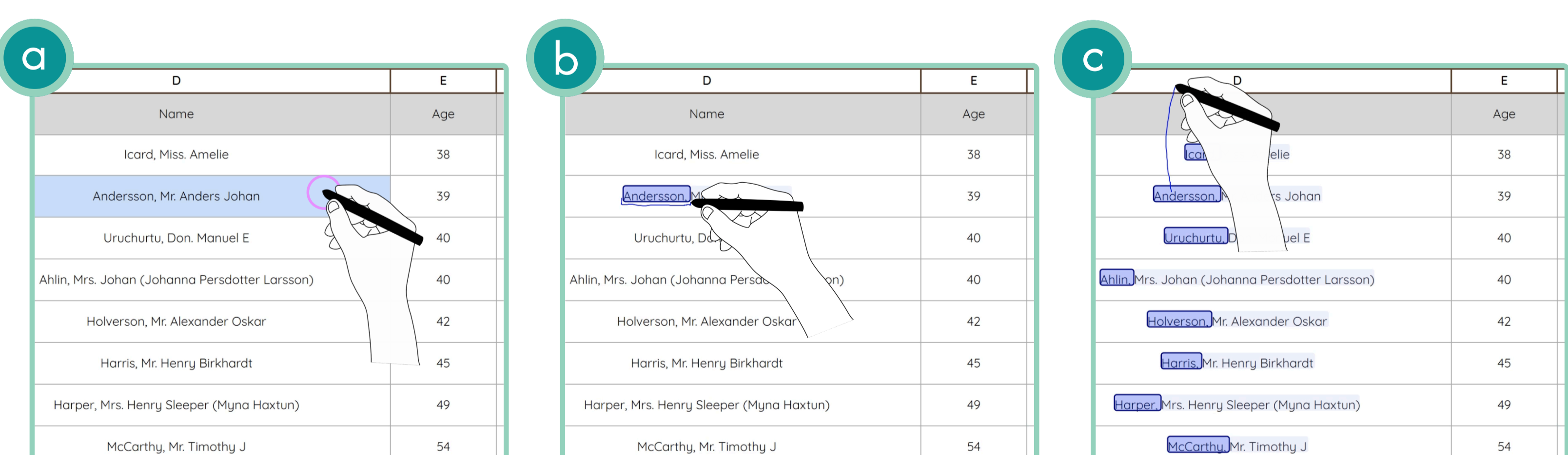


Evaluation and Takeaways

After a demonstration of the techniques, 6 data workers explored their own dataset for 45 minutes while thinking aloud. Participants were generally satisfied with the system, quickly became efficient in using it for various tasks, including value-level manipulations and data