Envisioning Generative AI Interaction for Collaborative Design

Stephanie Houde
IBM Research
Cambridge MA USA
stephanie.houde@ibm.com

Siya Kunde
IBM Research
Yorktown Heights NY USA
skunde@ibm.com

Rachel Bellamy
IBM Research
Yorktown Heights NY USA
rachel@us.ibm.com

Abstract
We propose that the potential process benefits of new generative AI tools for design are not limited to activities of design professionals designing interactive systems. They can also extend to professionals of any discipline who are engaged in design-like activities where collaborative idea generation, exploration and idea extension selection occur. We present a vision scenario depicting how generative AI could support material chemists engaged in a collaborative molecule discovery task. We comment on specific design process benefits at each stage.

Author Keywords
Authors' choice; of terms; separated; by semicolons; include commas, within terms only; required.

Introduction
The call for participation for this workshop states:

The year 2022 saw a boom in the field of Generative Artificial Intelligence (GenAI). The radical accessibility of these technologies has the potential to transform the creative field including design practice and design research. For instance, by helping designers generate, explore, and extend ideas more quickly, or by offering serendipity, surprise and generative friction through its unpredictable outcomes.

In this position paper, we propose that the potential process benefits of new generative AI tools for design are not limited to activities of design professionals [3] designing interactive systems. They can also extend to professionals of any discipline who are engaged in design-like activities where collaborative idea generation, exploration and idea extension selection occur. Designers of interactive system's can learn from applications developed for design in other domains. As an example to learn from, we present a vision of the potential benefit of generative AI support for material chemists engaged in a collaborative molecule discovery task.

AI Support for Molecule Selection

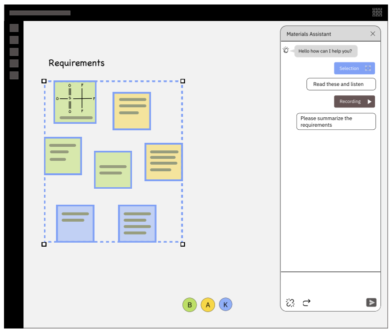
Figure 1 depicts an abbreviated version of a scenario used to envision how integration of a conversational AI assistant with generative model capabilities which can suggest new molecule designs could benefit a group of chemists who need to find or create a molecule that meets a particular set of requirements in a synthesis process. This process, with or without AI support, involves group brainstorming, collaborative agreement on requirements, individual exploration, and generating group consensus on candidates for further exploration and synthesis. These activities are familiar parts of design thinking [1] and collaborative design practice among UX design, architecture, and other fields of professional design [2].

In the scenario we propose that integration of a conversational AI assistant, powered by a large language model (LLM) that has been fine tuned with materials science content may have the following process benefits:

- A conversational AI assistant that is prompted with project requirements and progress, could help individuals and groups maintain that context across independent (divergent) and co-creative (convergent) design activities.
- Automated summarizing and formatting of meeting content could save time and effort to allows greater focus on content over the logistics of capturing and reporting it.
- The ability to express search queries in domain specific terms may allow for faster and more expressive filtering of domain content which could free experts to think beyond the set of options offered in a predefined UI.
- Enabling a multi-modal interaction paradigm that allows user to metaphorically "point" to visual content via direct manipulation selection in combination with the ability to ask questions or make requests related to that selection can offer an easy and intuitive interaction.
- AI generation of alternative artifacts (in this case molecules) can provide new ideas for consideration and inspiration.
- Asking the AI assistant to provide feedback on how candidate artifacts do or don't fit with project requirements could be useful when choosing between alternatives and keep the discovery process from straying.

Feedback from Chemists

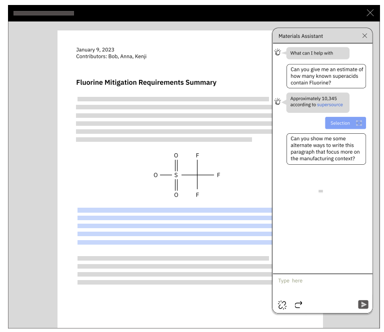
The vision depicted in Figure 1 was inspired by interviews with seven chemists and previous experience integrating a conversational AI assistant in programming environment [4]. To understand how chemists work, we interviewed the chemists using a think-out-loud protocol while they attempted to create a fluorine free superacid for photolithography using tools of their choice. We followed this up with questions about the potential role of a conversational AI assistant in helping them achieve discovery and creation



1. Ben, Anna, and Kenji are materials chemists. They need to work together to find or create a fluorine-free superacid to meet a new manufacturing requirement. They begin by meeting a virtual collaboration space where they all write notes about project requirements. A conversational AI Assistant is available in a chat window. They ask the assistant to listen to their discussion and read their notes to generate a summary.

