LOI For Phase 2 Projects / Subprojects template

Completed Letters of Intent (LOIs) should be sent as email attachments to 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

Project Title and Description	☐ Full project LOI	☐ Subproject only LOI
Title of proposed project COORDN8: Real-time Coordination in Simulation and Training Environments		
Brief description for public use Ask your teenage son, if you have one - first-person shooter games are passe' unless your friends are on-line playing with you. But when video games are used to educate or train military or rescue personnel for hazardous missions, the multi-player game must be realistic. That means that, to succeed, players must be aware of each other's situations, players should be able to communicate quickly and naturally, and group activity must be tightly coordinated. This project will provide the technology to enable these.		

Proposed Project Leader	☐ Form 100, SSHRC CV, or CIHR CCV has been attached
Name Gerald Penn	Email gpenn@cs.utoronto.ca
University University of Toronto	Title/Position Professor

Proposed Project Co-leader	☐ Form 100, SSHRC CV, or CIHR CCV has been attached
Name Carl Gutwin	Email gutwin@cs.usask.ca
University (must be different from Project Leader) University of Saskatchewan	Title/Position Professor

Proposed Project Champion	☐ Confirmed	☐ Contacted	☐ Not Yet Contacted
Name Ray Sharma	Email ray@xmg.com		
Organization XMG Studio Inc.	Title/Position Founder & President		

Instructions for Letter of Intents 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 CAE Integrated Enterprise Solutions	☐ Confirmed ☒ Contacted ☐ Not yet contacted
Brief description of involvement CAE is a defense and civilian aerospace contractor that can productize the technology we develop. They can help us shape our approaches into something transferrable, and can also provide hardware, software licenses and cash contributions.	
Organization Defense R&D Canada	☐ Confirmed ☐ Contacted ☒ Not yet contacted
Brief description of involvement DRDC Downsview has had a long-standing interest in advancing the state of the art in military training environments. They can provide training data and opportunities for testing battlefield simulations with the Canadian forces, both land and sea-based, as well as serve as an advanced development unit to transfer our research prototypes to.	
Organization Directorate of Land Synthetic Environments, Canadian Forces	☐ Confirmed ☐ Contacted ☒ Not yet contacted
Brief description of involvement Home to the Army Simulation Centre, this directorate at CFB Kingston regularly hosts large-scale land combat simulations that provide a natural receptor for the technology that we develop.	
Organization Thales Canada	☐ Confirmed ☐ Contacted ☒ Not yet contacted
Brief description of involvement Thales is a defense contractor that can productize the technology we develop. They can help us shape our approaches into something transferrable, and can also provide hardware, software licenses and cash contributions.	
Organization	☐ Confirmed ☐ Contacted ☐ Not yet contacted
Brief description of involvement	
Organization	☐ Confirmed ☐ Contacted ☐ Not yet contacted
Brief description of involvement	

Part B: Relations to existing and proposed projects in the GRAND NCE
Related Current Projects SIMUL, HLTHSIM, HSCEG, INCLUDE, NEWS
Related LOIs Big Data, LPD, SHARE

Part C: Additional Co-Applicants List up to nine additional co-applicants		
Name Joe Armstrong	Email joe.armstrong@cae.com	☑ Project Champion ☐ Researcher
Organization CAE Integrated Enterprise Solutions	Title/Position Regional Business Leader	
Name Scott Bateman	Email sbateman@upei.ca	☐ Project Champion ☑ Researcher
Organization University of Prince Edward Island	Title/Position Assistant Professor	
Name Cristina Conati	Email conati@cs.ubc.ca	☐ Project Champion ☑ Researcher
Organization University of British Columbia	Title/Position Associate Professor	
Name Nicholas Graham	Email nicholas.graham@queensu.ca	☐ Project Champion ☑ Researcher
Organization Queens University	Title/Position Professor	
Name James Hieronymus	Email James.L.Hieronymus@nasa.gov	☐ Project Champion ☑ Researcher
Organization NASA	Title/Position Senior Scientist/Ames Associate	
Name	Email	☐ Project Champion ☐ Researcher
Organization	Title/Position	
Name	Email	☐ Project Champion ☐ Researcher
Organization	Title/Position	
Name	Email	☐ Project Champion ☐ Researcher
Organization	Title/Position	
Name	Email	☐ Project Champion ☐ Researcher
Organization	Title/Position	

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

Many operational tasks are difficult because of the large number of smaller tasks that must be coordinated in order to perform them, either stochastically by a single agent, or in parallel by a group. Artificial simulations are often constructed in order to provide opportunities for trainees to practice and perfect these coordinated actions, but simulation's limited ability to support realistic coordination is often what unravels the training's effectiveness in providing constructive experience and feedback. There are, in fact, a number of crucial abilities that a training simulation must possess in order to support coordination, because even novice trainees are adept at everyday coordination using multiple modalities, when they are acting in situations familiar to them.

