

## LOI For Phase 2 Projects / Subprojects template

Completed Letters of Intent (LOIs) should be sent as email attachments to [applications@grand-nce.ca](mailto:applications@grand-nce.ca) with "GRAND Phase 2 LOI" as the subject line.

A successful proposal will address problems of significant relevance to the GRAND research program and must meet all of the guidelines for projects within GRAND, including the following mandatory requirements:

- The project must address significant research issues relevant to one or more of the GRAND Challenges identified for Phase 2 of the GRAND NCE
- The Project Leader and Co-leader must work at different universities; often they will represent multiple disciplinary approaches, appropriate to the project.
- There must be at least three researchers (including the Project Leader and Co-leader) who are or are eligible to be Principal Network Investigators within the GRAND NCE.
- There must be at least one Project Champion personally involved in planning and carrying out the project who is affiliated with a current or potential GRAND Partner drawn from the receptor community.
- One or more Partners from the receptor community must commit to making significant cash or in-kind contributions to the project.
- A current NSERC Form 100, SSHRC CV, or CIHR Common CV for both the Project Leader and Co-leader must be submitted as attachments to the LOI. Failure to include these attachments will be cause for immediate rejection.

Detailed instructions for completing this LOI template are on Page 2. More information on Phase 2 of the GRAND NCE is available on the GRAND website at the following URL, which will be updated with links to additional information as it becomes available: <http://grand-nce.ca/renewal>

**Please note: If you complete this form using Preview, do not enter more text than is visible within the dimensions of the provided text box. Text that exceeds the visible limits will not be reviewed.**

### Project Title and Description

☒ Full project LOI    ☐ Subproject only LOI

Title of proposed project

SHREXP - Shared Experience

Brief description for public use

SHREXP examines the affordances of new media in support of interaction and collaboration at appropriate levels of fidelity, across time, space, and scale. Sub-projects investigate different approaches to capture, encode, transmit, synthesize, render, and perceive shared experiences in support of users' activity at work, play, or social interaction.

### Proposed Project Leader

☒ Form 100, SSHRC CV, or CIHR CCV has been attached

Name  
Jeremy Cooperstock

Email  
jer@cim.mcgill.ca

University  
McGill University

Title/Position  
Associate Professor

### Proposed Project Co-leader

☒ Form 100, SSHRC CV, or CIHR CCV has been attached

Name  
Anthony Tang

Email  
tonyt@ucalgary.ca

University (must be different from Project Leader)  
University of Calgary

Title/Position  
Assistant Professor

### Proposed Project Champion

☒ Confirmed    ☐ Contacted    ☐ Not Yet Contacted

Name  
Danny Grant

Email  
dgrant@immersion.com

Organization  
Immersion

Title/Position  
Principal Engineer

## Instructions for Letter of Intent for Phase 2 of the GRAND NCE

**Front Page:** All fields are mandatory. (a) Provide a project title and indicate whether the LOI is for a full project with subprojects or is only for a single subproject. LOIs that only propose a subproject will be matched with related LOIs to form full projects. (b) Provide a brief description of the proposed research suitable for posting on a public website that explains the project in terms accessible to the digital media community. (c) Provide the name, email address, university, and title for both the proposed project leader and the proposed project co-leader. (d) Provide the name, email address, organization name, and title for the proposed project champion (a person affiliated with a project partner who will be engaged in planning the project) and indicate whether the project champion has been confirmed, has only been contacted, or has yet to be contacted.

**This Page:** Read all of the instructions for completing the LOI template before filling out any of the information on later pages.

In **Part A**, provide the names of up to six partner organizations, indicate whether each has been confirmed, has only been contacted, or has yet to be contacted, and provide a brief explanation for how each organization will be involved in the project either as an active participant or as a potential receptor that will benefit from the research.

In **Part B**, list all GRAND projects that are related to the new LOI and also any other LOIs you are aware of that may be relevant to the new LOI.

In **Part C**, list up to nine additional co-applicants (not including the individuals listed on Page 1) who are expected to be involved as active participants in the research project. Indicate for each whether the individual is a project champion from the receptor community or an academic researcher.

In **Part D**, succinctly summarize (up to one half page) the problem being solved by the research.