transformations, and were able to derive new insights from their data that they couldn't achieve with desktop tools. It revealed how identifying and exploiting the structure with pen-based interactions could facilitate the use of spreadsheets on interactive surfaces.
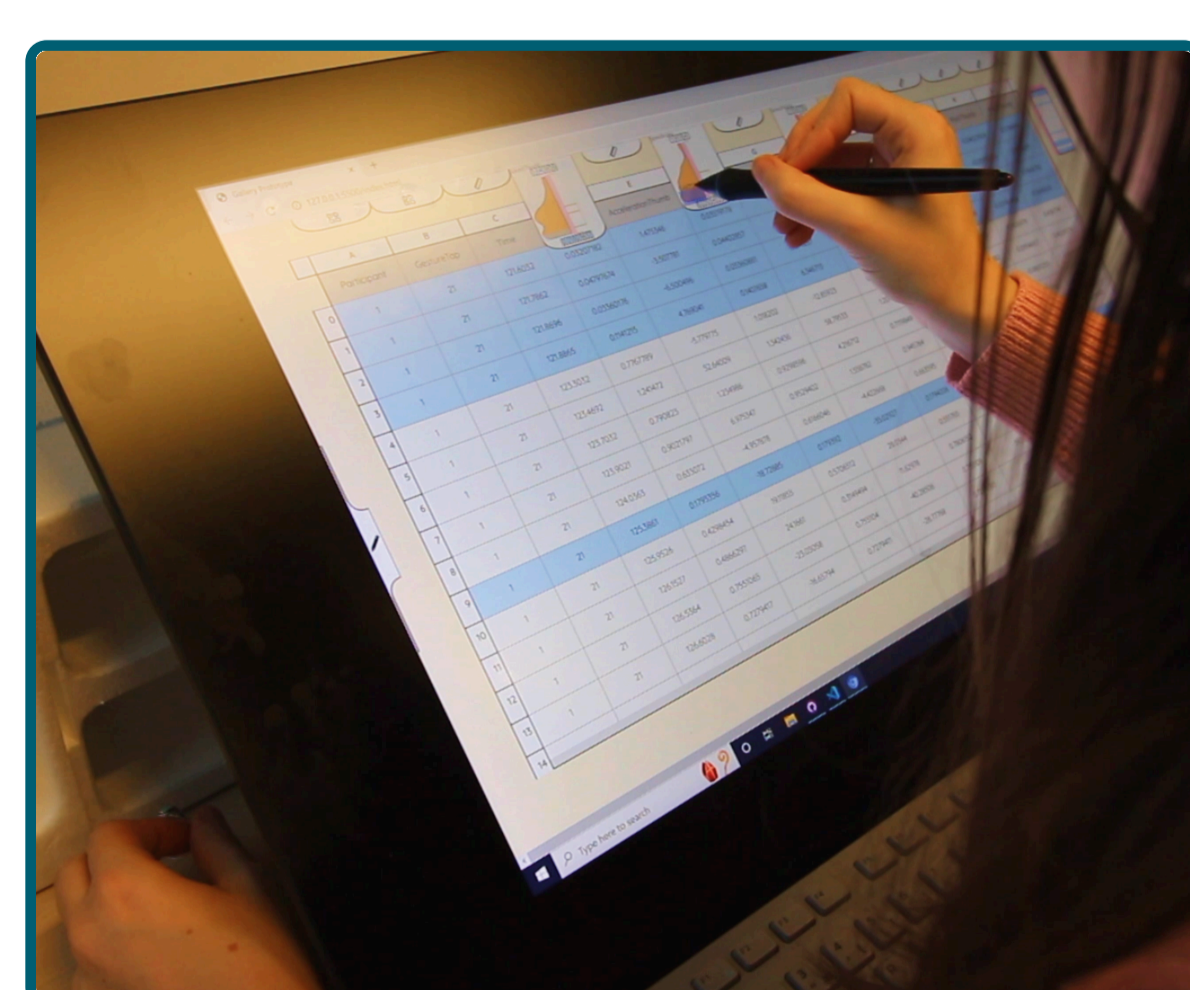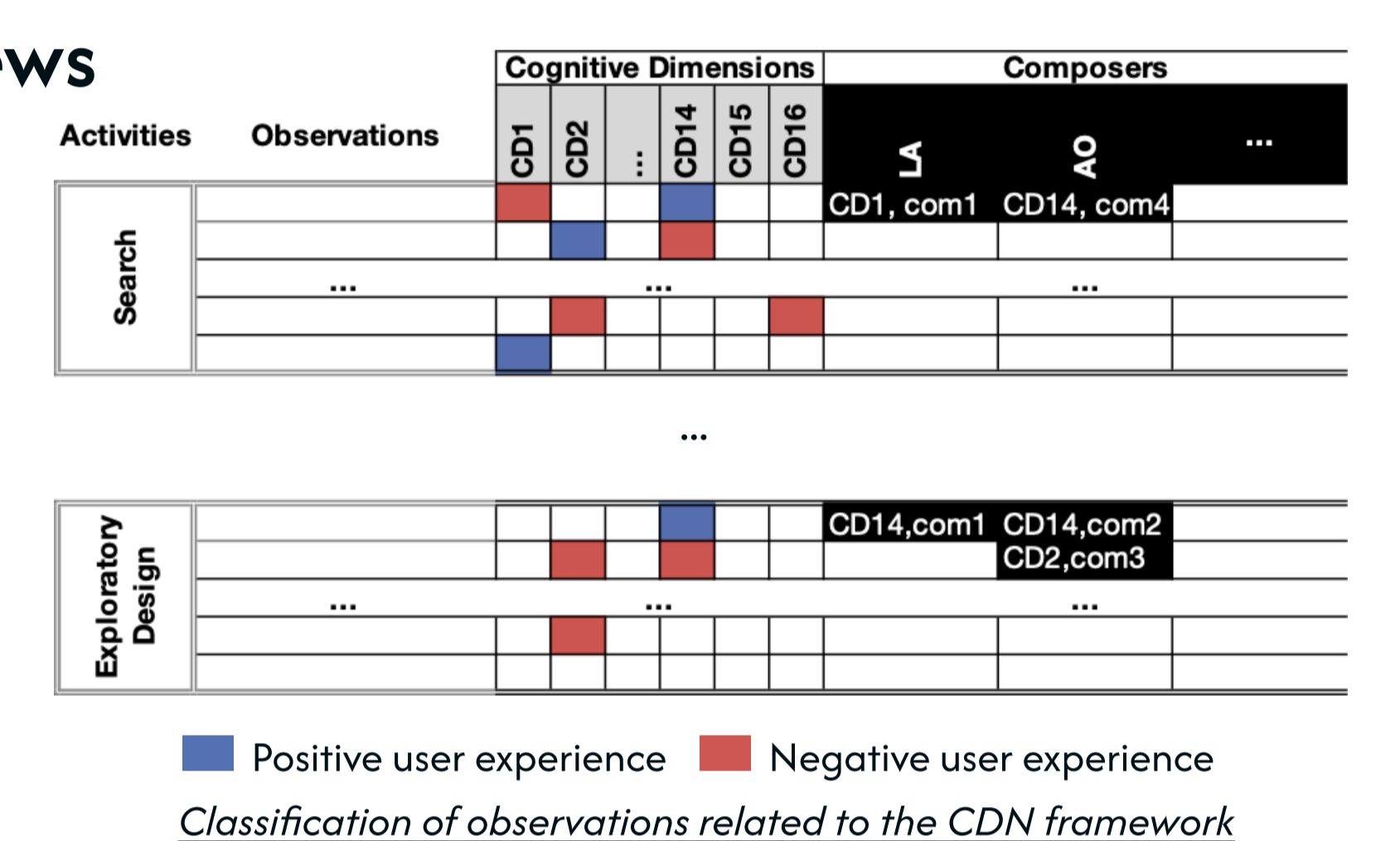