The problem is compounded if there are large numbers of participants and/or the participants are remotely located, such that the simulation is the only channel that mediates their mutual awareness and communication.

Irrespective of the goal of constructing better training simulations, simulations are also a great forum in which to study how people coordinate, because they so immediately and clearly demonstrate when something has gone wrong. The art of simulation is not the art of imitating all of the real world, but of imitating its essence - the necessities that are critical to the performance of the task at hand. This project seeks to undertake this study, as well to develop technologies that improve our ability to coordinate in training simulations drawn from several empirical domains.

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

Our tactic for pursuing this topic consists in focussing on six key technical challenges:
1) how a simulation can network the differing points of view of large numbers of agents,
2) how a simulation can personalize its support for multiple agents in open-ended training tasks,
3) what information agents need in order to maintain awareness (of each other),
4) how agents communicate and coordinate using speech,
5) how agents communicate and coordinate using gesture, and
6) how network and other technical delays affect smooth and expert collaborations.

Consider as an example a pilot that must negotiate his own airspace separation from other commercial jets in the same sector that he is about to enter (as they will soon be required to do - see subproject 3). To assist him, he has his visual field, a number of instruments for determining his position, speed, orientation, and the relative positions of other jets, and an audio channel with which to communicate with other pilots. In a manner of speaking, all of the necessary information is at the pilot's disposal, but there are some fundament mismatches with their various presentations. Both position and relative position can be very precisely displayed on his instrumentation and visual field, but the natural conventions of human speech to refer "there" to another aircraft aren't precise enough, and gestures, even if precise, are not available over the audio channel. Audio channels also are highly ineffective when communicating with large number of other agents - unlike, for example, watching a number of agents in the same visual field.

Now suppose that the pilot is not in a real jet, but in a flight simulator. One of the learning goals of the simulation is to teach the pilot to negotiate airspace separation safely and efficiently. But if a network delay causes the other jets to move unnaturally, or the speech to break off or distort unlike his radio channel, then the trainee is not acquiring the most useful kind of experience that he could. At the same time, there are clearly aspects of other pilots' speech or appearance, for example, that are not required in order to develop expertise at this task. And if the trainee pilot does commit a safety-critical error, the simulation must provide some kind of support to ensure that the pilot understands what went wrong, and how to improve. It is also important for the simulation

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

to be able to render each of the pilots' cockpit views and actions in a manner that is sensible to the interactors who are controlling the simulation.

Cross-cutting each of our subprojects are some common concerns:
a) speed: much of the realism of a simulation comes from the low latency of the feedback that the trainee receives;
b) naturalness: natural coordination is a common concern in part because it is so difficult to define - but we know when it isn't there. Naturalness also can be antagonistic to speed in that more natural modes of interaction can only be found in much larger search spaces.
c) learnability: increasingly, we often do not have an explicit recipe for how the simulation should proceed, but merely a large set of example interactions from non-computer-based simulations or live missions. In this case, the answers must be learnable from the training data.
d) goal-directedness: in addition to being realistic, the simulation must also tend towards achieving the learning goals as set by the interactors that control the simulation.

This project is a natural outgrowth of the SIMUL project in GRAND's first phase. Subproject (1) resulted from insights made while testing the results of tabletop interfaces desgined for SIMUL in on-site military training sessions. Subproject (2) was an idea born directly of SIMUL's early investigations into intelligent tutoring and user modelling. Subprojects (3) and (4) came directly from combining datasets that became available through SIMUL collaborators with SIMUL work on situational awareness. The subproject on awareness will use SIMUL's groundbreaking achievements in audio awareness as its starting point.

Our solutions to these challenges will involve several approaches, including:
- studies of coordination in real-world situations
- models of coordination and interaction that characterize important facets of the problem for developing computational support for both human-human and human-machine coordination
- speech and acoustic models that allow systems to understand and monitor verbal interaction
- invention of new interaction techniques to provide coordination mechanisms in distributed environments
- development of computational infrastructures for simplifying the implementation of this support
- user studies to demonstrate the effectiveness and efficiency of our inventions.

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)

Networked Environment for Simulation-Based Training

Summary

Simulation-based training is widely used in the Canadian military to train all levels of troops, from small groups of infantry to battalion commands that direct thousands of troops. Simulations allow training in environments that would be expensive and hazardous to create in real life, but require the connection over a network of numerous tools, such as crowd simulators, tools for first-person simulation (e.g. Bohemia Interactive's VBS2) and large-scale infrastructure tools (e.g. the commercial JCATS and ABACUS products).

