Small or medium-scale focused research project (STREP)

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Live Interfaces for Creativity and Metaphor: Interdisciplinary support for new Algorithmic Literacy

LIMINAL

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Proposal abstract

International competitiveness relies on extending the opportunities for all members of society to engage creatively with technology. The goal of the LIMINAL project is to gain new understanding of how technology enhances creative work, with focus on creative professionals. Our research focus is on technology as language. Existing digital technologies use specialised languages – programming languages or design notations - that not only exclude the public, but inhibit linguistic creativity. In LIMINAL, we challenge this assumption, reconsidering how language technologies are used creatively, via a focus on the role of metaphor in constructing meaning. We apply participatory co-design and ethnographic methods to explore the social factors in creative use of technical language, alongside gaze tracking and fMRI methods to understand cognitive factors. Based on insights from these studies, LIMINAL will create experimental languages, building on our track record of successfully implementing novel languages and representation systems. The LIMINAL consortium consists of leading researchers in live coding, tangible interaction, metaphor in human/computer interaction, neuropsychology of language, and participatory methods in IT, together with the expertise in leadership and facilitation that is necessary to bring these interdisciplinary fields together. A unique strength of the consortium is the degree of expertise using these technologies in public and performance contexts. As a result, this research will move beyond the laboratory, where creative experience, collaborative behaviour, and measurable outcomes will be assessed using controlled research techniques, to enable creative linguistic use of technology in the wild. This combination of methods from collaborators in creative, technical and scientific disciplines will result in both truly innovative scientific outputs and the direct impacts of broader public empowerment through creative engagement with technology.

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Section 1: Scientific and/or technical quality, relevant to the topics addressed by the call

1.1 Concept and objectives

In this project, we are concerned with the use of linguistic technologies in creative situations. Our definition of "language" is intentionally broad, encompassing not only the use of language to communicate or construct narratives and interpretations, but also technical languages such as programming languages, or specialised notations such as music, dance and design notations. We also consider means of expressing language, for example through visual and gestural elements.

All use of language is potentially creative because language is generative, in the sense defined by Chomsky. Linguistic technologies allow us to create new artefacts and experiences. But language itself can also be renewed and regenerated through use of metaphor, moving beyond literal constraints to use the language itself in new ways. Using linguistic technologies in creative situations can be reflexive, a form of "meta-design", in which new resources for creativity emerge from creative use itself.

The generative and expressive power of language and metaphor are well understood in creative disciplines. However, linguistic technologies, technical languages and specialised notations are often derived from formal and literal mathematical or engineering foundations rather than with a fundamentally creative purpose. Engineering and mathematics incorporate their own forms of creativity, but these seldom offer metaphorical or non-literal interpretations of their work. As a result, many new technologies bring creative opportunities that are only recognised after they are constructed, rather than having been explored during the design process.

The LIMINAL project will address definitions of creativity which integrate the multiple creative functions of generative and metaphorical language. This requires a "confluence" model of creativity, as defined by Sternberg and Lubart (1999). It is necessary to integrate cognitive and socio-personality views of creativity in order to understand both the technical generative components of linguistic technology and the socially embodied interpretations of meta-design and metaphor. Creativity research, as a field, is increasingly adopting this perspective, for example in the work of Amabile (1996) or Czikszentmihalyi (1996). However, the unique emphasis of our own proposal arises from rigorous analytic focuses (metaphor, language, representation) that have been identified from creative practice itself, rather than from a prior computational, personality or sociological model.

We will therefore explore the creative use of linguistic and representational technologies in the context of creative practice, rather than in an isolated academic context, in order to avoid the temptation to constrain creativity to a specific scientific perspective. Our team includes an extremely diverse range of technical orientations toward creativity, including programming language design, participatory design process, and cognitive neuroscience, in addition to a wide range of creative practitioners with extensive experience in computational arts practice.

Objectives

The LIMINAL project will take a fundamentally "*multi-disciplinary research"* approach, forming a consortium which includes prime expertise in Interaction Design, HCI, Experimental Cognitive Psychology, Participatory IT, Computer Science, Design, Games Design, Software Engineering, Software Studies, Serious Games and Music Technology, to achieve the following eight main objectives. Expectations quoted from Objective ICT-2013-8.1 are highlighted in italics.

O1: Work within professional cultures of practice in participatory design processes
In order to *"enhance the creativity of workers pursuing different professions"*, we rethink the role of software in supporting creative work, stepping out of the frame of conventional design processes. One way of doing this is to shift some emphasis from the designer-client relationship to a participatory process which includes all stakeholders, to better understand where radical interventions could operate, based on participatory design techniques rooted in an understanding of how people communicate to one another. In particular, we follow three main phases of development: to better understand current practice; to generate

new design ideas; and to engage with cooperative prototyping, where users and designers engage *"domain-specific skills"* in collaborative design activities. Our point of departure is that users are active and productive in new and divergent ways, and so we involve stakeholders in evaluating progress towards our aims and to provide feedback for further iterations.

O2: Re-establish a role for metaphor in the design and use of open devices
Metaphor is a fundamental enabler of human creativity, culture and cognition. Literally, it describes the way that we use language to carry across meaning from one context to another. To fundamentally address the need for more effective creative tools, we will reconsider the role of metaphor in their design. To support the full breadth of creativity, our tools should not perpetuate fixed interface analogies, but must instead support construction and communication of socially grounded metaphor. These metaphors should emerge from professional practice, through a collaborative creative process supported by the tools we develop. This objective is key in establishing *"theories and models for hybrid (human-computer) systems"*, in approaching computer languages from a human perspective. We do not wish to make the category error of treating computer languages as natural human languages. But, in order to reimagine computer languages which better support human expression, we support human communication through metaphorical constructions including via our visual, auditory and tactile faculties.

O3: Extend live coding as a model for creative interaction
Live coding, the use of live programming languages in audio/visual performances, is an important cultural movement which has emerged over the past decade. Because live coders work with the computational medium of source code, live coding allows unique isolation of creative behaviour, and targeted investigation of the role of language in creative processes. Live coding is a key contribution to *"the potential of technology to enhance human creative processes"*, providing immediate sensory feedback in computational explorations, based on creative abstraction and combination. The fast-appearing live programming languages are rich environments often made both by and for creative artists and designers, where each system shows radical departures from established norms in programmer tools. To properly understand this new field, and identify and exploit its relevance in relation to *"creative processes in professional contexts"* it is important to focus not only on the live programming languages themselves, but also on the psychological and social context in which they are used. We need to be able to compare and contrast live programming language features such as representations of time, how computations are described, the visualisation of syntax, the manipulation of code history, and the presentation of data and code. But to fully understand how creative performance is enhanced by live coding, we also need to understand the human factors involved; how these features and design trade-offs impact and support interaction, communication and collaboration, and also conceptual shifts, divergent thinking, reflection and surprise.

O4: Translate understanding of media computation between academic and professional contexts
In addressing *"theories and models for hybrid (human-computer) systems"*, we will consider the design of linguistic technology and the social contexts in which they are used. An important objective towards this goal is to take advanced understanding of this area in higher education, in particular of how creativity and learning support one another in live, audio/visual computer programming domains, and translate it to professional practice. Children's use of computer language has been a key to research into the *"potential of technology to enhance human creative processes"* for over 30 years. Many have recognised the need for people to develop "computational thinking" from a young age, and computer languages developed for early years curricula have supported radical modes of use, including sketching and live edits. Some systems, such as Logo and Scratch, have been widely adopted in schools, with familiar counterparts such as Google App Inventor now seen in semi-professional use. Furthermore, the recognition of the importance of cultural context in programming pedagogy has now reached higher education in the form of media computation, where live coding and audio/visual manipulation is used to teach otherwise abstract programming constructs. It is important therefore to engage with research across this area, including within FP7 objective ICT-2013.8.2 Technology-enhanced learning, to bring understanding of how we may creatively learn, talk, think about and explore with computers into professional life.

O5: Understand the relation between visual and textual representations in creative tasks
Computer programming language interfaces are often seen as entirely text based, and just as we call programming text "code", people's natural associations are of difficult or impossible to understand, obscure language. In order to *"explore the potential of technology in the human creative processes"*, we will find

new ways of representing computation with visual language. To achieve this objective we will build upon work in the visual programming field, by investigating how visual and textual representations can work together in mutual support, creating manipulable computing languages conducive to creative exploration, and to involve interested third-parties in programming, by presenting aspects of a computer program in visual form for them to manipulate without needing to understand the detail of the whole software architecture. This goes beyond creating a user interface; by presenting an open and visual interface to abstraction and combination, users may make fundamental changes to aspects of software. By relating human perception and expression to representations of computation, we provide further ground to approach both theory and practice of *"hybrid (human-computer) systems"*.

O6: Develop new collaborative programming techniques and interfaces
The concept of using a linguistic technology to communicate abstract concepts that can be manipulated, will be enhanced by the ability to build upon processes already described by others, supporting *"collective creative processes in professional contexts"*. This collaboration should ideally be co-located, in order to facilitate collaborative modification of processes and concepts by participants. In such a context, we will build upon existing research into collaborative, co-located programming techniques and interfaces, such as pair-programming, and domain-specific programming languages especially designed for collaboration, such as tangible programming languages. We must foresee how different programs should cooperate in order to interrelate in a functional level, by defining ways of connecting the information flows, and also to share the resources of the device, such as through the use of sensors and other input devices.

O7: Bring together advances in live coding, tangible interaction, on-line worlds, and programming language design
In order to design new *"intelligent computational environments stimulating and enhancing human creativity"*, we must integrate multiple approaches, to support a broad spectrum of human behaviour. We relate research into live, physical and social interactions, which make metaphorical constructs tangible, extending our understanding of technology-enhanced creativity. The result will be new, collaborative languages as *"fully functional prototypes of computational environments"* which extend far beyond conventional conception of programming languages, bringing creative activities of abstraction, combination and visualisation to transform a wide range of professional work. The resulting tools will be fundamentally computational, but also intelligent in supporting multimodal interaction and metaphorical structures sympathetic with a broad spectrum of human faculties. Through these linguistic technologies, we not only stimulate creative behaviours such as divergent thinking, but also enhance creative processes by allowing new concepts to be described, explored and extended.

O8: Assess and evaluate creativity in the development of creative support technology
Throughout, our work will be evaluated in terms of *"sound methodology"* which we develop for the *"assessment and measurement of creative performance"*, including in-line design feedback. This work will take a confluence approach, evaluating the extent to which the technology supports creativity in terms of individual and collective experience of creative flow, of the validated ability to support creativity in domain specific situations, and of creativity demonstrated by creative outputs as independently judged by domain experts, as well as other participatory processes. In addition, methodologies in experimental psychology will be engaged to develop and evaluate a cognitive basis for creativity using LIMINAL technology. This objective is key to ensuring our "*fully functional prototypes of computational environments"* are valid demonstrations of our *"theories and models for hybrid (human-computer) systems"***.**

1.2 Progress beyond the state-of-the-art

In order to better understand *"the potential of technology in human creative processes leading to enhanced domain-specific human creative performance"*, the LIMINAL project will make advances in the development and assessment of creative support tools with a synthesis of techniques. In particular;

- Develop and apply a confluence model of creativity and its assessment
- Support new classes of creative coders by designing technical languages for their problem spaces
- Extend work into live coding, bringing abstract technical language into live interactive domains
- Extend work into visual and unconventional language design, evaluating novel approaches to the specification and notation of technical language in our target domains
- Take a user-centred approach to language design, drawing on the Psychology of Programming literature to reconsider computer programming as human-computer interaction
- Address the creative support tools we develop to advance science outreach activities and policy decisions
- Extend research into tangible and gestural interaction with collaborative exploration using creative language technology
- Develop novel methods in experimental psychology, including neuroimaging and gaze-tracking, to establish new understanding of human cognition in technical language, targeted at use of the creative support tools we develop
- Engage participatory techniques to involve end-users in grounding design processes in real contexts in professional culture.

These points are expanded upon in the following sections.

Assessment of Creativity

As noted in the introduction, **we adopt a "confluence" model of creativity**, as defined by Sternberg and Lubart (1999) to integrate cognitive and socio-personality views of creativity. Creativity research, as a field, has increasingly adopted this perspective, for example in the work of Amabile (1996) or Czikszentmihalyi (1996). However, the LIMINAL project will explore these dynamics in specific contexts, because there are clear differences between the role of creativity and associated human behaviour in different domains. For example, creativity as it is observed in painting may be quite different from that in engineering. There are also commonalities; in particular, we would expect to observe cognitive thinking strategies common to both. Through our research, we are prepared to be confronted with **different kinds of creativity at play in different professional domains**, and to generalise our understanding of creative behaviour in terms of family resemblances rather than a singular unifying theory. However, we will extend the use of descriptive frameworks in comparing these different kinds of creativity, based upon relevant prior work within the consortium in collaboration with a leading researcher in Computational Creativity who is a member of the LIMINAL Evaluation Advisory Board (McLean and Wiggins, 2012).

One recognised attribute of creative experience is the state of flow, as identified by Csikszentmihalyi (2008). States of flow are marked by complete absorption, in tasks that are well balanced in terms of difficulty and feedback. An experimental HCI paradigm has been developed by consortium members, which measures flow during musical composition with digital tools, involving periods of focussed activity (Nash and Blackwell, 2011). We expand this approach, in **measuring focussed periods of engagement with user interface as correlates of creative flow**, and where appropriate, **looking for design interventions which maximise these states**. The state of flow is most often associated with individual activity, but is also recognised as achievable in collaborative situations, such as group musical improvisation (making music without a pre-written score). We will therefore not only assess support for creative flow in solitary creativity, but also collaborative group work.

Despite the importance of flow, both in terms of happiness and productivity, in many situations flow is not practical or indeed desirable. Many creative shifts occur through unexpected disruptions, difficulties and

interactions which are incompatible with the single-minded absorption of flow. It is therefore important to include alternative ways of measuring creativity, for example those which consider **creative development as an interaction between individuals and surrounding culture**. This approach is described by Moran (2010) as "a temporary misalignment of society and individual as they learn from and develop each other." In order to include assessment of creativity in sociocultural context, we will **develop a number of domain-specific testbeds for creativity**. We develop these **through participatory methods**, working with professionals to identify areas of work where creative methods are already active or could be introduced. We then define particular activities where creative behaviour can be measured, for example in terms of productivity and engagement, in such a way that the effects of our interventions can be measured and evaluated.

The sociocultural contexts we establish will also be important for **judging creative outputs**. In addressing creativity in the workplace, Amabile (1996) has developed Consensual Assessment Technique (CAT), as an operational means of measuring creativity. This is done by soliciting **independent judgements of creativity by experts in the domain at hand**. Their judgments are considered robust if they are in agreement, according to the inter-judge reliability measure. The argument which underlies CAT is that **creativity is marked by originality relative to cultural norms**, and so we must rely on experts within those norms to make judgments of creativity. In this approach, it is not left to researchers to try to establish formal criteria for creativity. Although this work is designed with human creativity in mind, it has been adapted by Pearce (2007), in order to judge the creativity of computer generated musical works. It is therefore apt to apply CAT to hybrid human/computer systems.

By drawing together the results of **taking multiple approaches to the assessment of creativity across our work**, we will build a rich, multifaceted view on which **to inform ongoing design decisions**, and strengthen our position in disseminating our work in both academic and professional contexts.

Coding as creative practice

In the present project we will bring **creative coding** (creative approaches to computer programming) **to new classes of users**, supporting them through **multimodal (audio/visual/tactile) interfaces** to **bring technical languages to new problem spaces and far wider creative use**. To do this we build on the increasing recognition of programming as a means of human creative expression (Cox and McLean, 2012), following the creative cultures of practice forming around comparatively new language environments such as Fluxus, Processing, OpenFrameworks and Cinder, and around open hardware systems such as the Arduino and the Raspberry Pi.

We consider relevant existing notions of **creativity in professional and computer programming contexts**, such as **the reflective practitioner** (Schön, 1984), **bricolage programming** (Turkle and Papert, 1992) and **embodied computer programming in the creative arts** (McLean and Wiggins, 2012), in formulating engagements in the field to gain deep understanding of the issues and processes involved with creative coding. This requires an **anthropocentric view of programming**, focusing on its use in **open, exploratory tasks**. To improve support for exploratory creativity then, we should focus on understanding and streamlining **interactions between concepts and computer language**, taking **human perception** into account. To support collaboration in this process, we must do so in a way that also takes individual differences into account, considering **collaborative creativity** in terms of **enmeshed feedback loops**.

To introduce creative coding in existing professions, there are often established norms and expectations around technology which need to be broken down. Our approach is to first work with groups who are demonstrably open to reconsidering their use of technology and use our successes to motivate wider engagement.

Our consortium includes international leaders in the research and practice surrounding creative coding, and so we are well-equipped with the insights to drive this movement forward. We do this in a number of core areas, which we discuss below under the headings of live coding, visual programming and unconventional programming language design.

Live coding

In the LIMINAL project we will **extend the field of live coding** (see O3 in 1.1) dramatically in order to address problems in wider areas, including but not exclusively those involving creative programming (such as visualisation and games). We will adapt tools and concepts that have arisen from this field, but which continue to find new uses in areas including musical performance, rapid prototyping, 3D graphics, shared exploratory working and educational realms.

In terms of live coding technology, we will review and develop new live coding features such as **representations of time, how computations are described, the visualisation of syntax, the manipulation of code history, and the presentation of data and code**. In terms of human creative behaviour, we will develop **understanding of how design trade-offs support interaction, communication and collaboration, and also conceptual shifts, divergent thinking, reflection and surprise**. We combine and build upon our substantial expertise in this area, and fully expect profound new results by bringing this background together in collaboration.

We relate all this work to the theory of creative flow, in particular notions of "direct and immediate feedback" in optimal experience (Csikszentmihalyi, 2008). We also build upon work by Tanimoto (1990), who categorises levels of liveness in human-computer interaction. We bring these together in understanding the ways in which notational use in design feedback loops can **support creative flow**, extending earlier work (Nash and Blackwell, 2011; Church et. al, 2010) into new domains, taking **multiple collaborating users and multiple notations** into account.

In the field of live computer music and video animation, techniques for live, dynamic feedback in computer programming have been adapted for the purposes of live performance art over the last decade, lead by several members of the present consortium. In particular the Fluxus and Overtone developments with core support from Dave Griffiths at FoAM and Sam Aaron at Cambridge, and the pure functional and visual live coding prototypes produced by McLean at Leeds (e.g. McLean, Griffiths et al 2010; Aaron, Blackwell et al, 2011; McLean 2011). By extending this activity we develop techniques and interfaces for **bringing abstract code into live interactive domains**, which we will repurpose and build upon for wide use.

Visual and unconventional programming language design

In LIMINAL, we will create **new user interfaces for programming**, that are derived from the visual programming paradigm. Visual Programming is an active research field, looking at how to design programming notations that go **beyond conventional linear text**. Note that this is distinct from some popular brands, such as Microsoft "Visual Basic and Visual Studio", which refer to conventional text languages that are used to create GUI forms and event-driven programming. Instead, visual programming languages are those making heavy use of visual elements in the code itself, for example where a program is notated as a graphical diagram.

We consider all programming languages to have visual features of some kind, although these are often secondary notation, such as layout and syntax colour highlighting, forming no part of the language grammar. Furthermore visual programming languages necessarily have some kind of grammar, and more often than not still involve the placement of words or at least ideographic symbols on a surface, and so all have textual aspects.

There are two dominant styles of visual programming languages in use. Block-based languages such as Scratch programmed using the mouse, where instead of typing words, users drag words into the program from a palette like jigsaw pieces, slotting them together. These environments have been popular in school education but are now seeing wider takeup such as for Google's Android appbuilder. The other dominant approach is the box-and-wire model, seen in LabVIEW and Max/MSP. This again places functions in boxes, in the case of LabVIEW represented by ideographic symbols, and in the case of Max/MSP by words. Rather than slotting functions together however, boxes are connected by 'wires' into directed graphs. This fits well with the underlying dataflow programming style which these languages generally adopt, as these wires represent concurrent flow of data from one operation to the next.

These are established and successful paradigms, but we will investigate **more radical approaches which bring visual elements further into grammar**. Towards this we draw upon **visual semiotics** such as the work of Bertin (1984), **unusual visual interfaces** such as the **Reactable**, and esoteric languages such as Befunge (McLean et al, 2010). Members of the consortium have already begun researching in this area producing prototype visual languages such as DaisyChain, Al-Jazari (McLean et al, 2010), Texture (McLean and Wiggins, 2011) and Palimpsest (Blackwell 2012, forthcoming) exploring novel approaches such as live visual feedback and visuospatial grammar.

We also propose to extend the concept of language syntax **beyond the purely visual**, to incorporate **tangible and tactile elements** that are interpreted **as "3D diagrams"** (Edge & Blackwell 2006). These open up the possibility for novel language semantics, beyond those that have conventional diagrammatic or text representations. For example, Functional Reactive Programming (FRP; Elliott 2009) is an example of an active research topic in computer science which is providing a radical approach to the problem of how to represent interactions over time. FRP provides a declarative system for defining behaviour rather than operational procedures, allowing time to be represented expressed in ways suitable for animation, games and interactive applications. Examples include Flapjax for Javascript, FRP in Haskell, and FrTime in Scheme. This is one area in which we can **contribute new practical applications to cutting edge computer science**.