Benefits:

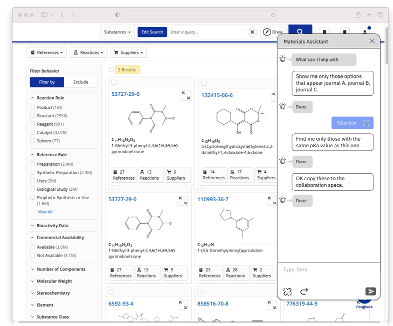
- ***AI Summarization of notes and discussion audio allows team to focus on content not documentation.***
- ***Saves time and effort.***



2. The assistant generates a formatted requirements document with summary content in place. The team opens the document in a shared document editor. The document is not perfect - the AI has made some mistakes and some content is missing, but it's a good starting point. They work together to complete the document. The same assistant, already prompted with project content, is available to answer questions and generate new text options in the context of project goals and requirements already established.

Benefits:

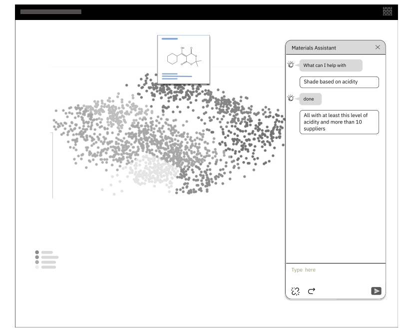
- ***AI Generated document allows collaborators to focus on content not formatting.***
- ***Saves time and effort.***
- ***Using the same assistant across tools facilitates in-context questions and answers.***



3. Next, the three chemists decide to search for solutions individually with a plan to share ideas later. Ben opens a molecule search tool, where the same AI Assistant is available. As an expert chemist, he can use natural language to ask the assistant to filter custom options quickly without needing to search the direct manipulation UI. After several search refinements, he identifies two superacid candidates and asks the assistant to copy them ot the collaboration space.

Benefits:

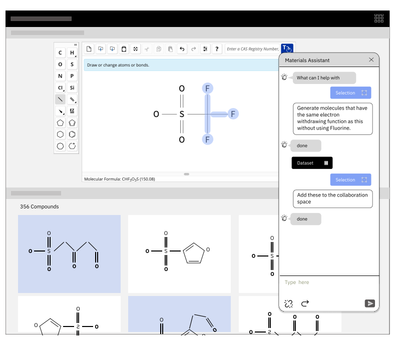
- ***Ability to express search criteria in domain specific language.***
- ***Using the same assistant facilitates in-context searching (Ben did not have to remind the assistant that he is looking for a fluorine-free superacid).***



4. Anna searches for candidates using a visualization tool. She also opens the same AI assistant and asks to filter and view candidate molecules. She iteratively filters and visually browses options. When she finds an example she likes, she asks for more options with specific properties like "this" as if she were pointing to an example while working with a human assistant. She identifies three options to share.

Benefit:

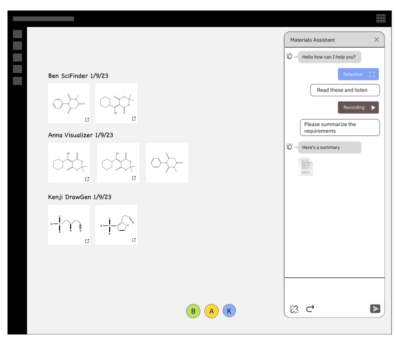
- ***Ability to easily refer to a selection from the chat saves time and typing (no name was required).***
- ***Using the same assistant across tools maintains the project context for all searches and questions.***



5. Kenji opens a molecule drawing tool where he can draw molecule diagrams. He loads a diagram of an existing superacid and selects the fluorine components that need to be replace. He asks the assistant to generate alternate versions of the same superacid that do not contain fluorine. After browsing the results, he chooses two to ask the assistant to copy to the group collaboration space.