ToCHI 2024 [1]

Context

The music score editor's structure enables composers to create high-quality scores, but its derived constraints impede the more creative stages in the composition process. On interactive surfaces, this structure is barely adapted and the global interaction model does not offer more overall flexibility. But because music score writing was initially designed for paper and not for desktop computer, there is potentially more to do than fix portability issues.
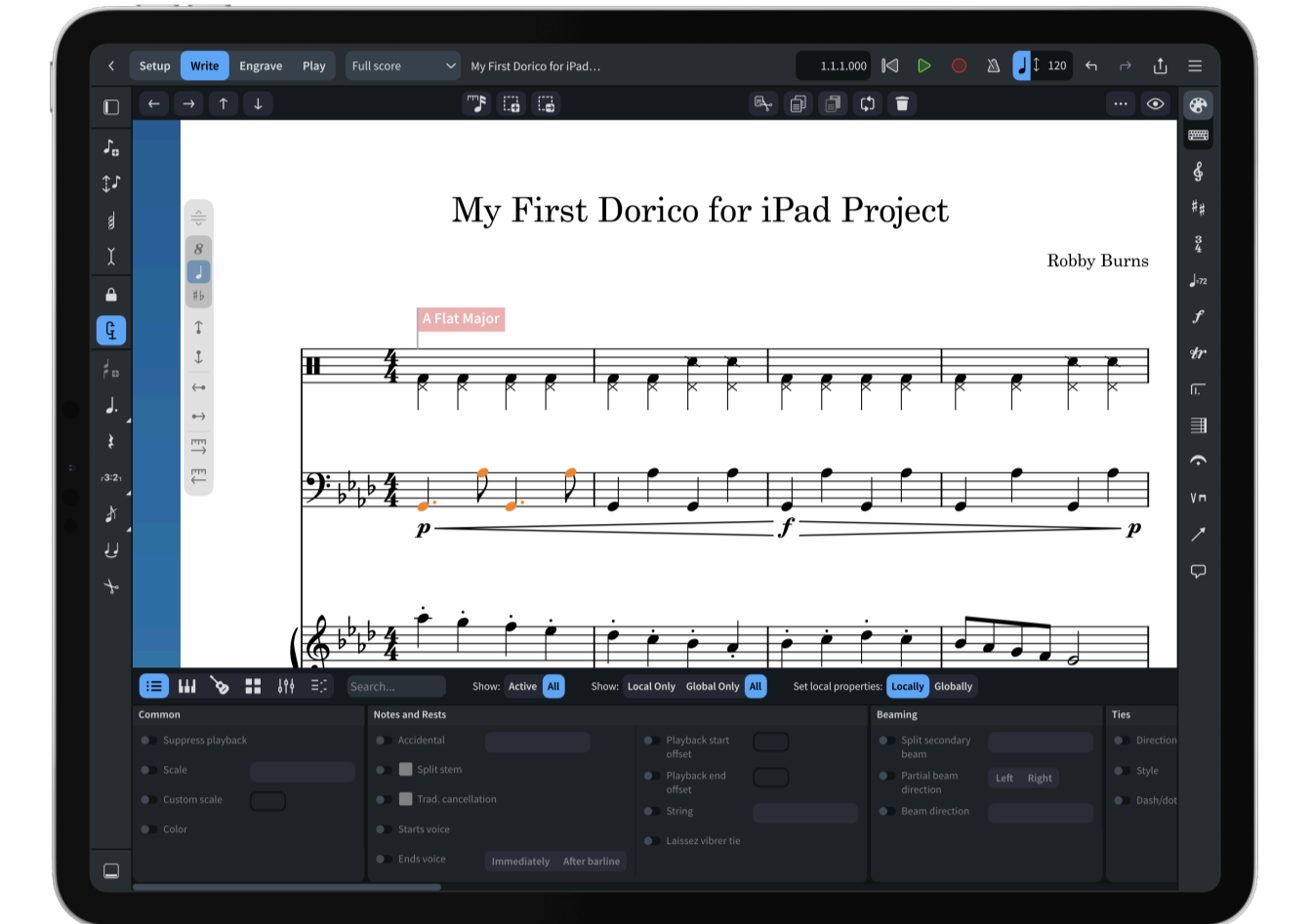
Design