In **Part E**, provide an overview (up to one and one half pages) of the proposed solution and the approach that will be taken in the research. Include relevant details about the theoretical framework, significant previous work, methodological approaches, and how the research will be managed and structured to achieve the desired goals. If you checked the box on the **Front Page** indicating you are submitting an LOI for only a subproject, just use the first box for **Part E**, don't use the second box on the continuation page.

In **Part F**, describe up to six subprojects (up to one half page for each subproject) that will be pursued during the first two years of the project. Indicate for each subproject the research question(s) that will be addressed, the relationship of the subproject to the rest of the project, the deliverables and assessment criteria appropriate for evaluating the success of the subproject, and the time frame (start and finish dates) estimated for the subproject. If you checked the box on the **Front Page** indicating you are submitting an LOI for only a subproject, enter "N/A" in all of the fields in **Part F** and continue to **Part G**.

In **Part G**, explain the likely technology transfer, knowledge mobilization, knowledge translation, or other activities that are planned for the project and how they may provide benefits to the receptor community.

In **Part H**, explain how the project will interact with other projects and the ways in which it may support or otherwise enhance the overall impact of the network.

In **Part I**, explain specific ways in which current or future partners will participate in the project and the mechanisms that will be used to ensure that this takes place.

In **Part J**, for each of the seven GRAND Challenges check whether the project will make its primary research contribution (check exactly one box) or a secondary research contribution (as many additional boxes as apply) to the challenge. Check "N/A" for any challenge that is not significantly impacted by the proposed research. For each challenge where a contribution is expected, provide a brief description of the likely contribution and its importance to the receptor community. The "Other" category may be used to describe anticipated contributions to the research infrastructure and enabling technologies and methodologies used in the GRAND NCE, or to other areas relevant to digital media that may be impacted, if the proposed research is expected to make a significant contribution in these areas.

Part A: Receptors and Partners list up to six organizations		
Organization Immersion	<input checked="" type="radio"/> Confirmed	<input type="radio"/> Contacted <input type="radio"/> Not yet contacted
Brief description of involvement Involved with Vertegaal in a CRD on flexible displays and haptic feedback.		
Organization Communications Security Establishment/VENUS	<input checked="" type="radio"/> Confirmed	<input type="radio"/> Contacted <input type="radio"/> Not yet contacted
Brief description of involvement CSE is already actively engaged with Biddle; the VENUS initiative is soon to be launched publicly, involving additional partners (e.g., RCMP, DND, National Defence), all of whom are looking for new and improved collaborative decision-making/investigation tools.		
Organization CA Technologies	<input checked="" type="radio"/> Confirmed	<input type="radio"/> Contacted <input type="radio"/> Not yet contacted
Brief description of involvement CA is already working with Biddle exploring ideas for novel ways in which software for control rooms can work better. They are interested in opportunities for simplification of the connections between components and individuals.		
Organization Flowton Technologies	<input checked="" type="radio"/> Confirmed	<input type="radio"/> Contacted <input type="radio"/> Not yet contacted
Brief description of involvement Small start-up, currently engaged with Stuerzlinger in an ENGAGE grant to explore Natural User Interface interactions.		
Organization Microsoft	<input type="radio"/> Confirmed	<input checked="" type="radio"/> Contacted <input type="radio"/> Not yet contacted
Brief description of involvement Interested in the video analytics subproject activities, for which a potential CRD is being discussed.		
Organization Ministry for Public Safety, Quebec	<input checked="" type="radio"/> Confirmed	<input type="radio"/> Contacted <input type="radio"/> Not yet contacted
Brief description of involvement Interested in safety-critical planning and decision making systems, offering in-kind contributions to tailoring systems for their use and field testing of the technologies.		
Part B: Relations to existing and proposed projects in the GRAND NCE		
Related Current Projects SHRDSP, VIRTPRES		
Related LOIs LPD, CONNECT, EXPERT, SENSE-I, HLTHSIM.EDU, PROTECT		