We also plan the possibility of **adding physicality to the instructions of a language**, improving some of their properties, such as the ability to allow multi-user programming strategies, as multiple users could manipulate the (now physical) code concurrently. Many block based programming languages have been developed such as Algoblocks (Suzuki et al, 1995) and RoBlocks (Schweikardt et al, 2006) which are based on stacking blocks that represents concrete instructions or commands that are interpreted by a computer, which may be embedded inside the blocks. In TurTan (Gallardo et al, 2008), developed by one of the members of the consortium, the authors wanted to go a step further and merge the input (program) and the output (results) in the same tangible tabletop device.

User-centred approach to language design

In order to carry out this research in a user-centred manner, the LIMINAL project will draw on insights from the psychology of programming field, not least that our **target domain of end-user programmers are in the majority**, and have rather **different needs** from professional programmers (Blackwell, 2006), as we have already mentioned in above.

Another key insight from the psychology of programming is that the **design of programming notations** necessarily involves a **complex of trade-offs**. Whereas visual programming language research began with the ambition to replace textual programming languages (Blackwell, 2006b), it is accepted now that by increasing visual aspects of a language notation, impacts are inevitable in other aspects. The **Cognitive Dimensions of Notation**s (Blackwell and Green, 2002) has developed over the past 15 years to provide a framework for describing these issues, not just visual aspects but all aspects of the design of programming language notations. Over this period a large number of dimensions have been identified, such as abstraction gradient, error-proneness, hidden dependencies, progressive evaluation and viscosity. Having these well-defined terms saves a great deal of time and confusion when **collaborating on programming language design**. The inter-relationships between these dimensions have also begun to be mapped out, although interestingly the relationships, relative importance and desirability of the dimensions are to some extent dependent on the target problem domain. If, as in the present project, we wish to create system features applicable across more than one domain, then we must consider the design space mapped out for us by the Cognitive Dimensions carefully, and **build flexibility into the underlying framework** so that the **notation is adaptable to the domain at hand**. We should also consider the role of Cognitive Dimensions in collaborative programming, for which we may build upon work on the role of visualisation in collaboration covered by Bresciani (2008).

Our contribution to this field will primarily be in **developing and applying Cognitive Dimensions in a live, collaborative and creative context**, with particular focus on the inter-dependencies between dimensions.

We also follow Ramsey (2005) in considering **visualisation not just as a presentation tool**, but as an

important part of an active interface. Interfaces that allow users to actively manipulate visualisations allow people to quickly take **multiple viewpoints within creative exploration**. In a very real sense, this allows people to use technology to **construct and explore their own metaphors**, rather than being constrained by metaphors hardwired by interface designers.

Use of code in science outreach and policy decisions

LIMINAL will advance research into the **use of code in the natural sciences and industrial design**. In the natural sciences there are two areas in which the project will bring new advances and engage end users to solve creative issues. Firstly **science outreach** is increasingly engaging use of creative technology as shown by recent initiatives such as the Wellcome Trust's "Gamify your PhD" (2012) and widespread use of smartphone apps in citizen science applications. LIMINAL will research creativity in this domain, as a specific niche requiring **cross-disciplinary collaboration between experts and creative practitioners**. **Citizen science** serves a two fold role, inviting interested individuals from the **public** to **take part in scientific research**, for example initiatives such as Zooniverse (launched in 2007) where astronomical objects are tagged using online software. At the same time **deeper knowledge is disseminated** about how scientific research is carried out, and related issues such as how risks are assessed to wide audiences.

The second area we will advance by the introduction of new understandings of shared creative working and live coding technology is that of **engagement of research and industry with policy makers**, both in **biomedical research** and **industrial design in urban planning**. The biological sciences currently makes use of programming tools and environments such as Excel, R, Matlab and Mathematica, used to build complex models programmed using a variety of ad-hoc methods specialised even to disciplines within the biosciences. This situation leads to lack of ability to explain methods and concepts to end users and hampers uptake of evidence by governmental bodies in the EU and national level for policy decisions (Pestel, 1982). This is seen as a growing problem and urgent priority (Wilkinson, 2004). LIMINAL tools will be designed to target specific areas of this problem space which will ultimately lead to **increased involvement of groups** including policy makers, journalists and the public **in the decision making processes** of bioscience and design research in two specific ways. Firstly **depth**, with live coding systems providing interfaces for models and data visualisation that are more easily shared and explainable to higher degrees, and secondly **timeliness** - with stakeholders being involved earlier in the process. Industrial design will also be addressed in the context of urban planning, having parallel issues with the understanding of large datasets and involvement of policy makers into a creative process.

We note that these **disciplines have their own languages**, coming from different contexts of professional knowledge. Words mean different things in different places, so in order to construct culture, we must be able to **translate and construct** their **meaning** as we hear them. **Creative use of metaphor** can help to navigate these cultural-linguistic divides, but the digital world has tended to deny the centrality of metaphor in language use, and has co-opted the word metaphor itself to refer to designed constructs which are imposed on the user. The classic example is of the "desktop metaphor" - an explanatory analogy that supposedly aids usability of computer systems. In fact, the explanatory value of the desktop metaphor was questioned from the outset, with laboratory experiments demonstrating its ineffectiveness, and large product investments by the world's largest software and electronics companies failing outright because of over-reliance on this kind of "metaphor" as a central design principle. Nevertheless, this mis-use of "metaphor" has persisted. It constrains the semiotic reading of software products as designed artefacts, and reinforces perceptions that computers only become creative tools when used by technologists. We believe it is possible to **address the divides between humanistic and scientific cultures** in policy and education by more closely **investigating the kinds of technical language** that are introduced to these contexts via technology.

Tangible and gestural interaction

In the LIMINAL project we are going to design **new tools for the creation and manipulation of gestural interfaces**, allowing more **user-level gesture description and programming** as well of professional gestural interfaces for the systems created in the project. By 'gestural interfaces', we mean interfaces that are based or make use of gestures, such as systems that allow issuing commands by waving a hand or drawing a symbol. As opposed to the keyboard-based ones, such systems also **allow rich interaction beyond a list of**

symbolic commands. One of the active fields is the development of algorithms and languages to successfully describe and recognize gestures. Two main approaches to this problem can be identified: Machine learning techniques and analytic techniques. Typical supervised **machine learning techniques** used in this case are Hidden Markov Models (Schlömer et al., 2008), or simpler techniques as the optimal angular alignment used in the popular 1$ recognizer (Wobbrock et al., 2007), and even sound-based approach (Caramiaux et al., 2010) for accessing auditory data using canonical correlation analysis. **Analytical approaches** include using specially-crafted languages such as regular expressions (Kin et al., 2012) or other (Midas), even strategies for adding collision-management of runtime 3rd party gesture detection for implementing concurrent multi-user multi-task gesture-based systems (Julià et al., 2013). These technologies will form the basis of our research and development.

Also, we will create **new tools for building Tangible User Interfaces** and experiment with them, focusing both **user-level programming** for Tabletops and in Tabletops. We will focus on tabletop-supported tangible interaction, where **digital data is represented and manipulated in the form of physical objects** in a tabletop-shaped interactive surface, **allowing a mix of gestural and tangible interaction**. Such objects can represent abstract concepts or real entities; they can relate to other objects on the surface; they can be moved and turned around on the table surface, and all these spatial changes can affect their internal properties and their relationships with neighbouring objects. Typically, this type of interface allows more than one input event to enter the system at the same time; in interactive tables any action is possible at any time and position by one or by **several simultaneous users**: the limitation of the single mouse pointer, with its restricted variety of the gestures used (click, double-click, drag and drop, etc.), gives way to dual (and full) hand interaction, from which the "pinch zoom" constitutes only one example of an extremely large number of possibilities. As an example, one of the most popular tabletop applications is arguably the Reactable (Jordà et al., 2007), a musical tabletop developed in 2005 by one of the teams, currently present in a dozen children's and science museums all over the world, and used also by dozens of professional musicians.

Toolkits such as reacTIVision, an open-source, cross-platform computer vision framework developed by one of the teams in this consortium (Bencina et al., 2005), which allows the tracking of fiducial markers and combined multi-touch finger tracking, and which is nowadays widely used among the tabletop developers community (both academic and industrial), has spread the development of tabletop applications mainly for education and for creativity (e.g. Khandelwal et al., 2007; Gallardo et al., 2008; Marco et al., 2010). Also, tools enabling the user to **create tabletop interfaces to further control their programs in an exploratory way** has been already developed by partners of this consortium, such as Musical Tabletop Coding Framework (Julià et al, 2011), an open source tool that allows programming tabletop (and mobile) interfaces using Pure Data, a visual live programming language, mainly used in electronic music. Those examples illustrate not only the base technologies that we will be using, but a precedent of our intent to **create useful tools in an open and free way for the benefit of everyone**.

The suitability of interactive tables as a **support for collaboration and social learning** has been highlighted by recent research (e.g. Marshall, 2007). This is due to the fact that s**ubjects share a physical space** in which communication during all creative, experimental and reflexive processes, is much more physical and direct than when done via a computer. Furthermore, it has also been shown that interactive table applications, with their ability for simultaneous action and visibility to collaborators, are **ideal for exploratory and creative activities,** and can allow and facilitate outputs that would be extremely difficult to obtain using more conventional interfaces. That said, the application of tabletop interaction to the specificity of programming and to the management of large datasets is a very young field, in which however, some of the members of this consortium have already shown some promising results (e.g. Blackwell & Hague 2001, Blackwell et al 2004, Edge & Blackwell 2006). In Català et al. (2012), one of the members of the consortium **has** recently developed a **creativity assessment model**, and conducted an empirical study in which it has been observed that in terms of creativity traits, interactive surfaces seem promising as groups working in the digital platform showed **significantly more performance in fluency of thinking and motivation**. Expanding this work to multiple assessments will itself be a significant advance over the State of the Art.

Large dataset exploration and manipulation will also be an important part of our approach to integrate creative discussion with technology, allowing participants to deal with **types of data in ways that they could not otherwise approach**. Tabletop devices also provide excellent support for dataset explorations. We can find an example in SongExplorer, a system for the exploration of large music collections on tabletop

interfaces developed by one of the members of the consortium (Julià and Jordà, 2009) that addresses the exploratory problem of finding new interesting songs in large music databases from an interaction design perspective using Music Information Retrieval techniques as well as visualization and tabletop interaction ones.

Language, communication, and high order cognition

Communication can be described as an exchange of linguistic information that involves coding and decoding of messages. The sender codes information and puts into a linguistic form, while the receiver de-codes the information. In this case, it is the common understanding of the linguistic format that enables the communication. Given that **language enables most of our day-to-day communication** (face-to-face or phone conversations, writing letters or e-mails, etc), some have come to believe that while a certain level of communication is possible without language, 'real communication' is linguistic in its essence, as demonstrated by the philosopher John Searle:

> "One can in certain special circumstances 'request' someone to leave the room without employing any conventions, but unless someone has a language one cannot request of someone that he e.g., undertake a research project on the problem of diagnosing and treating mononucleosis in undergraduates in American universities." (Searle, 1969)

However, evidence from human neuroscience and neuropsychological studies suggest that the capacity for language and the capacity to communicate are cognitively distinct (Willems, de Boer, de Ruiter, Noordzi, Hagoort & Toni, 2010; Willems, Benn, Hagoort Toni & Varley, 2011). Still, given the nature of language by which elements are automatically coded into words, and the importance of this encoding for the maintenance and manipulation of information in verbal working memory, it is difficult to isolate linguistic processes from other high-order cognitive processes (see for example the debate within the area of calculation: Benn, Zheng, Wilkinson, Siegal, & Varley, 2011; logical thinking: Monti, Parsons, & Osherson, 2009; false belief: Dungan, & Saxe, 2012; spatial cognition: Bek, Blades, Siegal, & Varley, 2013, etc.)

In this respect, **programming languages offer a unique opportunity** to examine such aspects that are infinitely difficult to examine using natural language. This is due to the fact that programming languages, in particular when used in the context of live coding, are in a sense 'real languages' in that they are used in **'real situations' to communicate often complex ideas**. This implies a fluent use in a language that is purpose built, and hence does not have the emotional involvement, nor does it dominate the thinking process in a way that is often observed in the use of natural languages.

In the LIMINAL project we will therefore study **high order cognitive functions** such as **communication and creativity**, using a language that carries **many of the markers of a real language without the complexity of human natural language**. In order to achieve this, we will study **live and independent interaction** using both **fMRI and eye-gaze equipment**. By doing this we hope to build on previous work done by members of the consortium and the External Advisory Board in order to make a unique contribution beyond the state of the art to **both the study of human cognition and that of computer languages**. We further believe that this method may in the future offer a window of opportunity to study not only normally functioning adults, but also those with unique language and communication difficulties, such as children and adults with autistic traits (Frith, 1989).

Participatory techniques

A key element of the LIMINAL project will be the development of new **participatory techniques for meta-design** - working with a wide range of **creative language users**, to make **new design languages that draw on tangible and visual resources**. We draw on the Scandinavian cooperative design tradition that follows three main phases of development: 1) Understanding current practice; 2) Generating design ideas; 3) Cooperative prototyping, where users and designers are in engaged in **collaborative design activities** (Greenbaum and Kyng, 1991). In the LIMINAL project we extend this tradition in ways that account for the **diffusion of production into everyday practices**. The classic PD formulation provides workers with **better tools to support their work**; understands **users as experts** in how to improve their own work and work life; takes these views and users' **perceptions of technology** as important to success; and the importance of

viewing computer-based applications in context. This has in turn led to approaches that come close to our interests in new methods that could help users and designers achieve the above aims together in co-production; one good example being **prototypes and "mockups"** (Ehn and Kyng, 1992). We are convinced that since users are understood as being the experts on their own life and work, using cooperative prototypes in situ allows users to try out early versions of the potential designed artefacts before they are actually realized (Hertzum and Simonsen, 2010).

Our point of departure is that **users are active and productive in new ways** but this is rarely understood at the level of programming. We aim to extend PD techniques, rooted in **HCI and interaction design**, to include technical languages to reimagine ways in which human language and creativity may be supported by computers, including using software and gestural hardware interfaces; to extend the ways we understand communication in the broader sense of human-machine relations. In terms of participation, we expand our understanding by asking how **cultural experimentation with technologies** leads to **new understandings of participatory culture**, and how **participatory cultures** lead to **new perspectives on the creative process**, the **role of the cultural producer**, and of **participation itself** (Cox 2012).

We are able to build on prior experience of developing novel tangible interfaces in a workshop context (Blackwell, Edge et al 2005) to develop workshop methods that explore **novel tangible representation in a participatory manner**. These will bring explicit awareness of the need to integrate **descriptive perspectives from multiple academic disciplines** (Blackwell 2006).

1.3 S/T methodology and associated work plan

The LIMINAL mission is to develop highly innovative technological solutions ready for embedding in, and most importantly capable of changing, current understanding and practice related to creativity. Our successful innovative interdisciplinary projects at European and national level led to the conclusion that the best way to accomplish the project mission is to follow an evolutionary approach with the following features: (1) throughout the project, stakeholders are actively engaged as participants in the design and evaluation of the technological solutions; (2) an agile development approach is followed to ensure that this stakeholder engagement is embedded in development process between code sprints (every 1-2 weeks); (3) evaluation with prototypes are the best way to gather feedback in order to test research hypotheses, and refine the overall conceptual model; (4) the "early and often" release of prototypes as open source software makes it easy to illustrate the overall concept and to reach and build potential user communities, which enables early dissemination and exploitation and ensures project success and sustainability.

The project will proceed according to major milestones, corresponding to scientific objectives in each WP and evolutionary methodology. It divides broadly into **3 main levels**: (i) Development of the overall conceptual framework; (ii) development of prototypes; (iii) evaluation and feedback into theoretical development and research, and to revise and improve prototypes iteratively.

The work plan is structured in 8 workpackages (WP):

- Five WPs (WP2, WP3, WP4, WP5, WP6) dedicated to the research and development of the framework;
- WP7 is focused on Demonstration
- WP8 is dedicated to dissemination and diffusion of the project
- WP1 deals with management and coordination of the overall project

The following work package dependency chart shows the main interactions and work flow through the LIMINAL project. WP1 provides the project management supporting work in all the other WPs. The development and evaluation work in WP4-6 is informed by the participatory methods applied in professional situations in WP2. The language meta-design studio develops understanding of metaphor in technical language through participatory workshops, which will inform development work in WP5 and WP6. Evaluation and experiments in WP4 will also inform development in agile development iterations, creating a cyclic dependency over time. The work in WP5 and WP6 will also provide technology to WP4 on which to base neuroimaging and other experimental work. All of the research in WP2-6 will be disseminated and diffused through WP8, and then WP8 dissemination materials and WP6 creative support technologies will be used in the demonstrations in WP7.

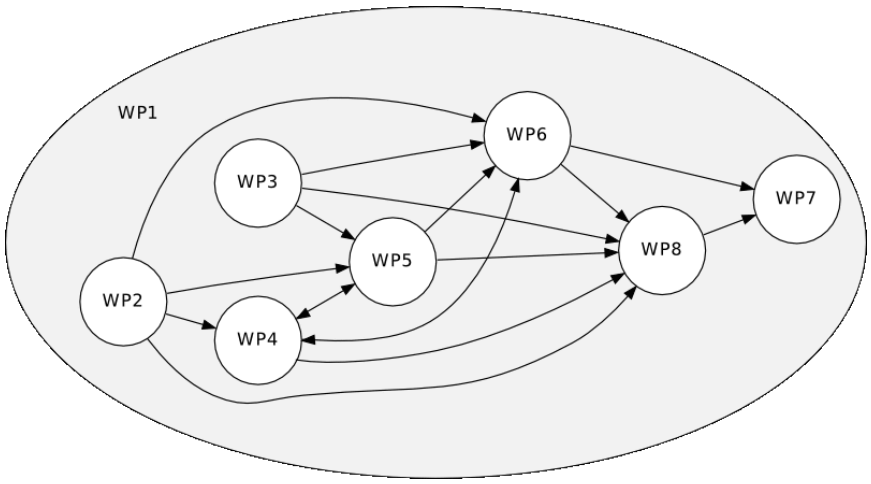

Figure 1.3.1: LIMINAL WP architecture

Timing of the different WPs and their components - Gantt

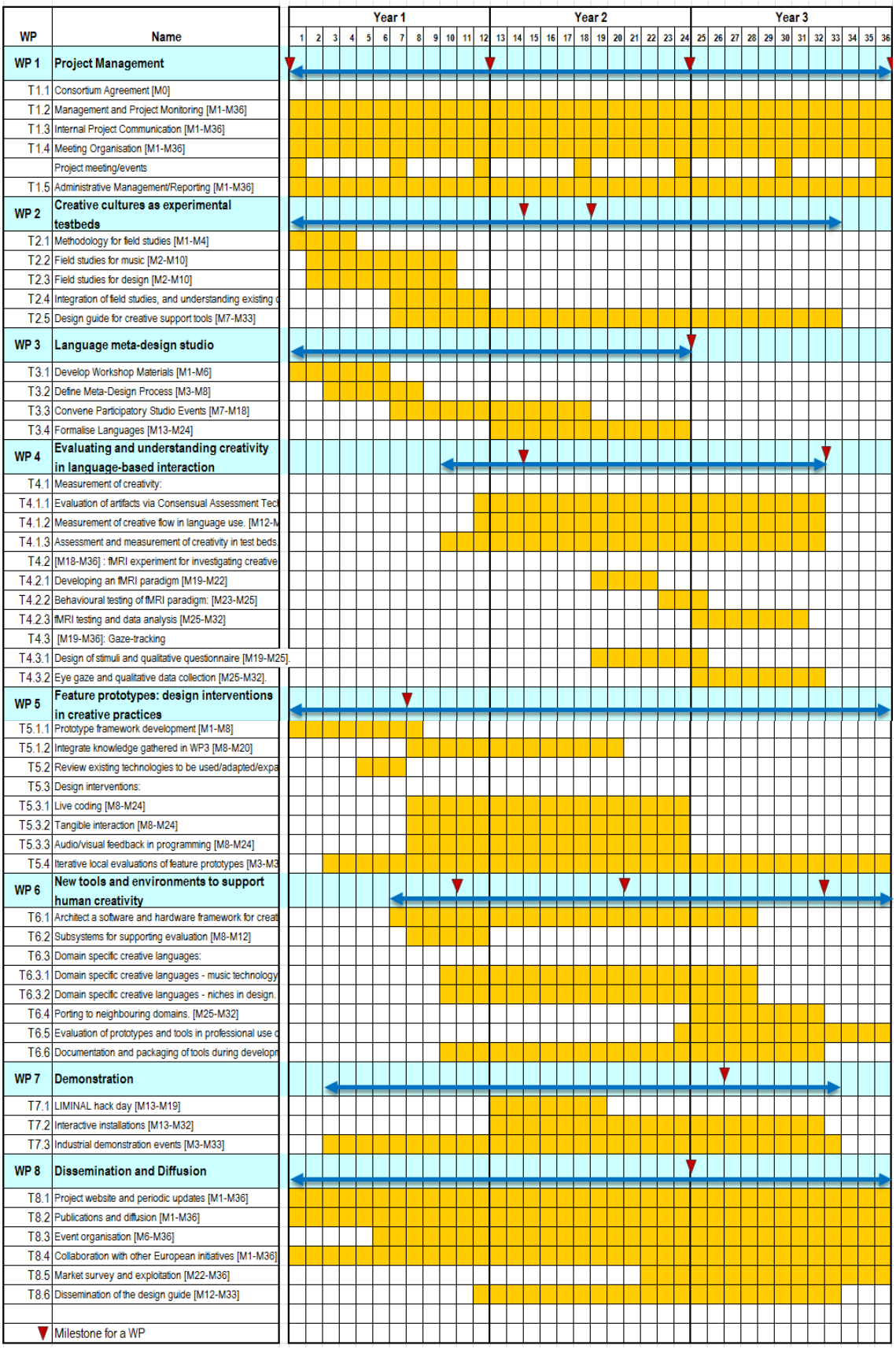

Figure 1.4. Time line of LIMINAL workpackages and the corresponding tasks.