What users can and could do - Interviews

We interviewed 9 composers to understand their habits and the challenges they face with their current desktop tools. We then conducted two complementary analysis through the prism of a *thematic encoding* and through the *cognitive dimensions of notation framework*, and proposed three ways in which breaking the structure could help composers' creative workflow.

■ Positive user experience ■ Negative user experience
Classification of observations related to the CDN framework

What users could do - Workshop

We led a workshop (3 hours) to confront two composers with our design ideas and observe their reactions to the first iteration of our prototype. It allowed us to confirm our proposals to break the structure and refine many features.

Prototype

##### *Breaking the score's linearity*

To enable composers to take a break from the score's temporal structure and explore ideas freely like they would on paper, we designed spaces that can be opened on the side of the score or between staves (a). Composers can also leave parts of the score "in progress" and without bar structure.

Breaking the score's homogeneity

To give more importance to the variability of content involved during the composition process, we relaxed the interpretation of handwriting and enabled different medium to coexist inside or around the score (b).
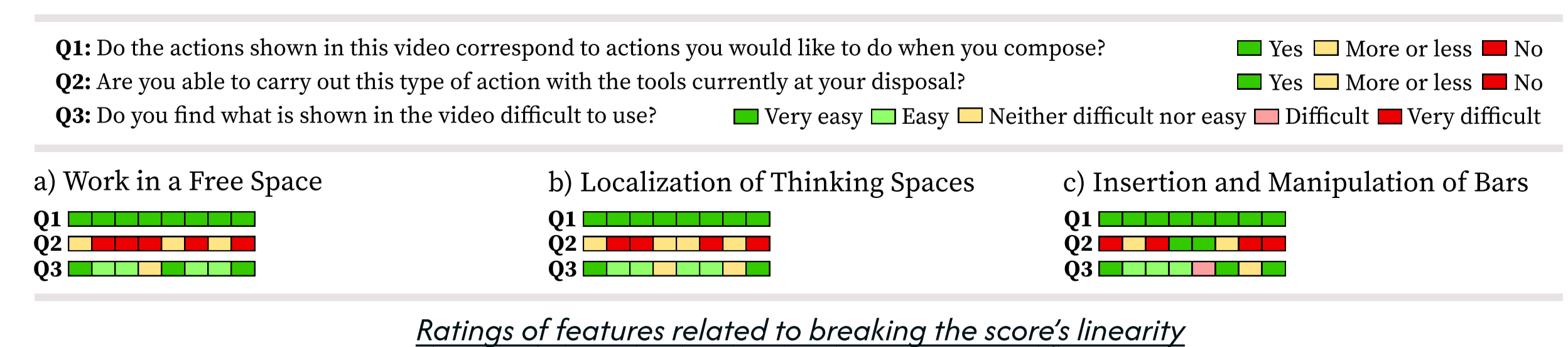
Breaking down musical elements