Part C: Additional Co-Applicants List up to nine additional co-applicants		
Name Berzowska, Joanna	Email joey@berzowska.com	<input type="checkbox"/> Project Champion <input checked="" type="checkbox"/> Researcher
Organization Concordia University	Title/Position Associate Professor	
Name Biddle, Robert	Email robberb_biddle@carleton.ca	<input type="checkbox"/> Project Champion <input checked="" type="checkbox"/> Researcher
Organization Carleton University	Title/Position Professor	
Name Vertegaal, Roel	Email roel@acm.org	<input type="checkbox"/> Project Champion <input checked="" type="checkbox"/> Researcher
Organization Queen's Universtiy	Title/Position Professor	
Name Fels, Sidney	Email ssfels@ece.ubc.ca	<input type="checkbox"/> Project Champion <input checked="" type="checkbox"/> Researcher
Organization University of British Columbia	Title/Position Professor	
Name Gutwin, Carl	Email gutwin@cs.usask.ca	<input type="checkbox"/> Project Champion <input checked="" type="checkbox"/> Researcher
Organization University of Calgary	Title/Position Professor	
Name Irani, Pourang	Email irani@cs.umanitoba.ca	<input type="checkbox"/> Project Champion <input checked="" type="checkbox"/> Researcher
Organization University of Manitoba	Title/Position Associate Professor	
Name Bateman, Scott	Email sbateman@upei.ca	<input type="checkbox"/> Project Champion <input checked="" type="checkbox"/> Researcher
Organization UPEI	Title/Position Assistant Professor	
Name Stavness, Ian	Email stavness@gmail.com	<input type="checkbox"/> Project Champion <input checked="" type="checkbox"/> Researcher
Organization University of Saskatchewan	Title/Position Assistant Professor	
Name Stuerzlinger, Wolfgang	Email wolfgang@cse.yorku.ca	<input type="checkbox"/> Project Champion <input checked="" type="checkbox"/> Researcher
Organization York University	Title/Position Professor	

**Part D: Summarize the problem being solved (1/2 page)**

Many human activities require the fundamental ability to interact with others, to share and co-create ideas, knowledge and artefacts. While we understand this need from practical experience, the tools we have to harness creativity and support the work of individuals operating in groups remains in its infancy. This applies equally to tasks ranging from collaborative design and analysis as it does to real-time decision-making, and all the more so when groups become very large and widely distributed. Although some progress has been made to address these challenges with digital media in the domain of computer supported collaborative work, the associated tools are almost entirely limited to virtual representations of content on planar displays. As a result, existing approaches fail to take advantage of the inherently expressive power of 3D content, in particular, when expressed as tangible, physical objects. Moreover, it is doubtful that the conventional interaction paradigms from the 2D world will remain suitable or effective as we begin to realize novel physical objects as 3D displays.

SHREXP aims to address the following research questions:

- \* What are the needs of people engaged in tightly knit collaborative activities such as analysis and sensemaking? To what extent are our knowledge and models of shared cognition applicable across a broader set of application domains?
- \* How do collaboration needs change when individuals are working at a distance from one another? How can digital media support such collaboration by enhancing inter-personal awareness and improving shared use of interactive surfaces that were designed primarily for co-located use?
- \* How can we design and develop tangible artefacts for remote collaboration and how should users interact with these artefacts? Our understanding of remote collaboration has been developed around virtual artefacts represented on planar displays, yet considerable design work focuses on 3D objects and 3D data. How can we develop interaction models around these new kinds of tangible displays, whether for collocated or remote collaboration?

**Part E: Summarize the proposed solution and approach (1 ½ pages)**

Our approach is based on a combination of focused research studies and technological developments in the domain- and media-specific contexts described by our subprojects. These efforts are organized around three major themes that cut across the subprojects:

- \* **Advanced Collaborative Contexts:** designing, deploying, and studying the use of collaboration technology in specific application domains related to our receptor partners and their interests. These include decision support for mission-critical network/operations management, emergency response, video analysis, future educational models, and shared health-care and management systems.
- \* **Co-located and Remote Sharing Behaviour:** studying and understanding how people engage with one another, and negotiate physical and virtual space in collaboration. These studies build on our collective expertise in the CSCW domain, and on literature from the psychology of sharing, presence, roles and responsibilities in sharing. In many cases, to support these studies, we will design, build and evaluate completely novel systems that enable new forms of sharing.
- \* **Technology for Sharing:** building infrastructure for new kinds of technology to be used for shared experience. This involves the design and development of both physical objects and software for supporting collaboration that may take place across time, space, and even at very large scales. Examples of these activities include developing technologies for tangible and flexible displays and objects, working with mobile technologies, online social networks, crowdsourcing, cloud services, as well as infrastructure for privacy and security.