Benefits:

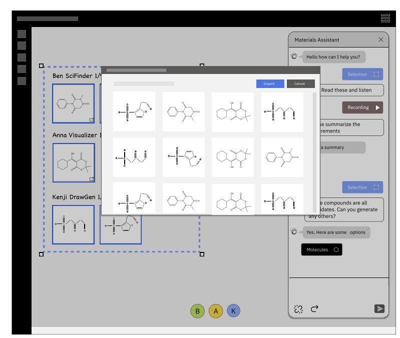
- ***Ability to mix direct manipulation with natural language requests allows for a natural interaction (again like pointing in a discussion with a colleague).***
- ***Generation of alternate options provides Kenji with new ideas and directions to consider.***



6. All three chemists asked the assistant to save their selections to the shared virtual collaboration space. The assistant groups and labels the options by author on a new part of the shared canvas which allows the group to jump right into a discussion when they come together.

Benefits:

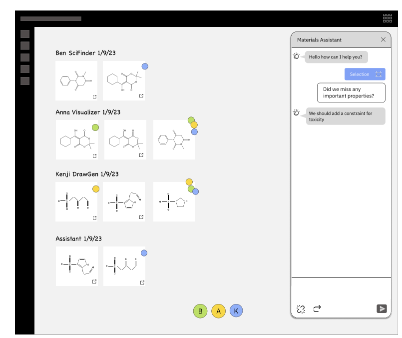
- ***AI generation of grouping, labeling, and placement provides a default level of organization so the chemists don't have to.***



7. After they discuss the superacid candidates they have each offered, they select them as a group and ask the assistant to generate more molecules "like those". The assistant generates a set of candidates. Some are not very good, but two seem interesting and the group chooses to add them to the canvas.

Benefits:

- ***AI generation of alternate options based on similarity to a selected group of superacids in the shared space allows the group to view and consider ideas that none of them had thought of.***



8. They ask the assistant for input on how well the different superacid candidates meet the requirements determined at the beginning. The assistant provides answers to their questions and informs them of other criteria to be considered. Armed with this information the group votes to select two molecules to synthesize in the lab.

Benefits:

- ***The AI helps the group to maintain the detailed requirements context in which they are evaluating options.***

Figure 1: A scenario visualizing AI support for creative exploration and collaboration. An AI Assistant powered by a large language model, fine tuned for the materials science domain, offers contextual support throughout a creative search process. A group of chemists use the assistant both collaboratively and individually to co-creatively define requirements, generate options, and make selections for testing.

tasks. We gained insights into chemists' methodology in tackling the discovery process, the types of tools currently used to achieve this, and how an AI assistant could bridge the gaps in current technologies and provide user-friendly conversational interface that can better help experts focus on the innovation process.

After defining the vision story, we organized feedback sessions with six of the same chemists to collect their input. The ability to converse with a assistant using technical terminology in natural language, summary generation, contextual maintenance of requirements, and the ability to interact with visualization and visual molecule diagram tools while conversing with an assistant were universally attractive.

Conclusion

Our preliminary exploration of how an integrated AI assistant might support a collaborative molecule design process was promising in two ways. We identified functionality and interactions that were attractive to our target users. We also recognized that the type of early stage collaborative problem definition, discussion, and selection activities explored are representative of similar activities in professional design and other professional domains. Further exploration, prototyping, and testing is needed to evaluate feasibility and desirability of the AI support depicted.

References

[1] IBM Design. 2023. Enterprise Design Thinking. (2023). Retrieved June 19, 2023 from `https://www.ibm.com/design/approach/design-thinking/`

[2] Jonathan Ball. 2005. The Double Diamond: A universally accepted depiction of the design process. (2005). Retrieved June 19, 2023 from `https://www.designcouncil.org.uk/our-resources/archive/articles/double-diamond-universally-accepted-depiction-design-process`

[3] A Baki Kocaballi. 2023. Conversational ai-powered design: Chatgpt as designer, user, and product. *arXiv preprint arXiv:2302.07406* (2023).

[4] Steven I Ross, Fernando Martinez, Stephanie Houde, Michael Muller, and Justin D Weisz. 2023. The programmer's assistant: Conversational interaction with a large language model for software development. In *Proceedings of the 28th International Conference on Intelligent User Interfaces*. 491–514.