Table 1.3a: Work package list

Work package list

Work package No[1]	Work package title	Type of activity[2]	Lead partic no.[3]	Lead partic. short name	Person-months[4]	Start month[5]	End month[5]
1	Project Management	MGMT	1	UNIVLEEDS	15	1	36
2	Creative cultures as experimental testbeds	RTD	6	AU	34	1	33
3	Language meta-design studio	RTD	4	UCAM	46	1	24
4	Evaluating and understanding creativity in language-based interaction	RTD	2	USFD	49	10	36
5	Feature prototypes: design interventions in creative practices	RTD	3	UPF	59	1	36
6	New tools and environments to support human creativity	RTD	1	UNIVLEEDS	67	7	36
7	Demonstration	DEMO	1	UNIVLEEDS	35	3	33
8	Dissemination and Diffusion	RTD	5	FOAM	18	1	36
	TOTAL				323		

1 Workpackage number: WP 1 – WP n.

2 Please indicate one activity (main or only activity) per work package:
RTD = Research and technological development; DEM = Demonstration; MGT = Management of the consortium

3 Number of the participant leading the work in this work package.

4 The total number of person-months allocated to each work package.

5 Measured in months from the project start date (month 1).

Table 1.3b: Deliverables List

List of Deliverables

Del. no. [6]	Deliverable name	WP no.	Nature[7]	Dissemi-nation level [8]	Delivery date[9] (proj. month)
D1.1	Signed Consortium Agreement	1	R	RE	00
D6.1	Software development guide	6	R	PU	03
D8.1	Project website	8	O	PU	03
D3.2	Pilot workshop	3	O		07
D5.2	Review of base technologies for new design features	5	R	PU	07
D3.1	Workshop software infrastructure	3	R	PU	08
D8.2	Strategy for dissemination and exploitation	8	R	PU	08
D5.1	Framework for feature prototype interventions	5	P	PU	09
D6.2	Framework architecture development	6	P	PU	09 30
D2.2	Testbed spec - Music technology	2	R	RE	10
D2.3	Testbed spec - Design technology	2	R	RE	10
D2.4	Testbed report	2	R	RE	12
D1.2.1 D1.2.2 D1.2.3	Periodic Annual Report	1	R	PU	12 24 36
D4.1.2	Measurement of creative flow in language use	4	R	PU	13 19 25
D4.1.3.1	Initial testbed evaluation method and plan	4	R	PU	14
D4.1.1	Evaluation of artefacts via Consensual Assessment Technique	4	R	PU	16 24
D2.5.1	Internal design guide	2	R	RE	18
D7.1	Hack day report	7	R	PU	20
D3.4	Formalised meta-design	3	R	PU	24

[6] Deliverable numbers in order of delivery dates. Please use the numbering convention <WP number>.<number of deliverable within that WP>. For example, deliverable 4.2 would be the second deliverable from work package 4.

[7] Please indicate the nature of the deliverable using one of the following codes:
R = Report, **P** = Prototype, **D** = Demonstrator, **O** = Other

[8] Please indicate the dissemination level using one of the following codes:
PU = Public
PP = Restricted to other programme participants (including the Commission Services).
RE = Restricted to a group specified by the consortium (including the Commission Services).
CO = Confidential, only for members of the consortium (including the Commission Services).

[9] Measured in months from the project start date (month 1).

	language				
D5.3.2	Prototypes of design features – Agile evaluation results	5	R	PU	24
D6.3	Creative support systems for Music Technology	6	P	PU	28
D6.4	Creative support systems for Design	6	P	PU	28
D3.3	Series of workshops	3	O	PU	12 19
D4.1.4.2	Testbed evaluation report	4	R	RE	32
D4.2.1	A map of brain areas involved in the communicative process of programming	4	R	PU	32
D4.2.2	Eye-gaze data and analysis	4	R	PU	32
D5.3.1	Prototypes of design features - Agile prototype development report	5	R	PU	14 24
D6.5	Documentation of evaluation results	6	R	PU	32
D6.6	Technical and user documentation review for LIMINAL tools	6	R	PU	32
D2.5.2	Public design guide	2	R	PU	33
D4.3	Behavioural measures	4	R	RE	33
D7.3	Industrial demonstration report	7	R	PU	33
D1.5	Final publishable summary report; Plan for use and dissemination of foreground; Report on societal implications of the project	1	R	PU	36

Table 1.3c List of milestones

List of Milestones

Milestone number	Milestone name	Work package(s) involved	Expected date [10]	Means of verification[11]
1	**Consortium agreement**	**WP1 (+all)**	**M0**	**Agreement reached.**
2,3	**Annual reviews**	**WP1 (+ all)**	**M12,M24**	**Review completed and agreed**
4	**Final review**	**WP1 (+ all)**	**M36**	**Review completed and agreed**
5	**Field studies in music and design**	**WP2**	**M14**	**Field study complete and test beds for supporting and evaluating development in WP5 and WP6 validated.**
6	**Design guide for creative support – internal release**	**WP2**	**M18**	**Validated report released to the public, with feedback solicited.**
7	**Meta-design languages**	**WP3**	**M24**	**Validated report supporting ongoing development design processes.**
8	**Testbed evaluation plan**	**WP4**	**M14**	**Validated report supporting ongoing evaluation and development**
9	**Integrated evaluation of creative support approach**	**WP4 (+ WP5,WP6)**	**M32**	**Reports and submitted publications detailing outcome of Consensual Assessment Technique, measurement of creative flow, and assessment in test beds.**
10	**Review of existing creative support tool features**	**WP5**	**M7**	**Technical report**
11	**Initial framework to support creative tool development**	**WP6**	**M10**	**Technical framework and documentation to support launch of T6.3**
12	**Initial creative support tools**	**WP6**	**M18**	**First stable release with minimal feature sets, designed for gaze tracking and fMRI experiments**
13	**Creative support tools**	**WP6**	**M32**	**Software, hardware (including design schematics), and documentation. Software and documentation packaged for public distribution.**
14	**Demonstration mid-term target**	**WP7**	**M26**	**Reports of demonstration activities that have taking place, and ongoing plan meets expected deliverables.**

[10] Measured in months from the project start date (month 1).

[11] Show how you will confirm that the milestone has been attained. Refer to indicators if appropriate. For example: a laboratory prototype completed and running flawlessly; software released and validated by a user group; field survey complete and data quality validated.

15	**Dissemination and diffusion mid-term target**	**WP8**	**M24**	**Survey that impact is forming a coherent story, review early feedback from industry, and that projected activities meet expected deliverables.**

Table 1.3d: Template - Work package description

Work package description

Work package number	1	**Start date or starting event:**		M1		
Work package title	Project Management					
Activity type[12]	MGT					
Participant number	**1**	2	3	4	5	6
Participant short name	**UNIVLEEDS**	USFD	UPF	UCAM	FOAM	AU
Person-months per participant	**15**	0	0	0	0	0

Objectives

This Work Package deals with the overall project management, coordination of the scientific and administrative work, team communication and collaboration, to ensure the efficient but creative project, and its technical coordination according to the work plan, and interface with the Commission. Specific objectives include:

- Coordination the partners' effort to reach the project objectives effectively;
- Promotion of collaborative and integrated working of the Consortium;
- Production of reports, organisation of meetings, and liaison with Consortium members, and committees;
- Monitoring and management of the finances of the Consortium; meeting legal and contractual obligations;
- Interface with the Commission.

In this way, the progress of the project can be measured and reviewed to ensure that the Milestones are met and verified, and that the Deliverables are delivered in a timely fashion, and timely remedial action taken if necessary if progress is not satisfactory. This WP will also be closely connected with WP8: Dissemination & Exploitation activities to ensure effective exploitation of the technologies being developed where appropriate, and promotion of the project to increase its wider visibility and profile.

Description of work

The overall project coordination and management is led by UNIVLEEDS, as project coordinator. A suitable structure is in place in order to guarantee fulfilment of the project objectives. It covers high-level issues and daily management activities. See Section 2.1 for details. It will combine effective leadership whilst ensuring consultation and representation of all Consortium members including the External Advisory Board, to ensure the success of the project. The tasks within WP1, as listed below, take place throughout the entire 36-month duration of the project:

T1.1 Consortium Agreement [M0]

Partners involved: ALL; UNIVLEEDS leads

A priority task is to conclude a Consortium Agreement (CA) amongst all consortium partners prior to the signature of the Grant Agreement with the Commission. The CA details the management structure and organisation of the project; the financial aspects of the project; dissemination; etc. Further details in Section

[12] Please indicate one activity (main or only activity) per work package:
RTD = Research and technological development; DEM = Demonstration; MGT = Management of the consortium.

2.1

T1.2 Management and Project Monitoring [M1-M36]

Partners involved: ALL; UNIVLEEDS leads

The Project Office will ensure, on a day-to-day basis, that the technical progresses made by the various WPs are proceeding to plan. All plans and reports will be reviewed by the Project Management Board (PMB), who will also act as the approving body for all WP reports and Deliverables submitted by the various WP leaders, to ensure qualities and time schedule. The PMB will oversee the strategic, scientific, empirical, and implementation work. The Coordinator, supported by managers and boards, will ensure that the technical work carried out within the WPs is coordinated and synchronized and will ensure harmony between the various WPs with regard to overall project Deliverables; initiating remedial actions where/if necessary, such as calling an extraordinary meeting of the PMB to either bring in a new partner or ask a partner to leave the Consortium, and will represent the Consortium to the Commission on progress and/or issues concerning the execution of the project's targets and Deliverables. See details in Section 2.1.

T1.3 Internal Project Communication [M1-M36]

Partners involved: ALL; UNIVLEEDS leads

One of the main coordination tasks will be to assure the regular flow of information between all Consortium partners via report dissemination and arrangement of appropriate boards including PMB, External Advisory Board, Dissemination and Exploitation board, and project meetings. The most effective means of communication available will be used, including: telephone/Skype, tele- and web-conferencing, e-mail, web portal, as well as face-to-face meetings. The aim is to have a free flow of communication amongst and between Consortium members; between the Consortium and the Commission project officer, via the Project Coordinator; and amongst the members of the various boards. This will be undertaken through both formal and informal methods.

T1.4 Meeting Organisation [M1-M36]

Partners involved: ALL; UNIVLEEDS leads

The Consortium will meet according to a well-defined schedule, outlined in Section 2.1. The Project Coordinator will organise the 'kick-off' meeting and subsequent project meetings, in addition to formal Review meetings with the Commission project officer and reviewers. The Project Coordinator, supported by managers and boards, will also ensure that appropriate Agendas are devised, appropriate meeting papers/presentations are prepared and circulated, and that full consideration is given to ongoing work and future plans. They will also assist in the organisation of at least one major international dissemination event within the lifetime of the project (as specified in WP8).

T1.5 Administrative Management/Reporting [M1-M36]

Partners involved: ALL; UNIVLEEDS leads

The Project Coordinator and the Admin Officer (Admin/Financial manager) will support the technical work of the project WPs by providing suitable tools and management processes of the project within EU guidelines and regulations including project structure, financial management, reporting templates for use by WP leaders, and risk register. This document will be regularly updated on at least at an annual basis. Management information will also be distributed to Consortium members and the Commission. The Project Coordinator and Admin Officer will ensure that Management Reports are produced to the highest standard and submitted in a timely fashion. Reports and Deliverables will be evaluated and quality controlled by the PMB.

Deliverables

- D1.1 Signed Consortium Agreement (month 0) – LEEDS, All.
- D1.2.1/D1.2.2/D1.2.3 Periodic Annual Report - Activity Reports and Financial statements, as from Guidelines of the European Commission [progress of scientific work, project management, cost statements and summary financial report] (Month 12/24 and 36) – LEEDS, All.
- D1.5 Final publishable summary report; Plan for use and dissemination of foreground; Report on societal implications of the project (gender equality, ethics etc.). (month 36) – LEEDS, All.

Work package number	2	**Start date or starting event:**	M1		
Work package title	Creative cultures as experimental testbeds				
Activity type[13]	RTD				
Participant number	1	2	3	4	5	**6**
Participant short name	UNIVLEEDS	USFD	UPF	UCAM	FOAM	**AU**
Person-months per participant	2	0	12	4	5	**11**

Objectives

We will engage with creative professionals in the computer music and design fields, represented in the External Advisory Board, in order to observe established and emerging cases of end-user programming in creative activity with a particular focus on socio-cultural context.

In the design domain we will work with industrial designers looking for ways to explore large, often messy datasets to solve real world problems (Skibsted Ideation), artists using games and interactive technology as a way to explore complex issues from different perspectives (FoAM, Tale of Tales, Field), environmental researchers designing visualisation techniques for their simulations and models (Exeter/ESI). Promising problem spaces and bottlenecks found will be fed into WP6, providing us with designs for domain specific prototypes. A key creative thread drawing these domains together are professionals who engage with programming languages on an ad-hoc basis, outside of conventional programming culture, in some cases without even realising that they are programming or working with programming logic. They represent opportunities to tap into emerging creative working practices which are now pervasive, and yet poorly understood in research and professional practice.

Our work in the music domain will draw from the pools of industrial collaborators of the Music Technology Group at UPF, and the Interdisciplinary Centre for Scientific Research in Music at UNIVLEEDS. This work will also greatly benefit from the agreed involvement of Reactable Systems, an enterprise working closely with well-known musicians in developing innovative high level music technology interfaces for composition and performance. The work of Reactable is a key example of programming interfaces (in this case, dataflow programming) being adopted by end-users who do not realise they are programming. We will investigate creative processes established by communities surrounding the Reactable and related music programming interfaces such as Max/MSP, SuperCollider and Overtone.

We will take a participatory approach to understanding and categorising patterns of usage across these esoteric uses of computational tools in current practice and collaborative design activities. These activities are fundamentally creative, in that they involve reflection, combination and abstraction in exploring ideas within networked, socio-technical cultures. The emergence of these activities signal a disruptive shift already underway, hidden from plain sight, to which our programme of research will provide measurable, radical acceleration.

We will identify these promising activities in a number of domains such as those listed above. Once identified, we will engage with professionals within each domain as participants in their formalisation. In each case we will establish a number of testbeds, as specifications of creative activities and their socio-cultural contexts. Evaluation methodologies will be adapted from established measures of creativity and collaboration in the field, as part of WP4. Together these testbeds will provide a key experimental basis for the development and evaluation of our research.

Description of work

Partners involved: *AU leads, UNIVLEEDS, UPF, UCAM, FOAM contribute*

[13] Please indicate one activity (main or only activity) per work package:
RTD = Research and technological development; DEM = Demonstration; MGT = Management of the consortium.

T2.1 Methodology for field studies [M1-M4]: Formalise means of engaging with participants in order to identify creative activities in such a way that they can be used in the design of repeatable experiments, where creativity is assessed. This ongoing work will ensures the following two field studies follow the same methods in order to have comparable results.

T2.2 Field studies for music [M2-M10] - Using interviews and visits to their workplaces, we will study how musicians engage with technology currently, how they work together in SME's such as collectives, recording and live performance groups - examining how separation of disciplines and team size effects issues that of creativity in solving design problems.

T2.3 Field studies for design [M2-M10] - Working with organisations concerned with design in highly specific cases which often involve interaction with policy makers, journalists and the public. Focusing on industrial design SME's and environmental researchers we will examine separation of disciplines and unique properties of these sectors and look for ways that improved live creative tools can help in building, understanding or explaining complex models and large messy datasets, and ways of including end-users in these processes.

T2.4 Integration of field studies, and understanding existing creative problems [M7-M12] - Analyzing and summarizing results from all field studies looking at similarities and differences both for the study domains and the user groups. An integrated analysis of field studies in different domains, different contexts and with different user groups will provide a deep understanding of the use of tools for end-user programming and creativity. The results will frame the development work carried out in WP5 and WP6, and evaluate the generality of results beyond the targets of domain specific tools.

T2.5 Design guide for creative support tools [M7-M33]. Generalise the ongoing development and evaluation work in WP5 and WP6, to produce a design guide as a catalogue of high-level descriptions of situations and design responses. This will follow the "pattern language" model developed in urban design by Christopher Alexander et al (1977) and then applied to software development, but taking in all relevant design strategies including visual layout, modes of interaction, use of metaphor and linguistic structures (much like 'generative grammar'). Preliminary version will be released by M13, and the revised version released M18. A version suitable for public release and comment will be prepared for M33.

Risks Analysis and associated contingency plans

There is a need to make sure that the domains represented are appropriate to the research for the results to be meaningful. The industrial partners and external advisory board will be particularly useful in this regard but wider relations to policy makers and the public are also identified as key to establish the grounding for further work in other WPs. The testbeds will be carefully constructed with this wider ecology in mind and to establish how creative and collaborate work is enacted relationally. Field work will require established methods yet also take into account subjective aspects that are significant in ethnographic work involving participants, but perhaps particularly so in fields that relate to creative practices. Methods are rooted in the participatory co-design tradition in workplaces and will be further attuned to these risks.

Deliverables (brief description) and month of delivery

D2.2 Testbed spec - Music technology [M10]
D2.3 Testbed spec - Design technology [M10]
D2.4 Testbed report [M12]
D2.5.1 Internal design guide [M18]
D2.5.2 Public design guide [M33]

Work package number	3	**Start date or starting event:**		M1		
Work package title	Language meta-design studio					
Activity type[14]	RTD					
Participant number	1	2	3	**4**	5	6
Participant short name	UNIVLEEDS	USFD	UPF	**UCAM**	FOAM	AU
Person-months per participant	6	0	8	**19**	6	7

Objectives

The objective of this work package is to develop a participatory studio method for the design of new languages in interdisciplinary collaboration contexts. This can be considered as participatory meta-design, in the terminology of Gerhard Fischer (2004). The goal in meta-design is to produce new tools and resources that enable others to become more creative designers.

In taking the role of metaphor as central to creativity and language design, the studio workshops will have a specific focus on embodied interaction, both as the basis for novel languages, and as a meeting point for people who have different ways of describing their own experience. Language is both a medium for professional communication, for engagement with publics, and for expressing creative intentions as computer code. Participatory studio workshops provide an opportunity to understand the ways in which creative languages come into being as shared social commitments. The workshops will incorporate practical and material construction tasks, working within the technical genre of the "hack day", but informed by previous work that explores physicality as a basis for interactive notations. A focus on metaphor, and on potential for social critique, provides a novel analytic focus such that these workshops are generative of new descriptive and creative languages.

Description of work

Partners involved: *UCAM leads, AU, FOAM, UPF, UNIVLEEDS contribute*

The studio meta-design method is reflective action research, carried out through a series of participatory workshops and activities. These workshops will emphasise the embodiment of digital technologies, and use of the body as a starting point for interpretation of technological experience. This will draw on extended concepts of agency among human and non-human actors, and will offer an engagement and critical perspective that is complementary to the notions of tangible, embodied and ubiquitous computing developed by UPF.

A key opportunity comes from use of the Raspberry Pi computer, created by a Cambridge-based charitable foundation to enable public engagement with computing. Less expensive than a Lego construction set, the Raspberry Pi presents digital computing in a form that is unthreatening, disengaged from corporate control and standardisation, and open to interpretation. Raspberry Pi has already been adopted enthusiastically by the international maker/hacktivist community, with sales approaching a million units. As a full Linux computer, it is able to operate as an internet node, either as a user-configurable and disposable server, or as an embedded client in the Internet of Things. Open source tools developed to engage children with the Raspberry Pi in educational and hobbyist contexts are also resources for metaphorical re-interpretation, in a programme to Reclaim the Digital. These include the use of live coding, embodied digital agents, massively-multiplayer online role-playing games, security hacking experiments, and many others at the boundaries of cultural, political and arts computing.

T3.1 Develop Workshop Materials [M1-M6]: Develop workshop materials suitable for rapid improvisation of novel interactive and embodied computational devices. These will include real-time sound and light control, as well as physical and mechanical components suited to a non-technical and craft audience.

[14] Please indicate one activity (main or only activity) per work package:
RTD = Research and technological development; DEM = Demonstration; MGT = Management of the consortium.

T3.2 Define Meta-Design Process [M3-M8]: Develop meta-design process that takes metaphor as a central motivating and organising principle can build on the technical capabilities and physical affordances of the Raspberry Pi to demonstrate the potential for users of digital technologies to construct their own economic, social and political interpretations. These may be supplemented by use of other user-configurable digital tools that have disengaged from established corporate models, such as the Minecraft construction/online game environment or other programmable objects or toys.

T3.3 Convene Participatory Studio Events [M7-M18]: Conduct participatory studio experiments at art venues, MakeSpaces and industrial venues such as technical conferences. Field recordings will be made quickly available to partners via internal reports, to inform ongoing development work.