As short term goals, through the efforts on individual subprojects, we intend to develop infrastructure and sharing technologies that are directly useful for the associated receptors. Leveraging the synergy of working as a project team, we will meet regularly, on-line and at GRAND conferences and workshops, for knowledge exchange within and across the themes. In this manner, we expect to advance the sharing technologies to be demonstrable and usable not only by our receptors but of value to internal GRAND partners and to the wider community. Our long-term objective is to abstract from our collective results an understanding of how certain techniques and infrastructure may be suitable for supporting shared experience across different domains, and ultimately, integrate

**Part E: Summarize the proposed solution and approach (continued, but only for full project LOIs)**

this knowledge and technology to help create a common infrastructure for advancing the state of sharing mechanisms.

We consider our receptors in three categories: (i) those that are providing funding, and specific context to study and develop for (i.e., a specific application or technology domain); (ii) smaller companies that have benefited from short-term engagements (i.e., either to help find direction for projects, or that benefit from the technology outputs of projects); (iii) non-industrial organizations that, through academic engagement, benefit Canadians as a whole. Our interactions with these receptors have guided our focus in the subprojects, described in Part F, toward areas that are of interest to them.

Broadly, we will tackle the associated challenges in the various subprojects, cutting across all three of our themes (advanced collaborative context, sharing behaviour, and technology for sharing), applying the following competencies of our NIs:

- \* Studying individual/group behaviour in relation to new technologies or environments (e.g., large, mobile, and wearable display technologies)
- \* Designing and evaluating tools that support group activity, awareness, and shared experience across different media
- \* Designing and building interaction techniques for entirely new contexts, tools, or infrastructure (e.g., tangible, 3D, wearable, and flexible displays)

Sub-projects F1 & F2 explore problems involving collaboration in digital workrooms, including network and security operations centers, and related decision-making scenarios, benefiting from our ability to perform in-the-field ethnographic studies of collaborative behaviour with the receptors in these areas. Our partnerships will result in design and development of systems for actual use to aid their decision-making or analytic processes, e.g., in emergency response and public safety management. F1 addresses problems of data understanding in collaborative work environments and seeks to support group data visualization activities, while F2 focuses on user experience and analysis of video data, in particular in contexts that can easily overwhelm human processing capacity.

To resolve the bottleneck of limited human information processing capacity, we consider the importance of scaling sharing technologies to support potentially large workgroups. In this regard, there is a need for improved tools that facilitate the task of developers to decompose specific problems in a manner suitable for large-group activity. As a test case, subproject F3 considers the challenges of exploiting crowdsourcing for educational contexts.

Beyond the collocated knowledge- and artefact-focused collaborative tasks considered so far, there is a similar need to investigate problem-solving behaviour and the associated technologies that support sharing of experiences in the distributed setting. These questions are considered in subproject F4 for which one of the primary test applications of the collaborative technologies will be to health and wellness. Here, the focus is on building a meaningful overall shared experience, rather than strictly on supporting knowledge and information exchange.

Finally, sub-projects F5 & F6 are guided by receptor interests concerning the role of tangible, 3D, and flexible displays, and the associated interaction paradigms suitable for these novel display technologies. Our general approach has been to design interaction techniques for these technologies with the focus on understanding how they might be used for collaborative, shared activity. We then study their use through evaluations of shared activity.

**Part F: Subprojects** list up to six subprojects that will be undertaken in the first two years (only for full project LOIs).

## Subproject Name (1)

Sensemaking in Digital Workrooms (Bateman, Biddle, Booth, Carpendale, Hawkey, Irani, Tang, Tory)

## Summary

**PROBLEM:** Increasingly, people are needing to collaboratively explore, study and make decisions with data. Most current sensemaking tools are designed for single users, but analytics situations often involve teams whose members bring unique expertise and perspective; using single-user tools can cause challenges for such teams.