One promising form of simulation that has received little attention allows multiple levels of the military hierarchy to work together. For example, trainees in a command headquarters might use a high-level simulation tool to carry out battle group manoeuvres, while individual soldiers use a first-person simulator to actually carry out the orders received from headquarters. This form of simulation is interesting because it allows for realistic training, with people making all of the major decisions, but without the expense of actual field deployment. To support such systems, technology is required to network the points of view of different trainees at different levels of the military hierarchy. Building on our OrMiS tool for military simulation and our Janus tool for game networking, we will investigate real-time infrastructure for military simulation involving large numbers of trainees operating with radically different perspectives. The Directorate of Land Synthetic Environments, CFB Kingston), and Thales Canada will participate.

Subproject Name (2)

Personalized Support for Learning and Training with New Media

Summary

Intelligent Tutoring Systems (ITS) are systems for education and training that provide learning experiences that fit the needs and abilities of individual learners – just like a good teacher would. Research and commercial systems to date have delivered techniques and systems that have successfully provided personalized support for structured learning activities. However, there are many other more open-ended educational activities that can benefit from personalized computer-based support, such as exploring interactive simulations or playing educational games. Personalized support for open-ended activities is not well supported in existing commercial or research-based tutoring systems, and with large numbers of tightly coordinated actors, the search space of possible behaviours requiring support is indeed daunting. This sub-project seeks to tackle this challenge by leveraging data mining and analytics techniques on user interaction logs from learning environments. The goal is to discover what aspects of user behaviour are conducive to, rather than detrimental for, learning, and generate personalized interventions that scaffold and promote successful behaviours and discourage detrimental ones. The outcomes of this project will be new insights into how people can be supported by tutoring systems through large-scale data analysis in a wide range of open-ended learning tasks.

Subproject Name (3)

Next Generation Air Traffic Control

Summary

By the year 2020, North American airspace separation among commercial jets will be negotiated directly by the pilots themselves, without the assistance of ground-control beacons (except at airports). This is a technical challenge that embodies, not only in training, but in actual deployment, many of the difficulties of coordinated activity among large numbers of agents, each of which possesses only partial knowledge about the state of several adjacent airspace sectors. Working with both CAE Integrated Enterprise Solutions and NASA, we will work on both pilot training and actual technology for deployment in commercial aircraft cockpits to coordinate and manage airspace separation and pilot dialogue.

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

Subproject Name (4)

Spoken Dialogue Systems that Listen

Summary

With the growth of cloud computing, on-line information sources, and "big data" analytical capabilities to tap them, there has been a growing awareness that speech-enabled computing devices can not only participate in human-machine dialogues, but offer intelligence assistance during human-human dialogues. Whether by calling up relevant background information on a nearby display, filling in form fields during a collaborative grant-writing session, or visually drawing one or more conversants' attention to salient features of their shared or private spaces, spoken dialogue no longer needs to talk in order to behave intelligently.

This project will pursue this strategy in military and rescue simulations by using spoken dialogue systems to maintain "situational awareness," which refers to the ability of interactors and supervisors in a training simulation to view the state of their trainees' progress and other relevant factors of the state of a simulation run. This work will proceed in collaboration with research staff at NASA (which conducts a fair amount of dual-purpose military research for the U.S. Armed Forces, including research on situtational awareness).

Subproject Name (5)

Rich Non-Verbal Communication in Shared Environments

Summary

Non-verbal communication is a main mechanism of coordination in real-world environments, but is poorly supported in online virtual environments and shared documents. In this project, we will enrich non-verbal communication in shared systems through enhanced avatars and improved support for gestures. In the real world, a person's appearance and movement allows us to instantly identify those we know and quickly ascertain information about them. Our first goal is to enhance visual identification and characterization of others in networked environments We will determine what types of information should be collected and displayed; we will then devise new ways of showing that information through texture synthesis algorithms and shape grammars that can be parameterised to represent abstract values. We will determine techniques for filtering and merging rich data, so that the more detailed representations do not slow the system, and then experimentally test human limits of these techniques, to see how many variables can be feasibly added to user representations. We will also develop techniques to allow higher-degree-of-freedom input for controlling avatars and embodiments, in order to increase the amount of information that people can communicate without verbal interaction. For example, we will use depth-camera data to enable realistic and detailed gestures to be expressed within virtual environments.