T3.4 Formalise Languages [M13-M24]: Formalise meta-design languages based on reflective ethnographic observation among the communities engaged.

Risks Analysis and associated contingency plans

Although facilities of this kind are occasionally brought together into community MakeSpaces or one-off hack-day events, developing a replicable creative engagement suitable for touring to a variety of locations and social groups introduces substantial logistic and technical challenges. Risk will be mitigated through engagement with established experts, but contingency plan will be to reduce travel distances.
Recruitment of participants may be a risk, although the existing network of contacts with schools and arts organisations shared by all partners reduces this substantially. Contingency plan would be to work more intensively with students in higher education, and established creative communities.

Deliverables (brief description) and month of delivery

D3.1 Workshop software infrastructure - based on open source software running on Raspberry Pi computers [M8]
D3.2 Pilot workshop conducted with geographically local partners [M7]
D3.3 Series of workshops, with field recordings for distribution to other partners [M12, M19]
D3.4 Formalised meta-design language [M24]

Work package number	4	**Start date or starting event:**	M10			
Work package title	Evaluating and understanding creativity in language-based interaction					
Activity type[15]	RTD					
Participant number	1	**2**	3	4	5	6
Participant short name	UNIVLEEDS	**USFD**	UPF	UCAM	FOAM	AU
Person-months per participant	14	**16**	7	3	6	3

Objectives

There are two different aspects covered by this work package, evaluation and assessment of creativity, and investigations into creative tool use by engaging experimental psychology.

As described in progress beyond the state of the art, we take a mixed approach to the evaluation of creative technology, to employ measurements of creative flow, of behaviour and productivity in the creative test beds established through WP2, and through the evaluation of creative outputs by applying Consensual Assessment Technique.

We also exploit unique opportunities to understand the creative use of language from an Experimental Psychology standpoint. Given the complexity of natural human language, it has been very difficult to investigate the role of language in many high-level cognitive abilities, including communication (Willems, Benn, Hagoort, Toni, & Varley, 2011). The development of live coding interfaces for computer languages gives us a constrained and yet creative language, providing a unique opportunity for controlled neuroimaging experiments on linguistic and non-linguistic based interactions. We will develop an fMRI paradigm to explore the neural substrates of interaction. In this setting, we will examine the effects of live coding with and without co-programmer (in a pair-programming setting). Shedding light on the under-pinning of human-human language-based interaction will help us gain insight into the processes involved in socially-based creative tasks. later experiments will introduce alternative textual and visual representations of code, to gain insight into the cognitive effects of our design interventions. Further, outcomes from this work may allow us to better understand and improve communication with individuals who engage in programming and computer interaction, but avoid human interaction when possible (such as individuals with autism spectrum disorders)

Specific key objectives are:

Evaluate ongoing development in WP5 and WP6 using a confluence of methods to measure creative behaviour, experience and outputs

Identify the neural network involved in linguistic and non-linguistic creative interaction, and hence,

Identify any core areas involved in creative interaction, regardless of its modality

Assist in developing tools and paradigms that enhance and encourage creative interaction

Description of work

Partners involved: *USFD leads, UNIVLEEDS, UCAM, UPF, FOAM contribute*

T4.1: Measurement of creativity. Using a confluence of methods to evaluate and inform development in WP5 and WP6.
T4.1.1: Evaluation of artefacts via Consensual Assessment Technique [M12-M32]
T4.1.2: Measurement of creative flow in language use. [M12-M32]
T4.1.3: Assessment and measurement of creativity in test beds. [M10-M32]

[15] Please indicate one activity (main or only activity) per work package:
RTD = Research and technological development; DEM = Demonstration; MGT = Management of the consortium.

T4.2 [M18-M36] : fMRI experiment for investigating creative use of technical language
T4.2.1: Developing an fMRI paradigm [M19-M22]
Using tools developed through WP5 and WP6, we will be working to develop an fMRI paradigm. The paradigm will consist of 4 conditions:
a. an individual taking part in creative programming on her own using a text based language
b. an individual taking part in creative programming collaboratively using a text based language
c. an individual taking part in creative programming on her own using a visual language
d. an individual taking part in creative programming collaboratively using a visual language
Where conditions a and c act as control tasks for conditions b and d.

T4.2.2: Behavioural testing of fMRI paradigm: [M23-M25]
In order to validate the tasks, we will aim to test 20-30 participants in a behavioural environment. The aim would be to identify the correct difficulty level for the task, collect normative behavioural data, and get feedback from participants which will allow us to confirm that the different conditions are neutral (not evoking any unusual emotional responses), engaging (participants are not drifting off and thinking about other things while performing the tasks), and reliable (i.e., participants are convinced by the interaction condition, and are able to engage in it even without seeing a partner)

T4.2.3: fMRI testing and data analysis [M25-M32]

Twenty subjects (skilled live programmers) will be recruited and scanned in an MR system operating at 3T (Philips Ingenia). Cerebral vascular response to task will be recorded using BOLD fMRI (nNordic Neurolab). A time series of approx. 175 scans will be performed with a repetition time (RT) of 3.0s. At each scan "time point," 35 contiguous, transaxial slices parallel to a line bisecting the AC-PC will be acquired using a T2* weighted, gradient-echo, single–shot Echo Planar Imaging (EPI)-based technique.

Data will be analysed using SPM. Two main contrasts will be considered:
a. Collaborative programming using a text based language > programming alone using a text based language
b. Collaborative programming using a visual language > programming alone using a visual based language

T4.3 [M19-M32]: Gaze-tracking
As well as examining the brain regions that are involved in creative interaction, we hope to develop an understanding of the nature and quality of such interaction by using eye-tracking technology. In particular, we would like to examine how visualisation tools affect users interaction:
1. Do users tend to examine the other party's screen more or less often when using a software package enhanced by visualisation, and
2. Does the use of visualisation affect their satisfaction with the creative process and/ or the end result.

T4.3.1 Design of stimuli and qualitative questionnaire [M19-M25].
Using the same new programming tools as for the fMRI study, a paradigm suitable for the eye-tracker environment will be developed. In this set-up, the user screen will be split into 'my screen' and 'my partner's screen'. In one condition, this will include only text based screen, but in the other condition the screen will be split into four parts, where each partner has both a text based and a visualisation screen available.
In addition, a one page short questionnaire will be constructed to measure the user's satisfaction from the tool, the nature of the interaction and their satisfaction from the final product.

T4.3.2 Eye gaze and qualitative data collection [M25-M32].
The same twenty subjects from the above fMRI study will be tested in the eye-tracking lab in Sheffield. Eye-gaze information will be recorded using SMI system, and qualitative feedback on the user's satisfaction will be measured afterward using a questionnaire.
Paired individuals will be teamed and given a programming task, with eye-gaze information recorded from one partner at the time (then partners swap). The participants' screen will be divided into regions of interest (ROI) that include 'own screen' and 'partner screen', with sub regions including either visual or textual based information. Number of gazes on each ROI, and patterns of gazes between ROI's will be recorded and analysed using SMI software.

Risks Analysis and **associated contingency plans**

In terms of evaluation, key risks will be evaluations taking too long to feed back into development design processes, and evaluations being inconclusive. Such concerns will be continually monitored by the Scientific Manager, who will ensure problems are identified and methodologies and techniques adjusted accordingly.

An important risk to the project may be posed by the difficulty to recruit suitable subjects, i.e. live programmers who are able to, and willing to participate in an fMRI study. To address this risk, we apply for additional funding in order to be able to offer participants appropriate rewards for their time, inconvenience and travel, and we hope that this will be sufficient. However, while we are aiming for 20 participants, the minimum number of participant required for meaningful statistical power is 12, and we are confident that this number can be recruited within the available time frame.

Deliverables (brief description) and month of delivery

D4.1.1 Evaluation of artefacts via Consensual Assessment Technique [M16,M24]

D4.1.2 Measurement of creative flow in language use [M13,M19,M25]

D4.1.3.1 Initial testbed evaluation method and plan [M14]

D4.1.3.2 Testbed evaluation report [M32]

D4.2.1 A map of brain areas involved in the communicative process of programming using text / visual based programming tools [M32]
D4.2.2 Eye-gaze data and analysis comparing interactive and non-interactive programming, along the with different patterns of gaze evoked by text and visual based tools [M32]
D4.3 A set of **behavioural measures** acquired to evaluate the interactive process and the satisfaction from the final product, analysed and evaluated against both fMRI and eye gaze data. These results will much advance our understanding of human creative communication, and the role linguistic, and non-linguistic methods may play in such interactions. Further, these results will help to shed light on the processes involved in live programming, and how creativity may be encouraged by designing tools that enhance and support fruitful interaction [M33]

Work package number	5	**Start date or starting event:**	M1			
Work package title	Feature prototypes: design interventions in creative practices					
Activity type[16]	RTD					
Participant number	1	2	**3**	4	5	6
Participant short name	UNIVLEEDS	USFD	**UPF**	UCAM	FOAM	AU
Person-months per participant	15	0	**20**	9	12	3

Objectives

A series of design interventions in the support of creativity informed by research in WP3 and WP4. Experimental design interventions will include live coding, tangible interaction, visualisation, auditory display, integrated open data and rapid fabrication / graspable data. These interventions will take the form of small scale experiments in professional contexts examining specific creative aspects identified and formalised through WP2; disruptive, challenging experiments in unfamiliar contexts; and larger scale experiments in uncontrolled public contexts. They will explore and assess individual features across multiple domains, for later inclusion in the design of the final domain-specific systems built in WP6.

The key objectives of WP5 are:

Integrate all the knowledge previously acquired in WP3 and WP4

Design and implement prototypes to be used in interventions with the goal of testing the developed ideas and collect experience from them

Accumulate all preliminary experience in order to give the essential knowledge for the development of the final technologies to WP6 processes

Description of work

Partners involved: UPF leads, UNIVLEEDS, UCAM, FOAM, AU contribute.

T5.1.1 [M1-M8]: Prototype framework development
Define tools and methodologies for processing data from WP2 and WP3 for creating a development framework. This includes the creation of a catalogue to classify and rank the needs of the future interventions and prototype a framework for these interventions.

T5.1.2 [M8-M20]: Integrate knowledge gathered in WP3
As a continuous effort, the knowledge acquired in WP3 should be used to improve the prototypes and interventions.

T5.2 [M5-M7]: Review existing technologies to be used/adapted/expanded for the prototypes.
Several existing technologies should be assessed in terms of their possible role in the building process of the prototypes. This includes studying the adequacy of different alternatives in the fields of Embedded technologies, Live coding environments, Tangible, tabletop and mobile interfaces and frameworks and Gesture recognition and control.

T5.3: Design interventions. Make interventions in professional creative testbeds, as specified in WP2.
T5.3.1: Live coding [M8-M24]

- Investigate revision control in a live coding session, for capture, and visualisation of development, to aid creative reflection and re-exploration of possibilities.

[16] Please indicate one activity (main or only activity) per work package:
RTD = Research and technological development; DEM = Demonstration; MGT = Management of the consortium.

- Trial the use of live language interfaces in engaging third party stakeholders in creative exploration.
- Investigate the role of liveness in Functional Reactive Programming for open exploration of time-based relationships.

T5.3.2: Tangible interaction [M8-M24]

- Tangible interaction technologies will be developed to create generic frameworks for the creation of tangible systems, environments where live coding is not tangible, but makes use of tangible capabilities and tangible systems supporting (tangible) live coding.
- Investigate implications of consumer level rapid fabrication.
- Also efforts into presenting data as tangible representations.

T5.3.3: Audio/visual feedback in programming [M8-M24]

- Visualisation of data structures.
- Visualisation of digital processes.
- Sonification and auditory display.
- Combined approaches in visual programming.

T5.4: Iterative local evaluations of feature prototypes [M3-M36] Prototypes of features will be evaluated locally with small groups of users to provide rapid iterations for feeding back into T5.3, in-keeping with Agile development methodology.

Risks Analysis and associated contingency plans
Inability to find spaces, workspace contexts and subjects suitable for the interventions are significant risks. Those can be addressed by using the consortium member and partner owned spaces, activities and related personnel, as well as in-house testing where necessary.

Deliverables (brief description) and month of delivery

D5.1 Framework for feature prototype interventions [M9]
D5.2 Review of base technologies for new design features [M7]

Prototypes of design features in language-based creative support tools, assessed in professional creative testbeds
D5.3.1 Agile prototype development report – initial and final [M14, M24]
D5.3.2 Agile evaluation report [M24]

Work package number	6	**Start date or starting event:**	M7			
Work package title	New tools and environments to support human creativity					
Activity type[17]	RTD					
Participant number	**1**	2	3	4	5	6
Participant short name	**UNIVLEEDS**	USFD	UPF	UCAM	FOAM	AU
Person-months per participant	**18**	0	20	10	14	5

Objectives

The field studies carried out in WP2 (T2.2, T2.3, T2.4) will provide a range of domain specific problem spaces. We will design prototypes around these findings and will continue on-going engagement with the professional partners using agile methodology. This will allow project partners and creative professionals to become more deeply involved in the development process and utilise related evaluation inputs from WP4.

Specific key objectives are:

- To relate, connect and integrate work from all previous work packages.
- To improve present and future development of domain-specific creative support tools
- To design domain-specific technical language environments to support creativity for evaluation within the specific domains
- Provide software engineering guidelines including agile methodology for use by all partners involved in development
- To facilitate and respond to end-user design input including through evaluation
- To integrate new tools with existing systems and user communities

To generalise results for wider use

Description of work

Partners involved: *UNIVLEEDS leads, UPF, UCAM, FOAM, USFD, AU contribute*

T6.1 Architect a software and hardware framework for creative support tools. [M7-M28]
This framework will consolidate existing consortium-developed technologies such the tangible interaction of UPF's Reactable (and related systems), realtime 3D environment of FoAM's Fluxus, audio synthesis and signal analysis of SuperCollider via Cambridge's Overtone, and the capabilities of Functional Reactive Programming techniques actively explored by Leeds. New systems will also be developed from prototypes explored in WP5 into a coherent framework, with continued input from the speculative work in WP3 and WP4. The systems architecture will specify communication methods (e.g. with a simple JSON-based API) supporting an API communicable across high level network protocols such as HTTP/REST and OpenSoundControl. A central component will be a robust language engine which includes mechanisms for persistent state and the storage and retrieval of process histories.

T6.2 Subsystems for supporting evaluation. [M8-M12]
These subsystems will include a history mechanism based on established revision control systems, high-resolution mouse, keyboard and screen capture, and integration with physiometrics including eye-tracking systems.

T6.3: Domain specific creative languages.
Specifically to produce systems for collaborative creativity within the target domains:

[17] Please indicate one activity (main or only activity) per work package:
RTD = Research and technological development; DEM = Demonstration; MGT = Management of the consortium.

T6.3.1 Music technology. [M10-M28]
Live coding for professional musicians and sound designers [Lead: Leeds, Expert/stakeholders: Reactable/TOPLAP]

T6.3.2 Specific niches in design. [M10-M28]
Applications of live creative technology to designing visualisations, simulation modelling for science outreach and evidence-based policy applications, with focus on wildlife epidemiology and genetics (Exeter) and urban mobility (Skibsted Ideation). Systems thinking in industrial design and urban planning, data exploration and visualisation, with shared emphasis on policy making. [Lead: FoAM Expert/stakeholders: Exeter/ESI, Skibsted Ideation]

T6.4 Porting to neighbouring domains. [M25-M32]
Taking domain-specific tools developed with stakeholders in T6.3 and assess applicability to other contexts, for example independent games (with associated partners Tale of Tales) audio-visual installations, experiences for web and mobile, and shareable digital artefacts (with associated partners FIELD).

T6.5 Evaluation of prototypes and tools in professional use cases [M24-M36]
Domain specific tools developed through T6.3 will be evaluated both through controlled studies and in their normal working environments, drawing from the context of creative industries and related professional areas defined in WP2. The evaluation will provide iterative feedback throughout development following Agile methodology, where results of sprints are evaluated with input from the relevant professional SME and case study partners with whom we have pinpointed areas to develop creative tool prototypes for.

T6.6 Documentation and packaging of tools during development. [M10-M32]

Risks Analysis and associated contingency plans

The development process will have evaluation and design at its core, and excellent skills and experience in agile development, software engineering, hardware design and electronics will offset risks associated with overrunning deadlines, poor specification of requirements, and poor systems engineering.

Deliverables (brief description) and month of delivery

D6.1 Software development guide. Outlining agile methodology for development and in-line evaluation throughout WP6 and where relevant, WP5. [M3]
D6.2 Framework architecture development – initial and final report. [M9, M30]
D6.3 Creative support systems for Music Technology, packaged for dissemination [M28]
D6.4 Creative support systems for Design, packaged for dissemination [M28]
D6.5 Documentation of evaluation results for dissemination in academic and industrial contexts [M32]
D6.6 Technical and user documentation review for LIMINAL tools. Report covering documentation written throughout design and development process. [M32]

Work package number	7	**Start date or starting event:**	M3			
Work package title	Demonstration					
Activity type[18]	DEM					
Participant number	**1**	2	3	4	5	6
Participant short name	**UNIVLEEDS**	USFD	UPF	UCAM	FOAM	AU
Person-months per participant	**10**	3	6	5	6	5

Objectives

The consortium has significant experience with performance and public arts contexts (UNIVLEEDS, FoAM, UPF, AU, UCAM). Various activities will be used as demonstration opportunities to engage new industry contacts and will include public workshops at media arts festivals (eg. Transmediale, Berlin; Ars Electronica, Linz) and gallery installations (eg. Arnolfini, Bristol; Kunsthal Aarhus), LIMINAL will be present at Music Hack Days, and take advantage of UPF's connections with the Sonar Festival in Barcelona. These highly creative public contexts will provide the project with media attention as well as engaging a wide variety of creative SME's and startup companies on the lookout for innovative technologies. Some of these events will be organised specific to the project as part of conferences set up as part of T8.4.

This work package will take work developed in WP5 and WP6, adapted for demonstration in short events, with feedback gathered as short-term evaluation, to influence on-going development.

Description of work (possibly broken down into tasks) and role of partners

Partners involved: *UNIVLEEDS leads, all contribute*

T7.1 LIMINAL hack day [M13-M19]
Instigating a hack day to introduce developers to LIMINAL technology over an intensive period, co-funded by commercial funders and co-located with a major industrial event.
T7.2 Interactive installations [M13-M32]
Work with artists to showcase LIMINAL technology in creative arts and design contexts, supporting applications to major arts events such as Ars Electronica and Transmediale.
T7.3 Industrial demonstration events [M3-M33]
Engaging with industrial events, both by invitation and by participation in industry fairs. This will include major creative industries events such as SonarPro, MIDEM, and ISEA (International Symposium for Electronic Arts).

Risks Analysis and associated contingency plans

Significant experience in event organisation, marketing and hosting within the consortium will offset any risks associated with poor scheduling, low attendance and over-dependence on sponsorship.

Deliverables (brief description) and month of delivery

D7.1 - Hack day report. Evaluating outcomes and feedback. **[M20]**
D7.3 - Industrial demonstration report. [M33]

[18] Please indicate one activity (main or only activity) per work package:
RTD = Research and technological development; DEM = Demonstration; MGT = Management of the consortium.

Work package number	8	**Start date or starting event:**	M1			
Work package title	Dissemination and Diffusion					
Activity type[19]	MGT					
Participant number	1	2	3	4	**5**	6
Participant short name	UNIVLEEDS	USFD	UPF	UCAM	**FOAM**	AU
Person-months per participant	3	2	4	3	**4**	2

Objectives

This WP aims to disseminate the project results and awareness of the project in two main directions. To a professional creative audience in particular, and a wide and diverse general audience including; interested public, academic and industrial audiences. This will involve public events showcasing the work in the context of artistic performance, The LIMINAL project website which will be regularly updated to present information, updates and reports from the project. It will include a development blog, a public software repository and presence on social networks.

Professional partners (in particular the associated partners) will be expected to adopt relevant tools and techniques into their professional practice. Software developed will be made publicly available using open source development methods. Potential partners for technology transfer and investment will be identified during the project and involved where possible. Industrial conferences and networking events will be identified and targeted for presentation of research outcomes (see section 3.2 for more detail) The design guide for creative tools [T2.5] will also form an essential avenue of dissemination of the research outside of academic venues, to relevant companies, organisations and individuals.

Strategy for collaboration with other EU initiatives is discussed in more detail in section 3.1.5, but will include projects from ICT Call 8 such as IdeaGarden, researching creative learning tools and Collage, concerned with studying creativity in social networking space. Also concerned with education, Citizen Cyberlab is focused on mobile applications in citizen science so are the ideal project to collaborate with over the citizen science element of the collaboration with Exeter/ESI. LIMINAL will be able to provide GHOST (FET Open) with professional use cases in music and design and connections with Reactable Ltd.

Description of work

Partners involved: *FoAM leads, all partners contribute*

T8.1 Project website and periodic updates [M1-M36]
An online presence is essential to the success of any dissemination strategy, and will include a project website, software repository and presence on social networks. The dedicated website will be set up and regularly updated to disseminate information, updates and reports from the project. The website will also play host to prototypes and any other experiments from WP6 designed for use in a web browser, in order to provide easily digestible demonstrations of the research along with possibility of public feedback and further outreach.