**QUESTION:** How do we design tools to support collaborative data analysis and sensemaking?

**ACTIVITIES:** Our work has three conceptual phases. First, we will conduct observational studies in the field to understand collaboration practices and challenges in sensemaking applications. These studies will examine real-world domain scenarios (e.g., network/security operations centres), from which we will abstract our observations to theories applicable to other domains. Second, we will develop infrastructure support for collaborative interaction in multi-display and distributed environments. This will involve explorations into new technologies (e.g., mobile devices, hands-free wearable displays, HTML5), and reconfigurable environments. Finally, we will design and evaluate techniques and systems for collaborative visualization of data, including insight sharing, and collaborative thinking spaces.

**RECEPTORS:** We are already working closely with several partner organizations (CGI, CA Technologies, SMT-Research, Oculus), with several others interested in the work (SMART, SurfNet, and Calgary Scientific).

## Subproject Name (2)

Experience and Analysis of Video (Cooperstock, Fels, Irani)

## Summary

**PROBLEM:** Video data is an inherently complex spatio-temporal data type. It is also being produced at extremely high rates for entertainment (e.g., multiple cameras at a sporting event), and for emergency and crisis management (e.g., surveillance). Making sense of this voluminous and rich data for situational assessment imposes significant challenges and can be overwhelming for human cognitive capabilities.

**QUESTION:** How can we leverage collaborative tagging, sorting, data reduction, and visual analytics techniques to support decision making (e.g., in crisis management) or story-telling in entertainment applications?

**ACTIVITIES:** We will investigate image understanding techniques for semantic tag creation between groups of users, establish novel media experience metaphors and develop environments for semi-automated collaborative tagging, new media applications tailored to support real-time, fluid collaboration involving video data, and technologies to facilitate discussion and decision-making among users of such video data. Additionally, we will identify methods to reduce large volumes of data, collected using unmanned aerial units, coalesce it with spatio-temporal data, and use it for analytic purposes.

**RECEPTORS:** Microsoft, Ministry of Public Safety--Quebec, Manitoba Hydro International, Oculus

## Subproject Name (3)

Accessible Crowdsourcing for Complex Activities (Bateman, Cooperstock, Gutwin, Tang)

## Summary

**PROBLEM:** Crowdsourcing can be a potentially powerful approach to solve complex problems, but often requires significant effort to decompose tasks suitably for a crowdsourced pool of workers (e.g., Mechanical Turk) and to synthesize the resulting responses.

**QUESTION:** How do we scale up collaboration tools to easily supporting large groups of people?

**ACTIVITIES:** Making effective use of crowds requires careful crafting of requests and coordination of the crowd's activities.

Consequently, there is a need for systems and approaches that make harnessing the power of crowds more accessible for non-crowdsourcing experts and for individuals without programming experience. We will also examine how crowd-based tools can enable new forms of "extreme collaboration" in educational environments. For example, a classroom of 25 Java programmers could be able to carry out new kinds of productive work and new kinds of learning if they all worked on a programming task at the same time.

**RECEPTORS:** nGage, Parks Canada, Ministry for Public Safety, CrisisCommons

**Part F: Subprojects (continued, only for full project LOIs)**

## Subproject Name (4)

Tools and Techniques for Coordinated Distributed Problem-Solving (Gutwin, Hawkey, Reilly, Stavness, Tang)

## Summary

**PROBLEM:** While video conferencing tools facilitate voice and video chat across distance, people still experience problems trying to accomplish basic tasks such as brainstorming or organizing ideas. In face-to-face scenarios, people use tabletops and whiteboards to work together, but in distance-separated scenarios, this is much more difficult.

**QUESTION:** How can do we design software for interactive surfaces of varying sizes (tablets, whiteboards and tabletops) to support shared activity across distance?

**ACTIVITIES:** We will (1) explore techniques for providing awareness across sites to enable high speed collaboration, building infrastructure to support cross-site communication for large surfaces; (2) explore designs for both fixed (large-format whiteboard + teleconferencing systems) and ad hoc (smartphones, laptops) to support generic business-use meetings; (3) explore applications to remote art therapy, and remote physiotherapy as specific domains that require high-speed, subtle, but close interactions between remote individuals.