Subproject Name (6)

Network Issues for Real-Time Coordination in Distributed Environments

Summary

In real-time coordinated interactions, each person's actions immediately and continuously influence the actions of others, and actions occur too quickly for coordination to be carried out using verbal communication. Tightly-coupled interaction is highly sensitive to delay (e.g., latency, jitter, or loss), and delay is one reason why this type of collaboration is difficult in groupware. There is little information available about how delay affects tightly-coupled real-time interaction. This project will carry out studies to provide this critical information, and will develop techniques that can overcome some of the problems introduced by network delay.

We will develop groupware systems that implement 'atoms' of real-time interaction, and test people's performance with different types and amounts of delay. We will then identify delay-compensation techniques for the different types of real-time interaction, and carry out studies to determine how delay-induced problems can be reduced. This project will contribute a detailed understanding of how delay affects different types of real-time interaction, a set of design guidelines that indicate what kinds of coordination can be supported under different delay conditions, and a set of compensation techniques that have been shown to be effective in combating the effects of delay.

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

The principal investigators on this project already have well-established ties with the receptors and champions listed. With respect to the military and aerospace receptors, COORDN8 provides a critical link between the GRAND network and these generally very well siloed, but very resourceful sectors. Student internships are not always possible because of the sensitive nature of their work, but regular site visits, consulting contracts, and on-site "shadowing" of personnel during training exercises are activities that we already regularly undertake.

As for XMG, they see COORDN8 as their in-road to a much larger potential range of topics within GRAND that would be important to their game development business. They are extremely interested in student internships, reciprocal IP licensing, and joint data collection initiatives.

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

As the (probably) sole military and aerospace project in the GRAND network, COORDN8's broad goals of seamless, coordinated group action can serve as a point of contact for other projects to work in these application domains. HLTHSIM shares many of the same aspirations for simulations, although specific to the health-care domain. SHARE has a very clear point of contact with COORDN8 in its subproject on sharing across distances (relative to COORDN8's on awareness for coordination), and a more general overlap in its aspiration to enable more effective collaboration. Big Data and LPD are both data-oriented projects connected with COORDN8's subproject on data analystics for personalized support. COORDN8 also shares an interest in speech technology with INCLUDE and NEWS.

The project leader, Gerald Penn, is the Associate Chair of Research and Industrial Relations in the Department of Computer Science at the University of Toronto. Through his joint roles of ACRIR and SIMUL project leader, he has put a steady stream of prospective private-sector partners in touch with the GRAND industrial liaison, Vic DiCiccio. That will continue through COORDN8. All of the research staff are cross-appointed on several current and proposed projects within GRAND, and bring unique areas of strength to the network that are in demand in numerous projects, such as user modelling (Conati), speech and acoustics (Penn and Graham) and gestural interfaces (Gutwin).

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

Our partners will engage with us through the provision of simulators, software licenses, drills and training exercises, large datasets, staff secondment and technology transfer, all of which are vital to this project's success. All of the partners are eager to maintain or strengthen their connections to Canadian academic institutions, and will benefit from contact with GRAND on the whole as well as our individual laboratories.

See Part (G) on specific mechanisms that we have discussed for their participation.

Part J: GRAND Challenges Check all that apply and briefly describe anticipated impact	
Entertainment ☐ Primary impact ☒ Secondary impact ☐ N/A	Our work in simulation in military contexts (sometimes called "serious games") will have a number of positive, collateral outcomes for the video game industry. Our champion, in fact, is a major video game developer.
Learning ☒ Primary impact ☐ Secondary impact ☐ N/A	Simulations are a highly technical genre of intelligent tutoring system. The emphasis here on learning outcomes makes this project foremost an educational one in its application focus. We specialize in the design of these systems in complex and hazardous environments.
Healthcare ☐ Primary impact ☒ Secondary impact ☐ N/A	Although healthcare is not an explicit focus of our work, related simulations and training methods are used in healthcare. HLTHSIM studies simulations in healthcare.
Sustainability ☐ Primary impact ☐ Secondary impact ☒ N/A	
Big Data ☒ Primary impact ☐ Secondary impact ☐ N/A	Both our work in dialogue systems and our work in personalized support will make extensive use of methods in pattern recognition and data analytics. SIMUL's work in acoustic modelling was a major breakthrough in the application of "deep learning" architectures to speech.
Work ☐ Primary impact ☐ Secondary impact ☒ N/A	
Citizenship ☐ Primary impact ☐ Secondary impact ☒ N/A	[Our understanding of this challenge is that it is meant to imply participatory democracy, but not the defense & security of such democratic states.]
Other ☒ Primary impact ☐ Secondary impact ☐ N/A	The networking infrastructure developed in this sub-project also addresses the Infrastructure GRAND challenge.