To ease the manipulation of musical elements like copy and paste or the search for patterns (c), we let composers tap into hidden information with the pen which can point and delineate with precision (d).

CHI 2024 [2]
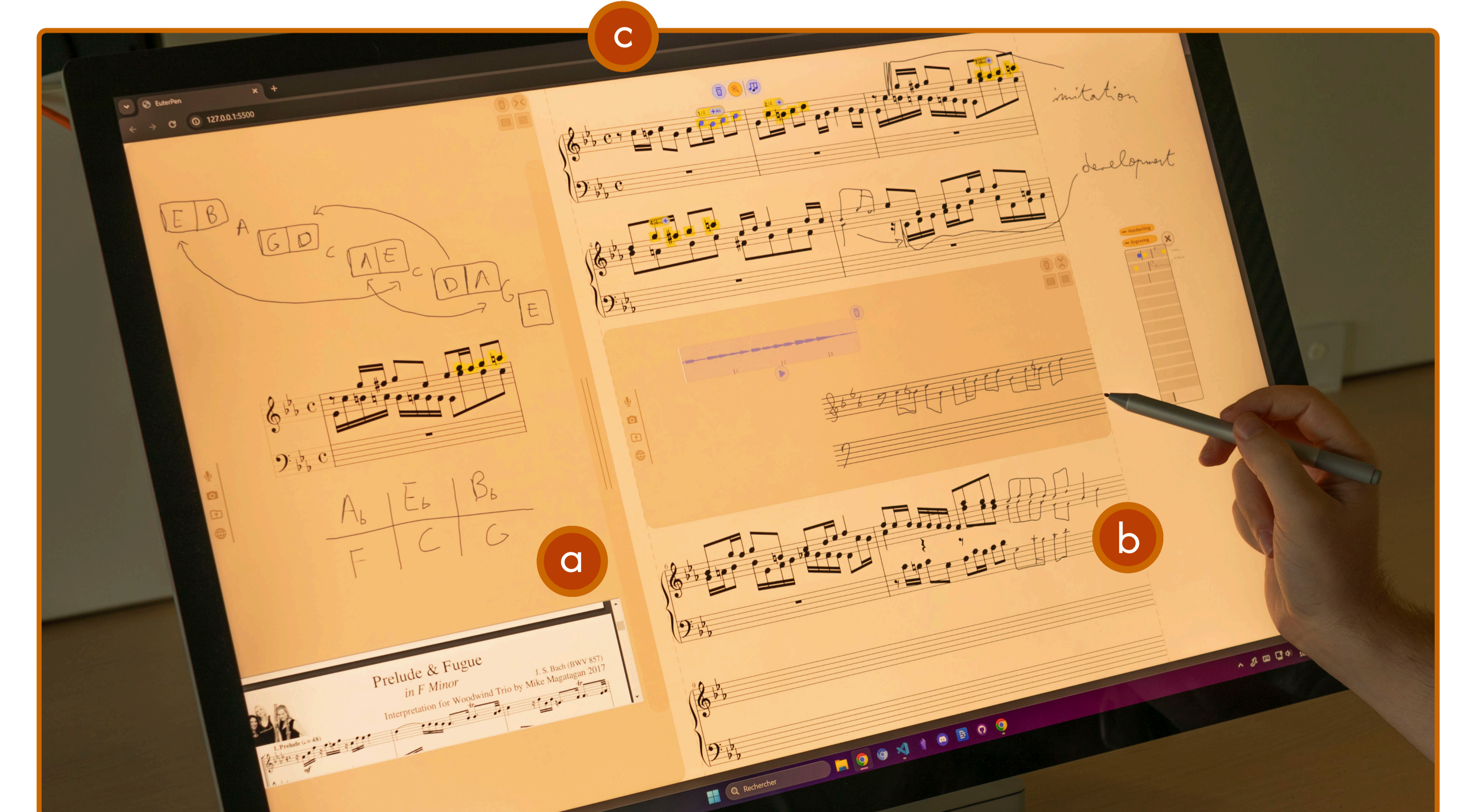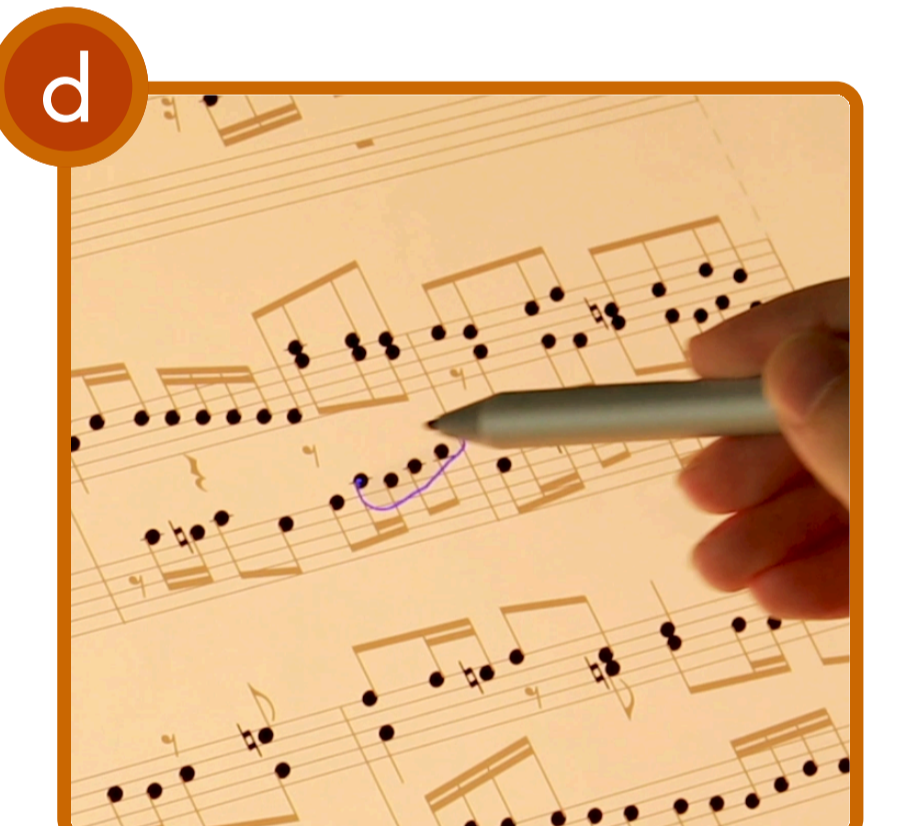
Evaluation and Takeaways