**RECEPTORS:** Microsoft, BC Cancer, Homebody Health

## Subproject Name (5)

New interaction techniques for tangible digital media (Cooperstock, Fels, Stavness, Stuerzlinger, Vertegaal)

## Summary

**PROBLEM:** Although interaction techniques with 2D content on conventional displays are now mature, these are unlikely to prove ideal or even effective for manipulation of synthetic 3D objects and deformable displays.

**QUESTION:** How can we leverage the unique input (e.g., gesture, deformation) and output (e.g., tactile feedback) affordances of novel technologies for interaction with tangible digital media?

**ACTIVITIES:** Using existing 3D display technologies, including multi-surface projection and combinations of small screens that themselves take on a three-dimensional form, we will investigate the best techniques for interacting with and manipulating simulated 3D content, including conventional CAD/animation tools, specialized 3D input devices, function-specific sketch widgets, and two-handed interaction paradigms. For some interactions, naturally shaped devices will need to be designed and built. We will also develop new interaction techniques for these displays, (e.g. bending/stacking), and investigate possibilities for improving haptic experiences through actuated deformation of displays. As part of this research, we will work on designing, recognizing and teaching motion and deformation gestures, as well as characterizing error and adapting to these errors around gestures.

**RECEPTORS:** Immersion Corporation, H+ Technologies, Autodesk

## Subproject Name (6)

New technologies for flexible and 3D displays (Berzowska, Day-Fraser, Fels, Girouard, Irani, Stavness, Vertegaal)

## Summary

**PROBLEM:** Representations of digital media have until now been almost entirely confined to rigid, planar, 2D displays. We have barely scratched the surface of alternative technologies that support interaction with tangible, flexible 3D objects, nor have we explored the rich esoteric and poetic expressive potential of wearable textiles.

**QUESTIONS:** How do sharing ideas and information, change with the advent of mobile, flexible, and tangible displays? How can electronic garments enable self-expression within the ecosystem and the cultural roles of digital media and online social media?

**ACTIVITIES:** We will prototype and compare the capabilities of different technologies suitable for rendering high-fidelity content, including flexible paper, wearable textile displays, optical liquids with high refractive indices to propagate light in air to facilitate natural interaction above tabletop surfaces, and deformable 3D objects, based on reconfigurable multi-screen OLED and thin-film e-ink FOLED technologies. We will explore the integration of experimental new fibers into textile substrates, the production of a new generation of cloth light-emitting displays, and development of new mechanisms/artifacts for personalization and expression.

**RECEPTORS:** Immersion Corporation, Fashion and lifestyle companies (Lululemon, Artizia), Health & Sports Biometric Monitoring (Adidas, OMsignal), Safety Apparel (Safe + Sound), Performance (Cirque du Soleil, ESKI), Architectural applications (Surface3), Gaming & entertainment (Kabam, EA, Ubisoft), Accelerator (Brooklyn Fashion and Design Accelerator).



**Part G: Summarize how the proposed project will pursue knowledge and technology exchange and exploitation activities within the context of GRAND.**

Continued and ongoing engagement with receptors involves early prototype sharing and discussion, allowing our industrial partners to consider these ideas within the evolution of their products. This engagement will allow them to consider actual productization and exploitation as appropriate, leveraging the following infrastructure that we expect to contribute:

1. Software tools for facilitating decision-making in collaborative environments,
2. Video annotation, analysis and segmentation tools,
3. Tools for decomposing problems (within education and video analysis domains) for crowdsourced analysis,
4. Tools for shared decision-making about 3-D artefacts in both collocated and distributed contexts.

Other contributions, in particular relevant to the academic community, will focus on design and theory, including:

1. Theories about collaborative sensemaking and decision-making in technology-rich environments,
2. Design contributions in relation to analysis across a broad set of data domains (e.g. video -- complex and dynamic data)

**Part H: Summarize how the project will network with other projects within GRAND.**

Our proposed activities for developing and evaluating collaborative technologies apply to a broad range of GRAND activities. We will have a natural fit with other projects and subprojects in GRAND that have already developed, or are developing, collaborative tools and processes that can be effectively used with our receptor communities and industry partners.