T8.2 Publications and diffusion [M1-M36]
Dissemination in academic communities will primarily occur through publication of project results in widely accessible and, where available, Open Access (OA) science and technology journals, as well as through conferences and other channels. A web presence and OA publications are seen as essential to reach audiences outside academic institutions. Publication of periodic press releases, online discussion and popular science press will be used to reach a wider general audience.

[19] Please indicate one activity (main or only activity) per work package:
RTD = Research and technological development; DEM = Demonstration; MGT = Management of the consortium.

Potential conferences and journals to target for dissemination include:

Music technology

- International Computer Music Conference
- New Interfaces for Music Expression
- Computer Music Journal

Creativity

- International Conference on Computational Creativity
- ACM Creativity and Cognition

HCI

- CHI - ACM SIGCHI Conference on Human Factors in Computing Systems
- BCS HCI
- NORDCHI - Nordic Conferences on Human-Computer Interaction
- International Journal of Human-Computer Studies
- ACM Transactions on CHI
- Interacting with Computers

Programming HCI and visual programming

- Psychology of Programming Interest Group
- International Symposium for End User Development
- IEEE Visual Languages and Human-Centric Computing
- Journal of Visual Languages and Computing

Technology and Creativity

- European Conference on Technology Enhanced Learning
- European Conference on Computer-Supported Co-operative Work

Tangible, tabletop and gestural interaction

- International Conference on Tangible, Embedded and Embodied Interaction
- ACM Interactive Tabletops and Surfaces
- Personal and Ubiquitous Computing

Psychology/neuropsychology of creativity and language

- International Conference on Language and Communication
- Journal of cognitive neuroscience
- Neuroimage (journal)

Visual interaction and serious games

- ACM SIGGRAPH
- Design for interactive systems (DIS)

Participatory design and digital culture

- Participatory Design Conference
- Critical Computing conference
- Computational Culture journal
- Leonardo journal
- Fibreculture journal

T8.3 Event organisation [M6-M36]
To engage with related events and to organise LIMINAL events including at least one international conference.

T8.4 Collaboration with other European initiatives [M1-M36]
Establish strategic alliances with other ongoing initiatives as well as participation in parallel activities, dedicated workshops, consultation meetings and other organised events.

T8.5 Market survey and exploitation [M22-M36]
An Open Access and FLOSS policy to encourage technology transfer will be part of a comprehensive Exploitation Strategy along with the exploitation of work developed within the project. Technology transfer to creative industries will be targeted via events such as SIGGRAPH Realtime Live! demonstrations, Art Gallery exhibitions, performances and Emerging Technology strands for reaching the music, games, film and post production communities. Presentations at events such as TIGA, Serious Games Institute UK, will reach further specialised audiences. Increasingly the independent games community is a highly active proponent and test bed for emerging technologies before being taken up by the larger commercial games industry and an important thread of our impact will target events such as game jams, local independent games festivals (eg. IGF, ExPlay UK) as places to present and demonstrate our outcomes. We will include particular focus on the exploitation of creative technology for matters involving policy makers, public and journalists, via associated partners Exeter University and Skibsted Ideation. We will be providing creative technology solutions involving issues of wide public interest in the areas of ecology, wildlife and livestock disease, urban planning and transport which will command media attention. Academic publications in these fields (for example Molecular Ecology Resources, Bioinformatics) will reach out to researchers who will be keen to exploit LIMINAL's outputs to explore new solutions for creating and working collaboratively on complex models and large datasets.

T8.6 Dissemination of the design guide [M12-M33]
Preparation of strategies for dissemination of the design guide output T2.5 for non-academic companies, organisations and SME's making tools for the creative sector, which may include strategies such as blog articles embedding interactive examples of interface mechanics with text linked with the project research.

Risks analysis and associated contingency plans

A primary risk factor for exploitation/dissemination involves barriers for introduction of tools to the market. This is mitigated by the close and early involvement of the associated partners and stakeholders along with the open source IPR strategy of the project as a whole. The factors mean that results will be available quickly and be able to involve feedback from interested parties in an effective manner.

Deliverables (brief description) and month of delivery

D8.1 Project website [M3]
D8.2 Strategy for dissemination and exploitation, including Open Access and FLOSS policy document [M8]

Table 1.3e Summary of effort

Summary of effort

Partic. no.	Partic. short name	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	Total person months
1	UNIVLEEDS	15	2	6	14	15	18	10	3	83
2	USFD	0	0	0	16	0	0	3	2	21
3	UPF	0	12	8	7	20	20	6	4	77
4	UCAM	0	4	19	3	9	10	5	3	53
5	FoAM	0	5	6	6	12	14	6	4	53
6	AU	0	11	7	3	3	5	5	2	36
Total		15	34	46	49	59	67	35	18	323

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Section 2. Implementation

2.1 Management structure and procedures

2.1.1 General management structure

The management of the LIMINAL project has been designed according to the size, scope and objectives of the project. The streamline and effective management structure (see Figure below) consists of (i) Project Office; (ii) Project Management Board (PMB); (iii) Work Package Managers; (iv) Dissemination and Exploitation Board; and (v) External Advisory Board.

The LIMINAL management structure ensures the realisation of the project objectives with efficient and timely delivery of tasks and project Deliverables and reporting. The LIMINAL Consortium Agreement (CA) formally details the decision making structures and tasks of the Consortium, and the responsibilities of Partners regarding the financial and scientific management of the project. It also sets out a clear dissemination and use of knowledge plan.

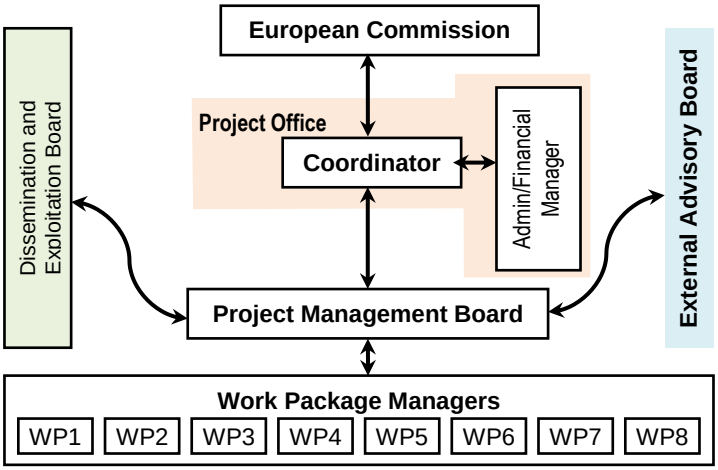


Figure 2.1.1.1: LIMINAL management structure

The project will be coordinated by the University of Leeds (UK), which has considerable experience in the management of European and international research projects. Day-to-day operational management is conducted by the LIMINAL Project Office, which consists of the Coordinator (Dr. Kia Ng) supported by a dedicated Admin Officer (Admin/Financial Manager) with additional support by the Faculty's Research Office and Finance Office. Dr. Ng is experienced in participation and coordination of a range of successful European and other international and national large scale projects, international networks and conferences, with particular interests in interdisciplinary collaborative research. The Coordinator is also supported by the Scientific Manager (Dr. Alex Mclean) who is an active researcher and network coordinator in the field of Live Coding, with a diverse CV including senior software engineer in the creative industries and internationally performing musician. The Coordinator is responsible for overall coordination, strategies and management of the project, to ensure overall scientific and technical management and progress.

The Project Management Board (PMB) consists of one representative from each project partner, chaired by the Coordinator. It represents the general assembly of the project and is responsible for discussing the general RTD direction, and for ensuring the completion of the work plan effectively as scheduled. The PMB advises the Coordinator, on strategic, management and policy issues, modifications to the work plan, changes to partnerships, overall financial and technical performance of the project, and assists any remedial actions as necessary. The PMB will meet face-to-face during 7 project meetings (1 at kick-off meeting and 2 at project meetings annually). It will also remain in regular contact via email, and/or video conferencing with at least one electronic meeting per month. Additional meetings can be convened in the case of emergency. The PMB responsibilities include:

- Decisions concerning the work plan, progress and any major changes;
- Financial and budget-related matters;
- Decisions with regard to any amendment of the terms of the EC contract and Consortium Agreement;
- Settling any disputes arising from project implementation;
- Making proposals to the Contractors concerning the remedies for any breach-of-contract and the termination of agreement in case of a defaulting contractor or member;
- Decisions concerning possible premature completion/termination of the project;
- Decisions on addition or removal of partner;
- Management of all IPR-related matters, legal, contractual and ethical aspects;
- Producing progress reports every 6 months; Producing final reports according to the list of deliverables;
- Managing press releases and joint publications by the partners with regard to the project;

All decisions will be taken by consent; where voting is necessary, each representative has one vote and may appoint a proxy to attend and vote at any PMB meeting. In case of deadlock, the Coordinator has a casting vote.

A team of Work Package (WP) Managers is appointed. Each work package is managed by a work package manager who is answerable to the Consortium via the Coordinator, and is responsible for the timely accomplishment of tasks and delivery of deliverables, to budget. The WPs and their leaders/managers are:

- WP1: Project Management (Dr. Kia Ng, UNIVLEEDS);
- WP2: Creative cultures as experimental testbeds (Dr. Geoff Cox, AU);
- WP3: Language meta-design studio (Dr. Alan Blackwell, UCAM);
- WP4: Evaluating and understanding creativity in language-based interaction (Dr. Yael Benn, USFD);
- WP5: Feature prototypes: design interventions in creative practices (Prof. Sergi Jorda, UPF);
- WP6: New tools and environments to support human creativity (Dr. Alex McLean, UNIVLEEDS);
- WP7: Demonstration (Dr. Kia Ng, UNIVLEEDS);
- WP8: Dissemination and Diffusion (David Griffiths, FoAM).

Key responsibilities of the Work Package Managers include:

- defining common work methodologies, standards and tools;
- monitoring the results achieved and reporting to the Coordinator and Partners of any events within the WP that may affect the planned activities and schedule;
- validating the deliverables (reports and prototypes) produced, assuring the quality and schedule of the deliverables;
- collecting the suggestions of peer reviewers and discussing them; Each Deliverable requires two peer reviewers and sign off by the WP leader to the Coordinator;
- estimating metrics defined for the assessment of technical, research and scientific aspects;
- maintaining a continuous technology watch, collating evidence and proposing eventual changes to be performed, in order to maintain the innovation of the project relative to progressions in the state of the art during the project's development.

The Dissemination & Exploitation Board (DEB) is led and chaired by the Dissemination Manager (David Griffiths, FoAM) of the SME partner who manages WP8. The DEB consists of one representative from each project partner and will convene during each project meeting and with at least one electronic meeting per month from M1; Key responsibilities include:

- active dissemination and exploitation of the results generated within the project, interacting with the stakeholders, professional communities, and open source communities.
- definition of reviewing and approval procedures for publications and press releases of the Project;
- estimating metrics defined for the assessment of the Dissemination and Exploitation area;
- ensuring that progress and targets are properly considered;
- continuously monitoring quality and usability of the outcomes and results;
- co-ordinating the dissemination and exploitation activities according to the plan.

An External Advisory Board (EAB) will be drawn from appropriate research and creative professional communities including Associate Partners and other Stakeholders. The EAB consists of up to 8 members nominated by Partners, chaired by Dr A. McLean, and will meet at least twice over the lifetime of the project. There are 5 Associate Partners (Skibsted Ideation, FIELD, Reactable Systems, Tale of Tales and

Exeter/ESI) who will support prototype development in WP5 as well as providing feedback on the projected as a whole through the EAB. The EAB chair will report to the PMB. Copies of Letters of Intent from the Associate Partners are attached in Appendix A.

Partners involved in each WP will share responsibility in order to work effectively and economically according to the plan. A Consortium Agreement between the partners will regulate the Partners' relations during the project, taking into consideration the General Conditions stated in the EC contract, including IPR protection. The Consortium agreement will also include provisions for a conflict resolution procedure. Each Project Partner will:

- participate in project meetings, reporting on past, current and future activities/plans;
- ensure that their work is carried out according to the work programme;
- manage one or more work packages, in accordance with the methodologies defined.

Each partner provides a Management, Administrative, Dissemination and Exploitation representative for the corresponding board. The corresponding board will be changed according to the addition and/or removal of some partners.

The project kick-off meeting, the above-mentioned Boards will discuss and define:

- the overall workplan for the project and the detailed plan for the next 18 months, and the forthcoming activities of the first 6 months: fixing deadlines and assigning work to people and not only to partners as a whole;
- the working methodology;
- the procedure for keeping record of costs and resources;
- a schedule of meetings and events for the year.

2.1.2 Financial/administrative management

The day-to-day operational management of the project will be carried out by a dedicated Admin Officer (0.4FTE) with additional managerial and administrative support from the Faculty Research Office. Further additional support will be provided by the University of Leeds European team within the Central Research & Innovation Service. Both teams have considerable experience of managing EU projects. Legal and IP support is also available through the European Office and Contracts team. Furthermore each partner will be supported through their own administrative and financial officers.

The Coordinator is responsible for:

- serves as the primary contact and Representation of the Consortium to the Project Officer, the Commission and external relations;
- Manage relationships and correspondence with the Commission and third parties, including the co-ordination of the negotiation of the EC Contract and the details of the Consortium Agreement with the Boards and all Partners;
- Chair and schedule the meetings of the PMB;
- Submits all reports including Deliverables and financial statements to the Commission;
- Administering and distributing the Community financial contribution regarding its allocation between
- beneficiaries and activities, in accordance with the grant agreement, and without unjustified delay, as well as
- informing the Commission of the distribution and date of transfer;
- Coordinates at consortium level of the scientific, technical progress and development of the Project, and oversee overall legal, contractual, ethical, gender issues, financial and administrative management of the consortium;
- Review and production of reports (periodic activity reports, deliverables, plan for use and dissemination etc) to verify consistency with the project task before transmitting them to the Commission;
- verify that the work programme and deadline are respected and issues resolved in due time;

Travel and subsistence for independent contributors, eg External Advisory Board members, and invited experts joining project events will meet the following criteria: following usual accounting and management principles and practices of the Coordinator and will be used for the sole purpose of achieving the objectives

of the project and its expected results, in a manner consistent with the principles of economy, efficiency and effectiveness and will be on a non-recurrency basis (up to 3 times a year/expert).

The Coordinator and Admin Officer will keep in regular contact with partners, as necessary, via email, telephone and/or web/video conferencing.

2.1.3 Consortium Agreement

A consortium agreement (CA) signed by every Partner, and required under Framework VII, will be ratified prior to the start of the project and signature of the grant agreement. The Consortium Agreement (CA) will be based on the widely accepted DESCA model adapted to a Small Project (Version 3.0 March 2011) since the project as conceived will not require a complex governance structure.

The Consortium agreement will include:

- The internal organisation of the Consortium including decision making procedures;
- Rules on dissemination and use, and access rights;
- Financial section with budget limits, and the distribution of the financial contribution;
- Specific clauses relevant to ICT projects such as clauses for using open source software;
- The settlement of internal disputes;
- Specification of quorum and majority; and,
- Liability, indemnification and confidentiality arrangements between the partners.

The Financial section will detail term of payment whereby financial contribution of the EC to the Project will be distributed by the Coordinator, after receipt from the EU-Commission without undue delay, according to: (i) the consortium budget, (ii) the approval of reports by the EC and (iii) the tasks to be carried out by the partner, taking into account the amounts already paid for the reporting period concerned (any pre-payment and interim payments).

Foreground results, intellectual property and innovation management
Considerable background information will be brought to the project by partners and significant foreground results are anticipated to be generated. The consortium recognizes that management of foreground results generated is critical for the long-term success of the project. We plan to develop all software as Open Source (under OSI Approved Licences) and publications as Open Access as much as possible. The IP rules will be embodied in the LIMINAL CA.

2.1.4 Contingency and risk management

Risk Management will be adopted to manage project issues and conflicts. During the initial start-up of the project, a risk assessment will be conducted to identify risks associated. The Coordinator and WP leaders will be involved in the assessment. This will establish a central risk register. Risks will be assessed for their impact on the project and the probability of the risk materialising. Risk mitigation plans will be established to reduce the impact and likelihood of the risk occurring, as well as action plans to manage the risk should it arise. This integrated approach to risk management will enable the Coordinator effectively to control intellectual property, market, technology, people, management and other implementation risks that may arise. Examples of such risk are presented in Table below.

The risk register will be reviewed periodically to monitor known risks and log any new risks. Issues raised will be first reported to and logged by the work package manager, who will assess the implication of the issue and associated risks, and seek to identify a resolution. Any mediated solutions, alternatives, assumptions or associated risks identified will also be logged along with risk mitigation plans. Unresolved issues or conflicts impacting the project plan will be escalated to the appropriate WP leader, Coordinator and then if required to the PMB. Should the need arise the necessary PMB will be convened to vote on the issue or dispute in question.

A review of the programme will be conducted every six months, with a detailed review every year. During the review, a more detailed plan will be assembled for the coming period, following an analysis of the programme progress. A PERT analysis of the more detailed plan will be conducted, which will look at

optimistic, expected and pessimistic activity durations. This will also help manage and enable project contingency planning.

2.1.5 Dispute and conflict resolution

As with all projects, unknown and unplanned events may occur throughout the lifetime of the project. Examples of these may include: Failure to produce deliverables by a partner(s); Loss of a partner(s) owing to bankruptcy; Loss of a partner(s) owing to arising and unforeseen conflicts of interest; and, Disputes between Consortium members.

Such disputes and conflicts will be resolved, wherever possible through mediation. The partner in dispute will first present their case to their respective WP leader and then to the Coordinator. The aim will be to try and resolve the issue in as simple a manner as possible. However, if the partner is not satisfied with the outcome then the dispute will be presented to the PMB, who will vote on the dispute in question.

2.1.3 Quality assurance

A Project Quality Plan will be established by the PMB, outlining the quality assurance activities and framework of the programme. The Plan will be maintained throughout the period of the programme and provide information on:

- Programme profile including a summary of each WP, the overall programme objectives, budget, timescales and partners;
- Standards & procedures, include:
  - Report reviews; standard templates for recurring reports & documents including agenda, meeting minutes, status reports, deliverable sign-off, issue log, risk log, risk mitigation plan and quality assurance documents; procurement procedures; deliverable sign-off procedures; configuration management & version control procedures; and, task assignment procedures.
- Programme communication plan, containing information on:
  - Team contact list, with address, phone and email details; roles & responsibilities of partners and teams; frequency of formal status reports from WP managers, and Coordinator; and, the frequency of board meetings.

Table 2.1.3.1 Project management risks analysis

Risk	**Probability**	**Impact**	**Action**
Failure to conclude Consortium Agreement	Low	Severe	Ensure early negotiation of CA; Use of third party mediators to facilitate agreement if required.
Withdrawal of partners	Low	High	Try and resolve any conflict causing threat of partner withdrawal through conflict resolution; The consortium has been carefully assembled so a back up cover is possible in most cases. Failing that, suitable alternative partner will be recruited.
Failure of WP managers to manage WPs effectively	Low	High	Use alternative partner from within WP to manage
Failure to develop new technology as per description of work	Medium	Severe	WP managers to supply individual reports and report developments to Coordinator, who will monitor developments; Bring in alternative partner if necessary
Inadequate communication between WPs	Medium	Medium	Coordinator and managers to ensure adequate channels exist to facilitate communications between all Consortium partners including: emails, telephone, project website, reports, regular meetings…
Failure to deliver Project Reports to plan	Medium	Medium	Coordinator/WP1 Manager to issue request for reports 2 months in advance of deadline; Suitable project management structures in place to remind participants and WP leaders when reports are due following request for information; Ensure the sharing of data where this is needed for the successful delivery of dependent WPs;

2.2 Individual participants

University of Leeds (UNIVLEEDS), Interdisciplinary Centre for Scientific Research in Music (ICSRiM), UK

The University of Leeds is acclaimed world-wide for the quality of its teaching and research, and continues to be ranked within the top 100 universities in the QS world rankings. Leeds is one of the largest universities in the UK with an annual income of €649m and over 33,000 students (over 6870 from overseas) and approximately 7,540 staff of 99 different nationalities, attached to 560 different undergraduate and 300 postgraduate degree programmes. In 2010/11 its annual research income exceeded €157 m of which 7.9% was derived from EU awards. The University of Leeds is currently successfully co-ordinating 82 FP7 projects and is a partner in a further 116 FP7 projects. A further 16 FP7 grants are under negotiation; 6 of which are co-ordinated by Leeds. It has hosted/is currently hosting 43 Marie Curie Individual Fellowships and Integration Grants and is currently co-ordinating 12 FP7 Marie Curie Initial Training networks and is a partner in a further 14. Leeds total income from FP7 is in excess of €84m with a further €16.5m under negotiation. Under FP6 Leeds was involved in over 200 funded projects that were awarded research income of over €60m. The University of Leeds therefore has a very successful track record of managing both individual fellowships and large international projects and of hosting visiting researchers of all career stages for both training and knowledge transfer purposes.
The University of Leeds Interdisciplinary Centre for Scientific Research in Music (ICSRiM; www.ICSRiM.org.uk) specialises in multi- and inter-disciplinary research and involves members of staff from the Schools of Computing, Electronic Engineering, Music, Mathematics, Psychology, Physics, Earth Sciences, and Sport and Exercise Sciences, as well as external members. ICSRiM provides a venue for research and development in a wide range of interdisciplinary research areas, including: Creative human-computer interactions, gesture interfaces, virtual and augmented instruments, modelling and simulation of expressive performances; Analysis, encoding and transcription of musical information and symbolic music representation; Music Psychology and its technological applications.
EU supported projects at ICSRiM include: MAESTRO IST FP6 STREP, Technology-enhanced learning for music. Key contributions include 3D motion visualization and sonification, creative interface, posture and gesture analysis and coordination of the project. AXMEDIS IST FP6 IP. For this project UNIVLEEDS key contributions include the programme and publication area, metadata editor and mapping, and user group. Interactive MUSICNETWORK, IST FP5, which aims to reduce the technological gap from technology providers and content owners and distributors.