We showed the features to 8 composers who rated them and discussed about them during 1h30 online sessions. Overall, they found the features easy-to-use and would like to use them when composing. They usually could not do those with their current tools, or found workarounds to achieve their goals, emphasizing how leveraging the structure while lowering constraints could benefit them.

Q1: Do the actions shown in this video correspond to actions you would like to do when you compose? ■ Yes ■ More or less ■ No
Q2: Are you able to carry out this type of action with the tools currently at your disposal? ■ Yes ■ More or less ■ No
Q3: Do you find what is shown in the video difficult to use? ■ Very easy ■ Easy ■ Neither difficult nor easy ■ Difficult ■ Very difficult

a) Work in a Free Space   b) Localization of Thinking Spaces   c) Insertion and Manipulation of Bars

Ratings of features related to breaking the score's linearity

CHI 2025 [3]

References

[1] Vincent Cavez, Caroline Appert, and Emmanuel Pietriga. 2024. Spreadsheets on Interactive Surfaces: Breaking through the Grid with the Pen. https://doi.org/10.1145/3630097

[2] Vincent Cavez, Catherine Letondal, Emmanuel Pietriga, and Caroline Appert. 2024. Challenges of Music Score Writing and the Potentials of Interactive Surfaces. https://doi.org/10.1145/3613904.3642079

[3] Vincent Cavez, Catherine Letondal, Caroline Appert and Emmanuel Pietriga. 2025. EuterPen: Unleashing Creative Expression in Music Score Writing. https://doi.org/10.1145/3706598.3713488