Our accessible crowdsourcing sub-project will network with EXPERT that includes crowd-based resources for expert recommendation. Likewise, our sense-making sub-project is positioned to network with the PROTECT project within the context of shared understanding of privacy and security data. Our video analysis sub-project will be relevant for other projects that involve video data, such as DATUM.

Our sub-projects related to building and interacting with new flexible 3D displays will network with other GRAND projects that involve 3D modelling and simulation of objects and people. These will provide a wide range of 3D digital content in health (HLTHSIM.EDU) and entertainment (CREATE, BELIEVE) that could be explored with new interaction techniques and non-planar displays.

**Part I: Summarize how one or more current or potential GRAND partners will be engaged in and benefit from the proposed research.**

The knowledge and prototype technologies generated through our research are of value to our receptors in several respects.

The ongoing field studies of collaborative practices in co-present scenarios benefits receptors such as CA Technologies and the Communications Security Establishment by informing them of opportunities to improve their decision-making and analysis workflows. Our development of technology prototypes to support collaborative activities across heterogeneous media also provides opportunities for them to test new tools and techniques before these are available as actual products. Similarly, our activities related to novel display technologies such as flexible displays, tangible 3D objects provide receptors such as Immersion and Autodesk with prototype solutions that can enhance productivity and evaluate novel interaction metaphors for their development tools.

For other receptors such as the Ministry for Public Safety (Quebec), Bederra and H+ Technologies, our technology prototyping activities serve (for them) as a low-risk approach to exploring potential new directions of interest to their internal toolsets, or product and service offerings that they might eventually wish to develop on their own. Finally, we will identify novel solutions to existing challenges faced by Oculus, SMT-Research and MHI, who are keen to work with academia for this purpose.

Part J: GRAND Challenges Check all that apply and briefly describe anticipated impact	
<b>Entertainment</b> <input type="checkbox"/> Primary impact <input checked="" type="checkbox"/> Secondary impact <input type="checkbox"/> N/A	Shared experience of video, whether for social network activities or sporting events, can benefit from the technological infrastructure we are developoing in subproject F2.
<b>Learning</b> <input type="checkbox"/> Primary impact <input checked="" type="checkbox"/> Secondary impact <input type="checkbox"/> N/A	We address a small part of the learning challenge by considering how new media and infrastructure can be used to support educational contexts, particularly in applying crowdsourcing ideas to this domain.
<b>Healthcare</b> <input type="checkbox"/> Primary impact <input checked="" type="checkbox"/> Secondary impact <input type="checkbox"/> N/A	We are engaging in some small domain-specific explorations with partners in health and wellness. For instance, some of our explorations in the “distributed sharing” subproject focus on delivery of wellness solutions to patients at home (rather than traditional modes of delivery, where patients visit the provider). These explorations will have direct implications for those receptors.
<b>Sustainability</b> <input type="checkbox"/> Primary impact <input checked="" type="checkbox"/> Secondary impact <input type="checkbox"/> N/A	
<b>Big Data</b> <input checked="" type="checkbox"/> Primary impact <input type="checkbox"/> Secondary impact <input type="checkbox"/> N/A	Many of the receptors are awash with data, and need means to analyze and make sense of this data. Our research fundamentally addresses how people will work with, and make decisions based on large volumes and often unstructured data, through sharing mechanisms and workrooms.
<b>Work</b> <input checked="" type="checkbox"/> Primary impact <input type="checkbox"/> Secondary impact <input type="checkbox"/> N/A	The shared experiences on which our research focuses apply to several different areas of work, including information processing, design and manufacturing. There is a strong rationale for considering these challenges across mutiple application domains, given that (collaborative) work is conducted by people from a number of different perspectives, and may involve broad groups of individuals who are not operating in a collocated fashion.
<b>Citizenship</b> <input type="checkbox"/> Primary impact <input type="checkbox"/> Secondary impact <input checked="" type="checkbox"/> N/A	
<b>Other</b> <input type="checkbox"/> Primary impact <input type="checkbox"/> Secondary impact <input type="checkbox"/> N/A	