Dr Kia Ng. The work that Dr Ng leads as Director of the Interdisciplinary Centre for Scientific Research in Music (ICSRiM, www.leeds.ac.uk/icsrim) includes gestural interfaces, multimodal analysis, interactive multimedia systems, performance technology, music technology and computer music, including the projects mentioned above. Currently, Ng is stream leader of a transformation project, with £0.5M funding from the University, on Human/Technology Interface for performance. Ng's Music via Motion (MvM) and the 3D Augmented Mirror systems allows users to have real-time control of musical sound and visualisation using their physical movement. Ng is a Fellow of the Royal Society for the encouragement of Arts , Fellow of the Institute of Directors, and Fellow of the British Computer Society (BCS).
Dr Alex McLean is a cross-disciplinary researcher in his first academic post as Research Fellow in Human/Technology interface at ICSRiM. He has 25 refereed publications across the computational creativity, psychology of programming, music interaction, and digital aesthetics literature, and completed his PhD thesis "Artist-Programmers and Programming Languages for the Arts" at Goldsmiths, University of London in 2011. His thesis introduced novel performance technologies, and a theoretical approach to creativity of embodied interaction with programming languages. McLean is a network co-ordinator in the Live Coding community, and has been awarded research development funds from the UK Arts and Humanities Research Council. McLean is a prolific organiser of outreach events, including over 100 arts/science seminars and performance events in the UK. He carries out his own live coding performances at international venues.

Other related personnel and researchers from UNIVLEEDS include members of the Centre and the executive committee (www.ICSRiM.org.uk), the School of Music (www.leeds.ac.uk/music) and the School of Computing (www.comp.leeds.ac.uk).

University of Sheffield

The University of Sheffield is among the top ten in the Russell Group, the association of leading UK research-intensive universities, according to the results of the independent 2008 Research Assessment Exercise (RAE). This is an independent review of research quality undertaken by the UK Funding Councils, and is used by them to selectively distribute over £1.3bn of public funds for research. The review evaluated 93% of the University's research 'internationally recognised '(3*) or 'world-leading' (4*). The quality of the student experience is also consistently rated as amongst the very best – The Times Higher Education Student Experience Survey in 2011 placed the University in the top five institutions in It is also a University with the broadest of horizons. It has around 6,000 staff and over 24,000 students from more than 130 nations, and is able to draw on the rich diversity and talent of the University community. The last Teaching Quality Assessment awarded Sheffield grades of "excellent" in 29 subject areas, a record equalled by only a handful of UK universities. This reputation for excellence is also global, with graduates in leadership positions around the world and outstanding performance for research, consistently confirmed by independent assessment internationally.

The Department of Psychology has an excellent reputation for teaching and research. Over the past ten years the Department has received consistently high ratings in all national reviews of research excellence. In the recent Research Assessment Exercise the department ranked 6th in the UK in terms of Research Power (i.e., quality × quantity of research activity) and the RAE particularly commended the quality of the department's research output in the areas of neuroscience and computational modelling. Research is closely integrated with teaching and the Department also received an "excellent" rating in a last review of teaching by the Quality Assurance Agency for Higher Education (QAA).

The purpose-built facility houses state-of-the-art neuroscience and eye-tracking facilities; including provision for brain imaging research and for neurophysical recording from individual cells. There are additional computer facilities for specialised project work and reading room facilities. The department previously attracted numerous ERC grant, with several current funding from the EU Framework 6 and Framework 7.

Dr. Yael Benn completed her PhD in Cognitive Neuroscience at the University of Sheffield In January 2010. The study focused on the role of language in cognition, and the experiments included both behavioural and fMRI studies, with healthy participants and individuals with brain damage to language areas. These studies resulted in two important publications in Neuropsychologia, and a third related publication recently been submitted. Prior to that, Yael attained a 1st class honours in Computer Science with a specialism in Software Engineering from the University of Strathclyde, Glasgow.

Throughout her academic journey, Yael has been able to combine her extensive information technology knowledge and experience, with her passion for understanding the human mind and brain. In April 2010, she was awarded a Wellcome Trust fellowship of £15,000. Since then, she has gained extensive experience in working with both healthy and clinical populations on projects related to language, cognition and communications. Further, she has developed collaborations with a large international network of clinicians and scientists, including working with Bar-ilan University in Israel on a project supported by Google looking at brain regions involved in personal information searches. She is currently employed as a research associate on a large ERC grant to Dr. Thomas Webb, in which she is investigating the neural substrates of goal monitoring and goal directed behaviour. Yael will be working on LIMINAL project with Iain Wilkinson, a professor of Magnetic Resonance (MR) Physics who leads the adult neuroimaging research programme within the Academic Unit of Radiology in the University of Sheffield.

Universitat Pompeu Fabra - Music Technology Group

The Music Technology Group (MTG) of the Universitat Pompeu Fabra in Barcelona, is one of the leading research groups in Sound and Music Computing, combining strengths in basic disciplines such as Signal Processing, Machine Learning and Human Computer Interaction. The MTG has coordinated or been involved in EU projects since FP4, and has participated or lead 15 FP7 projects, mainly under ICT and IDEAS programs (full list of projects is available here http://mtg.upf.edu/research/projects). It has also promoted the foundation of 3 spin-off companies (BMAT, Reactable Systems and Voctro Labs), aiming to transfer mature audio technologies to the market.
MTG is also very active in the organization of dissemination activities including those typically academic (SMC'10 or TEI'13), is very and also activities addressed to promote public awareness and understanding of our field of research such as the Music Hack Days yearly organised since 2010, educational workshops in schools through the Sounds of Barcelona initiative.

Role in LIMINAL: The MTG will carry out research and technology development, mainly in the form of prototypes and small scale experiments in professional contexts, grounded on the use cases specific needs integrating Human-Computer Interaction techniques, advanced interfaces and interaction design (real-time and multi-modal) in WP5 and WP6. In addition, the MTG will be the partner in charge of the organisation of 1 conference event and other dissemination activities such as the Music Hack Day within WP8.

Prof. Sergi Jordà holds a B.S. in Fundamental Physics and a PhD in Computer Science and Digital Communication. He is a researcher in the Music Technology Group of Universitat Pompeu Fabra in Barcelona, and an associate professor in the same university, where he teaches computer music, Human Computer Interaction (HCI), and interactive media arts. His main research interests are in the confluence of HCI and tangible and musical interaction. He has authored more than 20 articles in journals and book chapters and more than 50 peer-reviewed conference papers. He has received several international awards, including the prestigious Prix Ars Electronica Golden Nica. He is currently best known as one of the inventors of the Reactable, a tabletop musical instrument that accomplished mass popularity after being integrated in Icelandic artist Bjork's last world tour, and he is one of the founding partners of the spin-off company Reactable Systems. He has participated in 6 public funded projects both from the EC and the Spanish government (in 2 of them as the PI).

After the Reactable project, Jordà decided to focus on Tangible Interaction (TI), entering non-musical domains, creating tangible programming languages for children, studying the potential benefits of tabletops within special users such as autistic children, refining techniques for the tracking of objects in 3D space, studying augmented communication using tabletops and brain computer interfaces, developing open-source tabletop programming SDKs, analyzing the potential for creativity in tabletop interaction or creating frameworks and methods for the evaluation of complex interaction techniques such as the ones taking place on a collaborative tabletop.

Carles F. Julià is a PhD candidate in Universitat Pompeu Fabra University. He is a computer scientist and master in cognitive science and interactive media. He has worked on research and creation of new Human-Computer interfaces, mainly in Tangible User Interfaces (TUI). He currently works on designing strategies for the recognition of multiuser multitask gestures in non-conventional interfaces.

The Chancellor, Masters, and Scholars of the University of Cambridge

Led by Professor Andy Hopper, the Computer Laboratory is a department within the University of Cambridge that encompasses Computer Science, along with many aspects of Engineering, Technology and Mathematics. It consists of 38 full-time academic staff, 25 support staff, 40 post-doctoral research workers and 154 PhD students. The Computer Laboratory has been a global pioneer in each generation of computer technology since the 1940s, with many fundamental discoveries such as the concepts of subroutines and microprogramming, the first time-sharing operating system in the UK and so on. Building on its long and distinguished history, the Computer Laboratory continues with world class teaching and research. The grade point average for the Computer Laboratory's submission to the latest (2008) UK Research Assessment Exercise (RAE) was the highest of all submissions to Computer Science and Informatics. The Laboratory maintains very close relationships with the many high technology companies in the Cambridge area, and plays an active role as an incubator for new commercial activity

Relevant expertise is the study of cognitive factors in end user programming systems, including the Attention Investment model of abstraction use, the Cognitive Dimensions of Notations framework, and empirical methods for studying the Usability of Programming Languages. Blackwell has been developing end-user programming languages and visual programming languages since 1983, in both professional and academic research settings. The Computer Laboratory has a strong track record of successfully participating in European projects, including the current projects PURSUIT, RECOGNITION, and EIFFEL, and past projects WEBKIT, HAGGLE, PSIRP, and OPEN_TC. Blackwell was a central contributor to WEBKIT, leading the design of an end-user web query language, and was also a key member of the European Network of Excellence EUDNET.

Dr Alan Blackwell is Reader in Interdisciplinary Design at the University of Cambridge Computer Laboratory, with prior qualifications in professional engineering (University of Auckland 1982, NZ Inst Professional Engineers 1988), computer science (MSc Victoria University of Wellington 1989) and experimental psychology (PhD University of Cambridge 1999). He has 12 years experience of designing industrial systems, electronic and software products. He has taught design courses and supervised postgraduate design research students in Computing, Architecture, Psychology, Languages, Music and Engineering, and directs the Crucible Network for Research in Interdisciplinary Design, which has facilitated and coordinated more than 100 interdisciplinary design research projects. His research specialization is in the design and analysis of visual representation use, and the design and evaluation of programming languages for end-user programming applications. He has led and contributed to funded projects in these fields with UK, US NSF, and EU funding. He and his team have carried out consultancy and product design of end-user programming systems for corporate clients including Microsoft, Google, Boeing, Autodesk, Kodak, Hitachi and many others. He has more than 150 publications and patents in end-user programming, visual representation and interdisciplinary design, and has served as founder, chair, steering committee or board member for most of the academic venues in these fields.

FoAM

FoAM is a network of transdisciplinary labs for speculative culture with Its primary studio in Brussels, Belgium. It is inhabited by people with diverse skills and interests – from arts, science, technology, entrepreneurship and design. It is a generalists' community of practice working at the interstices of contrasting disciplines and worldviews. Guided by the motto "grow your own worlds," FoAM studies and prototypes possible futures, while remaining firmly rooted in cultural traditions. FoAM encourages speculation about the future by modelling it in creative experiments that allow alternative perspectives to emerge. By conducting these experiments in the public sphere, we invite conversations and participation of people from diverse walks of life. FoAM studios are designed to encourage reciprocal exchanges of ideas, techniques and experiences. FoAM is funded by the Flemish Authorities as a transdisciplinary research studio. It was previously involved in the successful FP7 project "LIREC" leading exploitation and dissemination and was coordinating partner for EC Culture projects "Txoom", "TRG", "Resilients" and "gRig" and a partner in EC culture project "PARN"

Nik Gaffney is a systems and media researcher, and a founding member of FoAM. His research focuses on biological and physical models for computation, generative systems and media rich responsive environments. While at FoAM, he has put this research into practice through the alife environment 'mutaGen', sensor analysis and media generation system for 'TGarden' and 'txOom', as well as developing a conceptual framework for 'sutChwon', a system functioning as a glue layer between indeterminate computational entities. He is a member and prominent contributor of 'farmersmanual', a pan-european, net-based, multidisciplinary collective, in which he is working on network sonification, development of media generating neural networks and tools for distributed performances.

Dave Griffiths is a researcher and award winning software artist and game designer working at FoAM. His past experience includes working as a Senior R&D programmer for Sony Computer Entertainment Europe, and Lead programmer in feature film special effects for The Moving Picture Company. His current work includes collaboration with biomedical researchers on software projects for visualisation, outreach and citizen science (Hapstar, a haplotype network visualisation tool for genetics and DorisMap, online mapping of lobster catches and marine wildlife). He also builds computer games to explore serious issues, and won first place in the 2011 VIDA prize alongside Aymeric Mansoux and Marloes de Valk with "Naked on Pluto" a game concerning online privacy issues. He created Germination X, an online game about permaculture, being used as a demonstration of AI technology developed for the Lirec FP7 project. Dave is an active contributor to the emerging live coding scene, developing Fluxus, an open source, live codable 3D games engine. He also develops a collection of experimental programming languages which he uses in worldwide performances as part of Slub, a live coding band.

Maja Kuzmanovic is a generalist, with a background in Design Forecasting and Interactive Media. Maja is the founder, principal invigorator and chef de cuisine of FoAM. Prior to FoAM, she experimented with MR & VR in research institutes across Europe (GMD, CWI, Starlab), lectured (HKU), as well as collaborated with technological arts collectives such as Post World Industries and Pips:Lab. Her particular approach to people & technology has been recognised by the MIT's Technology review & the World Economic Forum, awarding her the titles of Top 100 Young Innovator (1999) & Young Global Leader (2006). Her current interests span alternate reality storytelling, patabotany, resilience, speculative culture and techno-social aspects of food & food systems.

Aarhus University – Participatory Information Technology Centre

Aarhus University (AU) was founded in 1928. It has 41,000 students - of these about 1,950 are PhD students. AU has 7.500 employees, of these 6300 academic staff (2011). AU has recently undergone a transformation from nine to four faculties: Faculty of Arts, Faculty of Science and Technology, Faculty of Health Sciences & School of Business and Social Sciences. The new faculties cover the entire research spectrum – basic research, applied research, strategic research and research based advice to the authorities. In recent years AU has been moving up the most important university ranking lists: number 51 in the Leiden Ranking (2011), number 89 at the QS World University Ranking (2012) and number 116 on the Times Higher Education World University Ranking (2012). Further information can be found at http://www.au.dk/en/about

The newly established centre for Participatory IT (PIT) at Aarhus University innovates the Scandinavian participatory design tradition, and extends it through interdisciplinary perspectives from pivotal research areas, including digital aesthetics, interaction design, computer-mediated activity, and ubiquitous computing. The centre recognizes that in recent decades information technology has become an integrated element of almost all parts of people's everyday lives, and accordingly it poses the fundamental question of what participation currently means, and how it may be supported by IT, today and in the future. Further information can be found at http://pit.au.dk

The PIT centre has a total budget of 6.6 million EURO for the period of 2012-2016. PIT emerges from the core of a previous research project Digital Urban Living (2008-2012), funded by The Danish Research Council (2.4 million Euros) EU Fund for Regional development (0.43 million Euros) and The City of Aarhus (0.43 million Euros).

Dr. Geoff Cox is Associate Professor in the Dept. of Aesthetics and Communication, and Participatory IT Research Centre, Aarhus University (DK). He is also part of the Adjunct faculty of Transart Institute (DE/US), and Associate Curator of Online Projects, Arnolfini Centre for Contemporary Art, Bristol (UK). His research interests lie in the areas of contemporary art and performance, software studies, network culture and a reappraisal of the concept of publicness. He is an editor for the DATA Browser book series (published by Autonomedia), and co-edited Economising Culture (2004), Engineering Culture (2005), Creating Insecurity (2009) and is working on Disrupting Business (for 2013). With Alex McLean, his latest book is Speaking Code: coding as aesthetic and political expression (MIT Press 2012).

Other researchers from PIT, drawn from the departments of Arts and Communication (Professor Kim Halskov, Dr. Morten Breinbjerg) and Computer Science (Dr. Clemens Nylandsted Klokmose) will also contribute to the project. For a full list of researchers in PIT, see http://pit.au.dk/people/

2.3 Consortium as a whole

The LIMINAL project represents core interests of all six members of the consortium, who have fully participated throughout the development of the proposal, and are fully committed to its delivery. The individuals involved have a long history of collaborating in the area, including as co-authors, panel members, co-examiners, across academic, industrial, artistic and informal contexts. This history of collaboration amongst its members supports ongoing cohesion and shared purpose. Furthermore, the members are well used to working with the challenges and opportunities inherent in all interdisciplinary research, taking different methodologies into account, while still ensuring research and evaluation is coherent and rigorous.

The consortium consists of six members providing key research across four European countries, and the project as described would be infeasible without this cohesive team. The consortium is coordinated from the UK, with three partners based there. The fMRI neuroimaging unit is at USFD between UNIVLEEDS and UCAM; this is advantageous in maximising opportunities for test subjects travelling for neuroimaging studies to also be involved in workshops and other activities organised by UNIVLEEDS and UCAM.

The following table shows the relationship between fields, objectives and expertise. It demonstrates a cohesive team who, with the exception on USFD's specialism in experimental cognitive psychology, are able to work collaboratively across the numerous sub-areas of the LIMINAL project theme. Where consortium members share core expertise in fields of knowledge, this is generally from an interdisciplinary perspective, where each partner contributes particular core perspectives.

Field of knowledge / capacity	**Core objective(s)**	**Core expertise**
Metaphor in technical language	O2	UCAM, UNIVLEEDS
Interdisciplinary research	All	UPF, UCAM, AU, FOAM, UNIVLEEDS
Participatory Methods	O1, O2, O8	AU, UCAM, UPF
Music technology	O3, O7	UNIVLEEDS, UPF, UCAM
Game development, games design	O1, O3, O6, O7	FOAM
Live coding and creative coding	O3, O1, O4, O5, O6, O7, O8	UNIVLEEDS, UCAM, FOAM
Computing education	O4	UCAM, UNIVLEEDS
Cognitive Psychology of Language	O8, O5	USFD
Psychology of Technical Language	O2, O1, O3, O4, O5, O6, O7, O8	USFD, UCAM
Computational Creativity	O8, O7, O3	UNIVLEEDS, UCAM, AU
Assessment and measurement of creativity	O8	UCAM, UNIVLEEDS, USFD
Tangible/tabletop/gestural interaction	O6, O7, O5, O2	UPF, UCAM, UNIVLEEDS, AU
Software engineering/agile development	O8, O6, O7, O1	FOAM, UNIVLEEDS, UPF, UCAM
Computer graphics and visualisation	O3, O4, O5, O6, O7	FOAM, UPF, AU
Working with creative industries	O1, O4, O7, O8	FOAM, UPF, AU, UCAM,

		UNIVLEEDS
Creative technology for science outreach	O1, O6, O7, O8	FOAM, UCAM

2.4 Resources to be committed

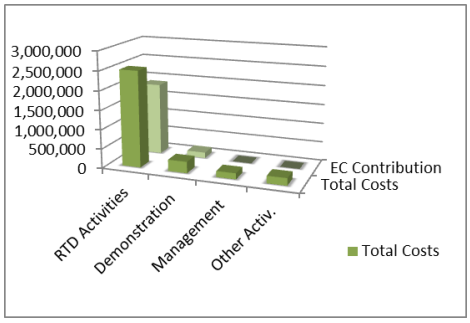
LIMINAL is a world-class interdisciplinary consortium bringing together internationally-leading researchers. Each of the 5 partner research institutes and 1 SME from 4 EU countries has significant experience and success in managing and participating in large collaborative national and European research programmes.

2.4.1 *Resources needed to carry out the project*

The overall budget of LIMINAL is €3.15 million with a requested EC contribution of €2.37 million (see Table below). As expected in a project of this kind, the majority of the total costs of the project are associated with personnel, with the remaining budget concerning consumables, equipment, and travel & subsistence. Overall management costs of the Consortium including dissemination is limited to 5% of the total EC contribution. The consortium has been assembled based on the expertise required without which and the project as described would be infeasible without this cohesive team. 3 of the consortium partners and the coordinator are based in UK and hence budget distribution is half to UK. The fMRI neuroimaging unit is at USFD between UNIVLEEDS and UCAM; this is advantageous in maximising opportunities for test subjects travelling for neuroimaging studies to also be involved in workshops and other activities organised by UNIVLEEDS and UCAM.

Table 2.4.1: LIMINAL budget information

Partner Short Name	Role	RTD activities		Demonstration		Management	Other Activities	Totals		
		Costs	EU Cont.	Costs	EU Cont.	Costs (EU)	Costs (EU)	Costs	Own Res.	EU Cont.
1 - UnivLeeds	RTD	642,751	482,063	86,801	43,401	137,882	38,840	906,275	204,088	702,186
2 - USFD	RTD	182,113	136,584	23,976	11,988	2,400	17,584	226,073	57,516	168,557
3 - UPF	RTD	476,308	357,231	38,496	19,248	2,400	35,264	552,468	138,325	414,143
4 - UCAM	RTD	484,791	363,593	46,029	23,015	4,800	34,017	569,637	144,212	425,425
5 - FoAM	SME	319,680	239,760	40,320	20,160	3,600	34,440	398,040	100,080	297,960
6 - AU	RTD	396,700	297,525	63,100	31,550	4,000	31,640	495,440	130,725	364,715
TOTALS		**2,502,343**	**1,876,757**	**298,722**	**149,361**	**155,082**	**191,786**	**3,147,933**	**774,947**	**2,372,986**



Personnel: A total staff effort of 323 person months (PM) will be devoted to the project over a 36 month period. It is fairly distributed according to the work being done by each partner, thus illustrating the truly interdisciplinary nature of the project. Experienced researchers as well as young researchers will be appointed to complement existing personnel funded from other sources. A proportionate contribution towards existing staff time is also requested. The personnel will provide essential contributions as part of the cohesive consortium described in section 2.3 above.

Travel: Budgeting has been made for 9 events; including 1 kick-off, 6 consortium meetings (2 per year with the end of year meeting co-located with the Review meeting) to synchronised of works, progress and planning, and 2 LIMINAL public events (with at least one Int. Conf.). Finance is also requested for attendance at approx. 4 conferences/partner and other events/exhibitions to promote dissemination of project results. Typical travel cost estimates are €800/meeting/staff person per partner meeting and €1K per conference/person/partner.

Associate Partners – External Advisory Board: Associate partners will be involved in the development and evaluation of prototypes on a no cost basis. Their travel costs to LIMINAL events/meetings will be reimbursed (following usual accounting and management practices of the Coordinator and will be used for the sole purpose of achieving the objectives of the project, in a manner consistent with the principles of economy, efficiency and effectiveness and will be on a non-recurrency basis, up to 3 times a year/expert). These costs are included as a central budget, €24k, held by the Coordinating partner. UNIVLEEDS will manage and reimburse travel costs for up to 8 Associate Partners (see Section 2.1), to attend at least two advisory board meetings planned over the lifetime of the project.

Dissemination/exploitation: 18 PM is requested to support dissemination and exploitation activities. This work package is led by FoAM, with assistance from UNIVLEEDS and all partners.

Management: Overall Project Management will be undertaken by UNIVLEEDS. Dr. Kia Ng, 10%, 3.6 PM

will act as coordinator with an Admin Officer on project admin/financial support who will be employed for approx. 40%FTE over the duration of the project.

2.4.2 Adequacy of overall financial plan

All partners have formally agreed to both participate in the LIMINAL consortium, and to commit the necessary resources. The coordinating partner, UNIVLEEDS, has participated in previous EU funded programmes and has well established procedures in place for reimbursing partner institutions for their costs. The overall plan has been thoroughly discussed between partners to ensure economy, efficiency and effectiveness, and all budgets have been verified by the partner's finance officers. The overall budget has been carefully constructed so that it is both adequate for the WPs and robust enough for the full 3-year duration of the project. The budget will be reviewed annually, in the light of progress and as part of the risk management to ensure that all major tasks are successfully completed and the coherence of LIMINAL.

WP3, the Language meta-design studio, involves running a series of practical construction studio events in different locations, during which new creative applications are prototyped. These applications will involve mixed textual, visual and tangible representations, able to control sound motion and light. Based on previous experience of tangible prototyping workshops, but informed by more recent collaboration with MakeSpace organisations, a minimal set of tools and materials has been specified to support a diverse range of creative prototyping explorations. Tools and equipment have been specified at a low-end professional/high-end consumer level, in order to be reasonably robust for use in repeated events, while also economical to fit within the overall project budget. Interactive software will be provided via ultra-low cost prototyping platforms (the Raspberry Pi) with suitable hobbyist-standard peripherals. Carriage of equipment to the workshop location has been costed on the basis of using a rental van, driven by the researcher, with ferry and accommodation costs appropriate for journey length. Packing cases for equipment have been specified at a cost appropriate for this transport method. Participants and venues will be expected to provide their own laptop / development workstations, but a single portable workstation is included for the workshop technical coordinator. The language meta-design components of the studio will rely critically on detailed recording and analysis of the work carried out. Recording equipment is specified at the level of low-end professional / high-end consumer budget, to reliably deliver quality suitable for transcription and/or publication.

With WP4, UNIVLEEDS is to purchase a mobile gaze tracker system so that both UNIVLEEDS and USFD can develop and carry out evaluation including in WP2 testbeds. With an existing gaze tracker at USFD, this can be used to study synchronisation between collaborating partners. In WP5 some material will be needed in order to develop and implement the prototypes around some core areas as live coding, tangible interaction and sonification/visualization. Implementation in some of these areas will require special equipment such as tabletop interfaces, 3D printers and material, auditory equipment or video projectors. In order to actually deploy the interventions using those prototypes some field material will be needed such as laptops for in-place deploying and evaluation, and video recording tools to document them. A further €2,300 is to be used by FoAM in the production of the project website (T8.1) and associated costs.

The consortium will make use of existing special equipment. For example:

- Experimental psychology laboratories at USFD including fMRI facility.
- The tangible interaction studio at UPF including Reactable system hosting wide range of open source software subtools including ReactiVision, GestureAgents and Essentia, and high-end auditorium and audio/visual facilities for performance, production and recording.
- ICSRiM lab at UNIVLEEDS equipped with a range of audio/visual equipment including computer vision technology ranging from a high specification VICON motion capture system to Microsoft Kinect, and fully equipped concert hall and sound studios within the School of Music with excellent facilities including high specification multichannel sound.
- FoAM's large research laboratory in Brussels used for performances, workshops and conferences, and wide range of open source software including game engines, live coding systems and experimental programming languages and hardware systems.

Section 3. Impact

3.1 Expected impacts listed in the work programme

This consortium is well placed to take advantage of its experience in the areas of music technology and serious games development in order to gain insights in understanding of the potential of technology in creative production processes. The increasingly fundamental role of computer programming in many aspects of the creative industries and related professions in European business has led to an urgent need to re-examine assumptions of programming culture and approach it with new creatively centred methodologies.

The LIMINAL project will engage with these two **specific domains in the creative sector** where the **lack of creative understandings of code** leads to **bottlenecks to creativity**. Due to these sectors' inherently interdisciplinary nature, and their necessary involvement of stakeholders in the creative process, our outputs will be focused on enabling discussion and sharing of knowledge within and across different disciplines within teams. Aiding the removal of these bottlenecks will enhance creative practices by allowing stakeholders (which can include co-workers as well as individuals outside of creative and related organisations) to be more deeply involved in creative processes. Deeper involvement and at an earlier stage will allow them to take a greater role in design processes and related decisions leading to greater mutual understanding and communication, and ultimately higher quality outputs and products.

The expected results of the project are grouped into the following areas:

I1 Comparative understandings of how creativity is defined and approached in the context of programmable and configurable technologies. (outputs from WPs 2,3,4,5)

The research will provide new approaches to understanding creativity in the context of technology. Our published methodology for assessing situations in terms of creativity will include our workshop formats, template interview questionnaires, and strategies for assembling collected data in order to gain new insights into how creativity emerges, and interacts with features in working environments, creative tools and the role of individuals in larger collective technology projects as well as evaluating creativity represented by the resulting artefacts. This work will benefit from input from Geraint Wiggins, Professor of Computational Creativity, and on the External Advisory Board.

The key users of this outcome will be the computational creativity community, as well as practitioners and researchers engaging with live and creative coding in both software engineering and performance technology contexts. **All these groups are potentially interested in new ways to categorise and assess creative material, in terms of evaluating research processes and outputs.** Metrics for creativity in terms of support tools will be used by third party developers of software and middleware for disparate sectors including music and games production, film post production, architecture and computer aided design. Studies will include examining features of working environments and how they interact with creative issues. Companies wishing to encourage creative thinking and innovative approaches in their teams, (e.g. in the web design sector) will be able to use our research to ground their decisions, taking technology and creativity into account. Other identified areas for impact include:

- Experimental validation (or otherwise) of aspects of design methodologies such as Agile, leading to improved practice and new directions of enquiry into new domains of design.
- Improved access to creative collaboration beyond the neurotypical, for example those with autistic spectrum disorders who work well with technical languages.
- Widening access to creative tools will broaden the range of people engaged in design programming both inside and outside of professional cultures.
- New rapid prototyping tools, concentrated on techniques such as in-game creation (user generated content) for the games industry.

I2 Improvement in understanding different modes of representation. Textual vs visual representations of language. (outputs from WPs 2,3,4)
Creative work necessarily involves transdisciplinary groups (e.g. 3D modellers, engine programmers, designers and marketing experts in game production), and often each group has its own unique way of conceptualising and abstracting the design problem. An increased understanding of how these modes of creative representation interact, and how technology may support these interactions more effectively, will lead to a key target impact of the project. This impact is applicable to broader sectors than we are able to cover in a focused project such as this, and so in order to maximise the uptake of our research in this area, we will produce and publish a design guide [T2.5] covering advantageous patterns of creative use highlighted by LIMINAL's research. This guide will at first be developed for internal use, with a final draft prepared reflecting on its use, making it useful for broader research and industrial contexts, as a well-tested practical design guide.

Many professionals and creatives rely on hidden but well established traditions which have emerged around current programming technologies. We see this as a twofold opportunity: on the one hand creating a **coherent pathway for broad uptake**, facilitating **significant shifts in professional culture**, but also providing a unique opportunity to examine how programming arises in professional creative cultures which are divergent from the traditional approaches in software engineering. With this understanding of creative technology we target the following kinds of impacts:

- Tools supporting transformation in the work of the large proportion of non-professional programmers who engage with code every day (e.g. those currently programming using spreadsheet formulae and macros)
- Heavy users of data from varied sources, such as architects or urban planners, will be more able to fully grasp and conceptualise information (including open data) at higher levels of abstraction than currently feasible.
- New strategies in embedding explanatory information with code, for example executable research papers for biologists to explain their work to end users more effectively.

The primary expected users of this outcome will be research communities of human computer interaction, user experience (UX) designers and programming language design, as well as those creating software with rich interfaces for creative industries in the form of third party tools or middleware for interactive or music production. **Enhanced understanding of the cognitive effects of interface modality** (from diagrammatic to textual descriptions) in creative interaction has the real potential to change how we align representation with modes and styles of thought in HCI research and practice. Programming languages that can switch between different representations of code for different activities, will have impacts in issues across different devices as well as different modes of use. With the recent explosion in the variety of screen sizes and input mechanisms, methods for interacting with code and configurations is a lack which needs addressing. Techniques in the design guide will also be useful for the elaboration of general problems surrounding scaling of data visualisation to suit different form factors or screen sizes, such as mobile app designers working with responsive or adaptive design. The techniques will be expressed in terms of high-level problems, with solutions proposed in such a way that each will be applicable to many of these domains.

I3 A set of open source prototypes which solve domain specific issues of creativity while demonstrating the research outcomes. (outputs from WP6)
A major outcome of the project will be working prototypes built in order to explore and alleviate the creative bottlenecks we pinpoint in selected use cases from the music technology and serious games fields. The prototypes will be designed to be used individually, in groups or shared online as web applications depending on the nature of the problem. These prototypes will be attractive for our partners who provide testbed situations, as they will be bespoke solutions to specific problems identified in interactions with them early in the research. Note: we do not expect that we will make immediate impacts with every end user, as their primary role is to provide background cultures in which to study creativity.

Our various focusses on technical language in terms of liveness, gestural/tangible interfaces, visual notation

and the composition and abstraction of form, will be brought together towards profound impact in music and performance technology. This will not only provide new interfaces for working with music improvisation and composition, but also on areas which rely on creative manipulation of code with live audiences, such as in software engineering peer-learning sessions (e.g. Katas), and computer science lectures within the successful Media Computation approach in computing education.

In terms of impacts specific to music technology, musicians will be able to engage in new kinds of creative collaboration, with each other and their audiences, via shared visual, gestural and physical representation and manipulations of generative structures which represent their music making. In terms of dissemination and impact, we take the existing Live Coding community as a starting point, but make assessable live coding environments with engaging interfaces, suitable for a wide range of professional musicians. To do this we take advantage of our existing close relationships in the music industry, including via Reactable Systems, working with well-known artists such as Bjork, Al Doyle (Hot Chip), Mark Fell (SND) and John Burton (Leafcutter John). We will also engage in music technology communities, by participating in Music Hack days and exploiting opportunities for feedback from public releases of our open source systems through community forums.

The primary end users in the area of visualisation, serious games and playful interaction for public science outreach and policy include the **Environment and Sustainability Institute at the University of Exeter**, who are interested in novel approaches to citizen science including the use of live interactive technology on a variety of highly visible environmental issues. Such issues include working with high level policy makers in the EU and UK governments, for example managing the ongoing bovine tuberculosis epidemic in the UK. Much of the material the researchers in these areas are dealing with are complex models programmed using a variety of ad-hoc methods. Earlier and more in-depth involvement in the decision making process of research by policy makers is seen as an urgent priority where complexity, opacity and difficulty in explaining the underlying working processes is hampering the uptake of their evidence on the policy level. **Other target end-users for their work includes journalists and the general public**. Also working in conjunction with the ESI is Exeter's Biomedical Informatics Hub, a Wellcome Trust ISSF project who have aims broadly in alignment with this project and are focused on cross-disciplinary approaches to emerging technologies and large datasets.

Tale of Tales and Field represent two very creative and challenging domains; Tale of Tales are a small games development company focusing on unique artistic approaches to game design, who are constantly experimenting with different approaches to coding, while FIELD create expressive and dynamic artworks for digital platforms and audio-visual installations, experiences for web and mobile, and shareable digital artefacts, using live coding techniques in their creative design process. Both these organisations present exciting opportunities to study creativity in digital contexts, and the research would provide them with specific methods for bridging gaps between prototyping and production phases or more immediate design cycles, enabling free flow of ideas in these fast moving creative areas.

Companies and organisations in similar sectors to the partners and associated partners will be targeted and have access to the prototypes. Ongoing development and customisation of LIMINAL open source tools will be encouraged, so that research end users can evaluate and widen their applicability quickly and with minimal investment.

I4 Frameworks, technology and formats for open engagement with creative technology (outputs from WPs 3,5,6)

During the course of the project and its many workshops, a set of frameworks will be created which interact with devices and software with a range of existing communities. This work will provide outputs for the project including, but not limited to, initiatives such as Raspberry Pi, Reactable, Supercollider, Fluxus, Haskell environments and extensions to online games environments such as Minecraft.

Such work will appeal to hacklabs, the open source community, education community (particularly in the case of Raspberry Pi) as well as the Live coding and digital music community. This kind of outcome provides means for further exploitation by SMEs who have uses for realtime, live, multiscale representations of code that we cannot anticipate. It will also provide a deeper engagement by providing associated partners and other end-users with opportunities to customise the technologies we develop, with the capability to

produce a wider range of tools than we can provide in a focused STREP research project.

I5 Computing education
Computing education research is an important resource for creative support tools, which we draw upon in order to meet objective O4. While LIMINAL is primarily guided by needs of professional end-users, we are motivated in this impact

both by the relation between creativity and learning embedded in Challenge 8, and in the fact that supporting the creative underpinning of computing education now supports the creative workers of the future. We will therefore find connections with call 11 "Technology-enhanced learning" projects within ICT-2013.8.2, as part of our drive to ensure that results are delivered back to computing educators (of which several exist within the consortium) and education researchers. We will also engage with educators already engaging with live coding techniques, such as Professor Mark Guzdial, who has observes that live coding is "best practice" in computer science lectures (http://tinyurl.com/guzdial), and whose Media Computation approach could benefit from our work. Our engagement will focus on those underpinning computing education with a creative approach based on media; our resources will at this point be focussed on areas of mutual knowledge exchange rather than on "winning over" educators with approaches not concordant with our aims.

3.1.1 Contribution to the European Commission Digital Agenda: Enhancing digital literacy, skills and inclusion

The LIMINAL project will contribute to the EC Digital Agenda, since the set of tools and techniques will enhance digital skills of both individuals and group practitioners and improve capacities required to fully participate in society. Increasing access to computers (up to 90% and increasing in more advanced ICT countries) and internet (65% regular use) requires defining new models for education and innovative ICT tools for workspaces, not only empowering users with computational skills, but also improving current creative methods which satisfy societal and industry needs.

3.1.2 Steps needed to bring about these impacts

- Realization of the **major tasks** as described in 1.3 Work Plan and successfully fulfilling the evaluations in professional contexts will provide understanding creative and problem solving processes as well as informing technological development.
- **Effective dissemination** of our results is key, and will be primarily addressed to our user groups, main stakeholders, policy-makers and other interest groups evidencing the benefits of LIMINAL for our target user cases, as described in section 3.2.
- Collaboration with creative professionals during RTD process, some of whom have already been contacted and confirmed their interest and participation (e.g. Skibsted Ideation, Field, Tale of Tales).
- High involvement of **policy-makers, main stakeholders and user groups** in order to introduce LIMINAL tools in creative environments, encouraging companies to build new and creative applications on the top of developed technologies and tangible embedded environments. Some have already been approached and have confirmed their interest in the results from the project.

3.1.3 Added value of a European approach

There are a number of aspects associated with the European dimension of this proposal that add value above and beyond the ones achievable by individual participants or country groups. In order to achieve its goal of generating innovative tools for learning and knowledge management for group and individuals, LIMINAL requires four primary resources:

- definition of cognitive models for creative and problem solving processes based on real use cases

- metaphors and conversations definition
- extended programming environments development and
- the capability to validate them through both exploratory and more focused experiments involving end-users from both creative industries and related fields.

No single centre has the required expertise and the needed resources (e.g. large datasets, target users, specialized equipment, infrastructure for experiments, etc.). In addition to the resources to be provided by consortium partners, the close collaboration with LIMINAL associated partners (representing targeted professionals) will result in shorter time periods for learning and speeding up time to competences.

Within the achievable scope of a STREP project, LIMINAL will contribute to the cohesion of a substantial critical mass gathered throughout Europe, representing together a number of research institutions specialized in psychology cognition, user studies evaluation, mental imagery, computational creativity, mobile computing and tangible interaction, including FoAM, an SME specialized in the promotion and exploitation of novel creative environments. Each of the recruited institutions is a recognised leader in its field, and each significantly participates in related national, European and international research activities. Isolated projects which would not take into account the effect of the different user profiles could not develop successfully relevant methods, conceptualized from a cross-disciplinary perspective.

LIMINAL would not be successful if it stopped at the point at which expected research and technological results become available. It is imperative that this knowledge and these tools are translated into industrial and cultural practice, and that the methodology and the framework will be seen as an exemplar and reference in the field. LIMINAL is therefore fully aligned with long-term interests of the project:

- UPF-MTG (ES), make it possible to reach research results and technology development and also to engage more final beneficiaries of foreseen outcomes, i.e. through their usual network of collaborators and other creative initiatives they take part (Music Hack Days organised by UPF-MTG, etc.). In addition to the industrial partners, UPF-MTG has great track record in technology transfer, having established 3 spin-off companies (BMAT, Reactable Systems and Voctro Labs) exploiting MTG technologies.
- FOAM not only brings the technology required for further development of relevant scientific areas, but also has vested interest in exploitation of research output.
- AU's Participatory IT centre also aims to builds on a set of industrial and commercial partners established through former strategic research projects (eg. Digital Urban Living, that included partners BIG Bjarke Ingels Group (Architects) and Martin Professional A/S (Architectural & Entertainment Lighting)) as well as their ongoing work around Media Architecture.

3.1.4 Related EU research activities

Several EU initiatives have also been launched in recent years with the aim of supporting the development of citizens' skills as well as improving education and learning systems so that they are better able to respond to the needs of the economy and society, forecasting and matching the supply of skills to the needs of the labour market through better cooperation between the worlds of work and education. LIMINAL will take advantage of such activities by reviewing achieved scientific and software results, as well as by monitoring ongoing activities and collaborating with them leading partners.

- Several EU initiatives have also been launched in recent years with the aim of supporting the development of citizens' skills as well as improving education and learning systems so that they are better able to respond to the needs of the economy and society, forecasting and matching the supply of skills to the needs of the labour market through better cooperation between the worlds of work and education. LIMINAL will take advantage of such activities by reviewing achieved scientific and software results, as well as by monitoring ongoing activities and collaborating with them leading partners.

We will invite members of consortia of related EU projects to LIMINAL project meetings, and investigate approaches to dissemination.

Specifically, LIMINAL will provide a bridge for projects from the FP7 ICT Call 8 specialising on education to connect with professional areas, IdeaGarden http://idea-garden.org/ researching creative learning tools and Collage http://projectcollage.eu/ concerned with studying creativity in social networking space. Also concerned with education, Citizen Cyberlab http://cordis.europa.eu/projects/rcn/106216_en.html is focused on mobile applications in citizen science so are the ideal project to collaborate with over the citizen science element of the collaboration with Exeter/ESI. GHOST (FET Open) http://www.ghost-fet.com/ are building flexible shape-changing interfaces, LIMINAL would be the ideal project to provide them with exciting, creative use cases in music, and design, fitting with our collaboration with Reactable Ltd.

3.1.5 Contribution to standards.

Scientific and technological strategy targets global consensus and standards. In the course of LIMINAL we will spend significant effort linking between technological advances, definition of new methods and its translation to standards. LIMINAL will also exploit to the maximum available international standards and tendencies through implementation of research results and collaborate in Standardization activities lead by the Professional Learning Cluster (PRO LC).

3.2 Dissemination and/or exploitation of project results, and management of intellectual property

3.2.1 Dissemination strategy arranged by impact area

I1 Comparative understandings of how creativity is defined and approached in the context of programmable and configurable technologies.

Expected users: computational creativity community, practitioners and researchers of livecoding, creative software tools SMEs. Companies needing to boost creative thinking and innovative approaches in their teams.

The computational creativity community will be reached by academic publications in relevant venues (e.g. ICCC, ACM Creativity and Cognition), and through direct interaction with leading researchers in the field, in particular Prof Geraint Wiggins as an External Advisory Board member. The creative software and live coding communities also place high importance on gallery exhibitions and performances, which the live prototypes and chosen creative domains of this project are well suited to. More specifically, existing connections the consortium has with organisations such as Sony CSL, SonarPro, Mozilla, Dorkbot, and many event promoters and venues will be utilised for appearances at concerts and events with high visibility from this field, including LIMINAL organised events.

Partners FoAM and UPF via Reactable Ltd work in areas crossing the design and implementation of tools for creativity, and are particularly well placed to spread knowledge of these new understandings of creativity by the direct demonstrations of the use of this research.

I2 An increase in the understanding of different modes of representation in relation to creativity (for example) linguistic vs visual representations of language.

Expected users: human computer interaction, user experience (UX) designers and programming language design more widely, mobile app designers working with responsive or adaptive design. software industry, creative third party/middleware/plugin developers for music, animation, games tools, computer aided design, application developers and third party plugin tools developers.

The focus for dissemination to end users of this impact will be principally via the design guide [T2.5] which will be published online and in industry journals targeting the HCI and UX communities. In order to reach relevant parts of the creative tool software industry (listed above) we will break the design guide down into more focused articles dealing with specific promising features discovered by the research. The trade press for these sectors is one example (Develop magazine, Game Developer) but more effective will be good use of online dissemination, for example blog articles embedding interactive examples of pieces of our prototypes, along with comparisons and links to the project research. As such these will provide engaging recipes for UX designers with creativity as the primary focus, and will be easily disseminated on social networks, featured on websites and forums read by these communities, for example creativecrash.com, blender project's forum (as a key way to reach SME's in the crossover of games and film industry). Existing consortium connections with Mozilla (FoAM, UNIVLEEDS) will provide potential for showcasing interface work at events such as Mozfest. In the music domain SonarPro and MIDEM events will be avenues for dissemination of new interface mechanics.

I3 A set of open source prototypes which solve domain specific issues of creativity and demonstrate the research above.

Expected users: musicians interested in new live performance technology, existing live coding practitioners, organisations involved with explanations of complex models or data where live, tangible interfaces will help involve stakeholders and policy makers earlier.

In dissemination and exploitation, the prototypes represent strategically the most engaging way to reach diverse SMEs and related organisations who will have an interest in the project's outcomes and build business strategies around them. The focus will be on end users in similar sectors to the creative domains focused on for the prototypes. As a consortium we have a number of strong avenues of dissemination for this available, namely musical performance, with associated workshops, "Music Hack Days" as well as gallery events. These range from small arts venues scattered over Europe all the way up to international festivals with large mixed audiences (Ars Electronica in Linz, Sonar Festival in Barcelona). Such public events are key ways to attract attention from new emerging professional sectors, especially, but not limited to the musical software industry as well as wider interactive and social technology (being very concrete demonstrations of the research). These events with broad public reach are also good potential for getting mainstream media attention. SIGGRAPH in the US, with it's surrounding arts and gallery events showcasing performance is a key target for reaching creative industries such as computer graphics, film post production and games industry. The European "demo scene", highly influential in feeding technology and ideas to the wider games and related creative industry will also be targeted, for example Assembly and Altparty events in Helsinki.

Engagement of organisations needing to use live, tangible programming interfaces to collaboratively explore complex datasets or computational models and simulations will have to be carefully focused. FoAM is already undertaking collaborations with partners in these fields such as the Environment and Sustainability Institute at the University of Exeter, a LIMINAL associated partner - and identifying opportunities, key organisations and ways of framing the research to ease adoption in this sector. Use of the prototypes for environmental research will lead to new publications in these fields highlighting LIMINAL research (e.g. Molecular Ecology Resources, Bioinformatics). Presentations of LIMINAL research outputs will be made at Exeter's Biomedical Informatics Hub, a Wellcome Trust ISSF project which runs regular seminars and related public events. The ESI is also committed to engagement with business on a local level in Cornwall (an area awarded European Union 'Convergence status' to help develop the local economy and move it closer to the EU average) providing further targeted business outreach for LIMINAL.

Working on environmental and urban design projects with high visibility and public interest will result in additional media interest in LIMINAL prototypes, specifically as journalists themselves are a specific and important use case in tandem with policy makers.

I4 Frameworks (including open source code and open hardware) and workshop formats for engaging with creative technology

Expected users: hacklabs, maker movement groups, the open source/arduino community, education community (in the case of Raspberry Pi) as well as the live coding and digital music communities already mentioned. SME's who may have uses for realtime, live, multiscale representations of code and abstractions that we cannot foresee.

Software and hardware frameworks created or added to during the course of the project provide more distinctive and separate dissemination strategies than the domain specific prototypes impacts. Contributions to software repositories associated with the tools and environments we wish to hook into, involvement with open hardware projects and publication of LIMINAL outcomes on the Raspberry Pi Store, existing live coding tools (supercollider, fluxus) with their existing diverse communities, all provide ways of being visible to SMEs and other small creative startups who employ the use of these open source technologies in innovative new businesses such as in advertising, mobile and the 'internet of things'. Increasingly the independent games community is a highly active proponent of emerging technologies and an important thread of our impact will target events such as game jams, local independent games festivals (eg. IGF, ExPlay UK) as ways to present and demonstrate our outcomes.

3.2.2 Management of intellectual property rights

The Consortium Agreement (CA) will set out terms for IPR, the Access Rights to Background for Use will be granted on a royalty-free access, while the Access Rights to Foreground based on any Partner's Background will require an agreement between interested parties based on fair and reasonable conditions, due to the fact that the project has a strong focus on software issues and several partners are providing the project with currently existing technologies. For the project Foreground, we plan to release all software as Open Source (under OSI Approved Licenses) and publications as Open Access as much as possible.

Section 4. Ethical Issues

Research and development, and evaluation to be performed during the LIMINAL project will be carried out in according to principles of good practice and research integrity by each participating partner. For instance, research conducted by project coordinator, UNIVLEEDS, is conducted according to the principles of academic excellence, community, integrity, inclusiveness and professionalism. The University expects high ethical standards of all its researchers and research projects. All research applications which involve human participants or have an impact on the environment will be subject to the University's ethical review processes. As such, if this funding application is successful, it will be subject to the University of Leeds processes for ethical review. This entails ethical approval by a Faculty level Research Ethics Committee, or delegated authority according to guidance and principles set out by the University Ethical Review Committee. Research which comes within other legislative frameworks, such as the EU Clinical Trials Directive, or the NHS Research Governance Framework, will be reviewed by the appropriate Competent Authority.

Ethical conduct will also be established in the project Consortium Agreement [and any associated side agreements] which all partners and associate partners sign. A prior assessment of risk with subsequent identification of precautionary actions, proportional to the potential risk/harm, will be conducted prior to inception of the project but will be reassessed on an annual basis over the lifetime of the project, as research progresses.

Issues concerning the ethical issues specific to the conduct of ICT research, such as informed consent of adult healthy human volunteers, personal data or observing or monitoring people will be carefully handled. For example, the research involves recruiting healthy volunteers for fMRI study (WP4 lead by USFD). Being in an MRI scanner may be extremely unpleasant to some, particularly those who suffer from claustrophobia. With this in mind, the nature of the procedure will be made very clear in the recruitment process, and in the screening questionnaire. These will also include clear questions about other exclusion criteria such as having metal fragments in the body, electronic devices such as a pacemaker or being pregnant. Furthermore, participants will have a 'panic button' in the scanner, and may press it at any point to get medical attention or to exit the scanner.

As part of USFD hospital unit ethics, if any medical conditions are discovered there is a duty to contact the participant's' family doctor, and inform the relevant health professionals. If such medical condition is discovered, it may cause the participant distress. This will then be handled by trained medical staff who are always on site.
Participants will be made aware of this in advance, and will give their family doctor details as well as informed consent to contact them if the need arises prior to taking part in the study. Participants will not be able to take part in the study if they do not wish to be informed of any unusual medical conditions.

All research evaluation will be lead by academic partners with oversight from UNIVLEEDS, and will conform to their strict ethical policies and procedures that adhere to national and EU legislation. Any potential data from associate partners will remain within that organisation. Ethical review and permission will therefore be obtained and remain within the associate partner organisation. The data will be then be anonymised before passing onto partners for use in the main programme.

Researchers involved in the project are aware of the principle that any volunteers have the right to remain anonymous and make an informed, voluntary decision about participation. Data protection legislation will be therefore adhered to in the member state of the partners where the research is carried out. In fact the data obtained from users during the project will be obtained anonymously. No personal identification information such as 'real' names, addresses, telephone numbers, or email addresses or identification by picture or voice, will be obtained during interaction of the user with the prototypes. Data collected for qualitative and quantitative research, will be fully anonymised and compliant with data protection requirements by the use case partners. It should be noted that all Deliverables which may include any identifying information as part of the use-cases have been classified as 'restricted'.

Participant bias, particularly gender bias, is an ongoing problem in computer language related professions, and we expect our inclusive participatory design processes will improve access and suitability to linguistic technologies to a wider range of people. Towards this end, we will commit to aim at gender balance in all project workshops, and monitor gender as a natural and integral part of our dissemination strategy and reporting of workshop engagement and success, adjusting our approach to gender outreach as required.

Finally, none of the issues of research concerning: involvement of children; human genetic/biological materials; human embryos/foetuses, foetal tissue or human embryonic stem cells; animals, either transgenic/cloned or nonhuman primates; resources/impacts in Developing Countries; direct military application; the potential for terrorist abuse; or, clinical trials of implants of ICT implants; apply to the LIMINAL project.

ETHICAL ISSUES TABLE

	YES	Page Number
Informed Consent		
• Does the proposal involve children?	no	
• Does the proposal involve patients?	no	
• Does the proposal involve persons not able to give consent?	no	
• Does the proposal involve adult healthy volunteers?	YES	69
Biological research		
• Does the proposal involve human genetic material?	no	
• Does the proposal involve human biological samples?	no	
• Does the proposal involve human biological data collection?	no	
• Does the proposal involve human embryos?	no	
• Does the proposal involve human foetal tissue or cells?	no	
• Does the proposal involve human embryonic stem cells?	no	
Privacy		
• Does the proposal involve processing of genetic information or personal data (e.g. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)	no	
• Does the proposal involve tracking the location or observation of people without their knowledge?	no	
Research on Animals		
• Does the proposal involve research on animals?	no	
• Are those animals transgenic small laboratory animals?	no	
• Are those animals transgenic farm animals?	no	
• Are those animals cloned farm animals?	no	
• Are those animals non-human primates?	no	
Research Involving Third Countries		
• Is any part of the research carried out in countries outside of the European Union and FP7 Associated states?	no	
Dual Use		
• Does the research have direct military application	no	
• Does the research have the potential for terrorist abuse	no	
ICT Implants		
• Does the proposal involve clinical trials of ICT implants?	no	
(IF NONE) I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL		

Appendix A:

Letters of Intent from the Associate Partners

UNIVERSITY OF EXETER

RESEARCH & KNOWLEDGE TRANSFER

The Innovation Centre
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EX4 4RN

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Email rkt@exeter.ac.uk
Web www.exeter.ac.uk/reserch/rkt

LETTER OF SUPPORT

To whom it may concern:

This letter is to confirm that the University of Exeter, represented by the lead scientist for this project Dr Amber Teacher, is pleased to support the project entitled **LIMINAL: Live Interfaces for Creativity and Metaphor: Interdisciplinary support for new Algorithmic Literacy** to be submitted by the University of Leeds as project coordinator to the Objective 8.1 Technologies and scientific foundations in the field of creativity into the 10th Call of the Cooperation programme in the 7th Framework Programme (FP7-ICT-2013-10) **that closes on 15th January 2013.**

The LIMINAL consortium will develop and test new tools which transform creative work and form the next-generation of multi-user language environments, delivering new capability for creative collaboration in professional life. The University of Exeter's interests are aligned with LIMINAL goals and thus is willing to get involved in this initiative in order to pursue the success and further sustainability of LIMINAL foreseen outcomes.

Specifically, we will participate in the following aspects of the LIMINAL project:

- Contribute where possible with scientific expertise to the external advisory board, offering consultation on solution led conservation genetics and genomics research, including modelling the impacts of selection on wildlife populations, working with policy makers (UK and EU Parliaments), and science outreach/dissemination. Particularly with respect to how researchers in biological sciences use software and programming to analyse and present data.
- Contribute where possible to dissemination, communication and exploitation activities to maximise the impact related to LIMINAL project.
- Strengthen the link with main stakeholders in creative industries, other professional fields and policy-makers, as well as engage where possible new early adopters of LIMINAL technological solutions.

Signed by:

UNIVERSITY OF EXETER Research and Knowledge Transfer

Full Name: Dr Lee Bridger
Job title: Authorised Legal Representative & Deputy Director, Research & Knowledge Transfer
Date: 08/01/2012

And

Full Name: Dr Amber Teacher
Job Title: Visiting Researcher, Centre for Ecology and Conservation
Date: RESEARCH FELLOW
11/01/2012

F ' E L D

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+44 (0) 7540 455 458

8 January 2013

Re: LIMINAL support

To whom it may concern

This letter is to confirm that FIELD.io Ltd represented by Vera-Maria Glahn is pleased to fully support the project entitled ***LIMINAL: Live Interfaces for Creativity and Metaphor: Interdisciplinary support for new Algorithmic Literacy*** to be submitted by the University of Leeds as project coordinator to the Objective 8.1 Technologies and scientific foundations in the field of creativity into the 10th Call of the Cooperation programme in the 7th Framework Programme (FP7-ICT-2013-10) that closes on **15th January 2013**.

The LIMINAL consortium will develop and test new tools which transform creative work and form the next-generation of multi-user language environments, delivering new capability for creative collaboration in professional life.

FIELD.io's interests are aligned with LIMINAL goals and thus our studio is willing to get involved in this initiative in order to pursue the success and further sustainability of LIMINAL foreseen outcomes.

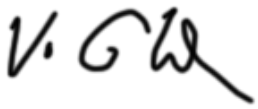
Specifically, we will participate in the following aspects of the LIMINAL project:

- Contribute with our expertise to the external advisory board, offering consultation on a.o. computational design and interactive art.
- Embrace LIMINAL set of tools to be obtained as major outcome of the project, acting as early adopter of the solutions to be provided.

- Contribute to dissemination, communication and exploitation activities to maximise the impact related to LIMINAL project.
- Strengthen the link with main stakeholders in creative industries, other professional fields and policy-makers, as well as engage new early adopters of LIMINAL technological solutions.

If you would like to verify the contents of this letter, please contact me on +44 7540 455 458 or at hello@field.io.

Sincerely,



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School of Electronic Engineering and Computer Science
Direct Tel: 020 7882 5200
Fax: 020 7882 7064
Website: www.eecs.qmul.ac.uk

LETTER OF INTENT

To whom it may concern:

This letter is to confirm that the School of Electronic Engineering and Computer Science at Queen Mary, University of London, represented by Geraint Wiggins is pleased to fully support the project entitled **LIMINAL: Live Interfaces for Creativity and Metaphor: Interdisciplinary support for new Algorithmic Literacy** to be submitted by the University of Leeds as project coordinator to the Objective 8.1 Technologies and scientific foundations in the field of creativity into the 10th Call of the Cooperation programme in the 7th Framework Programme (FP7-ICT-2013-10) that closes on **15th January 2013.**

The LIMINAL consortium will develop and test new tools which transform creative work and form the next-generation of multi-user language environments, delivering new capability for creative collaboration in professional life. My own research interests in computational creativity are aligned with LIMINAL goals and thus is willing to get involved in this initiative in order to pursue the success and further sustainability of LIMINAL foreseen outcomes.

Specifically, we will participate in the following aspects of the LIMINAL project:

- Contribute my expertise to the external advisory board, offering consultation on the theoretical and methodological underpinning of the evaluation and assessment of creativity as supported by LIMINAL tools.
- Advise on, and where appropriate contribute to, dissemination, communication and exploitation activities to maximise the impact related to the LIMINAL project, particularly in terms of academic impact.
- Strengthen the link between this research into creative support tools and the computational creativity research community, in terms of hybrid human/computer creative systems.

Yours faithfully,

Signed by *(please include here institution's stamp)*

Queen Mary
University of London
School of Electronic Engineering and Computer Science
Mile End Road, London E1 4NS, UK

Full Name: Geraint Anthony Wiggins, MA, PhD, PhD, MIET, MBCS, FRSA
Job title: Professor of Computational Creativity
Date: 11/01/2013

reactable

LETTER OF INTENT

To whom it may concern:

This letter is to confirm that Reactable Systems represented by Günter Geiger is pleased to fully support the project entitled **LIMINAL: Live Interfaces for Creativity and Metaphor: Interdisciplinary support for new Algorithmic Literacy** to be submitted by the University of Leeds as project coordinator to the Objective 8.1 Technologies and scientific foundations in the field of creativity into the 10th Call of the Cooperation programme in the 7th Framework Programme (FP7-ICT-2013-10) that closes on **15th January 2013.**

The LIMINAL consortium will develop and test new tools which transform creative work and form the next-generation of multi-user language environments, delivering new capability for creative collaboration in professional life. Reactable Systems' interests are aligned with LIMINAL goals and thus is willing to get involved in this initiative in order to pursue the success and further sustainability of LIMINAL foreseen outcomes.

Specifically, we will participate in the following aspects of the LIMINAL project:

- **Contribute** with our expertise to the external advisory board, offering consultation on tangible and tabletop interaction, both from a hardware, software and/or interaction design perspectives.
- **Embrace** LIMINAL set of tools to be obtained as major outcome of the project, acting as early adopter of the solutions to be provided.
- **Contribute** to dissemination, communication and exploitation activities to maximise the impact related to LIMINAL project.
- **Strengthen** the link with main stakeholders in creative industries, other professional fields and policy-makers, as well as engage new early adopters of LIMINAL technological solutions.

Sincerely,

Signed by

reactable SYSTEMS
Reactable Systems, SL · CIF:B65054710 · www.reactable.com

Full Name: Gunter Geiger
Job title: CEO
Date: 10/1/2013

SKIBSTED IDEATION A/S
KLØVERBLADSGADE 56 · 2500 VALBY, COPENHAGEN
DENMARK · SCANDINAVIA
WWW.SKIBSTEDID.COM

LETTER OF INTENT

To whom it may concern:

This letter is to confirm that Skibsted Ideation represented by Jens Martin Skibsted is pleased to fully support the project entitled **LIMINAL: Live Interfaces for Creativity and Metaphor: Interdisciplinary support for new Algorithmic Literacy** to be submitted by the University of Leeds as project coordinator to the Objective 8.1 Technologies and scientific foundations in the field of creativity into the 10th Call of the Cooperation programme in the 7th Framework Programme (FP7-ICT-2013-10) that closes on **15th January 2013.**

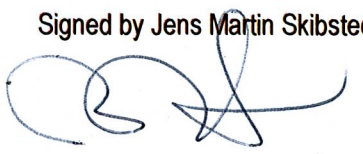
The LIMINAL consortium will develop and test new tools which transform creative work and form the next-generation of multi-user language environments, delivering new capability for creative collaboration in professional life. Skibsted Ideation's interests are aligned with LIMINAL goals and thus is willing to get involved in this initiative in order to pursue the success and further sustainability of LIMINAL foreseen outcomes.

Specifically, we will participate in the following aspects of the LIMINAL project:

- Contribute with our expertise to the external advisory board, offering consultation on branding, design and strategy.
- Embrace LIMINAL set of tools to be obtained as major outcome of the project, acting as early adopter of the solutions to be provided.
- Contribute to dissemination, communication and exploitation activities to maximise the impact related to LIMINAL project.
- Strengthen the link with main stakeholders in creative industries, other professional fields and policy-makers, as well as engage new early adopters of LIMINAL technological solutions.

Sincerely,

Signed by Jens Martin Skibsted



Full Name: Jens Martin Skibsted
Job title: Creative Director
Date: 08/01.2013

TALE OF TALES

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9000 Gent
BELGIUM
+32 (0)9 224 46 24
www.tale-of-tales.com

MICHAEL SAMYN
& AURIEA HARVEY
teller@tale-of-tales.com

B.V.B.A. VAT N. - BE 862 313 172

LETTER OF INTENT

To whom it may concern:

This letter is to confirm that Tale of Tales represented by Auriea Harvey & Michaël Samyn is pleased to fully support the project entitled LIMINAL: Live Interfaces for Creativity and Metaphor: Interdisciplinary support for new Algorithmic Literacy to be submitted by the University of Leeds as project coordinator to the Objective 8.1 Technologies and scientific foundations in the field of creativity into the 10th Call of the Cooperation programme in the 7th Framework Programme (FP7-ICT-2013-10) that closes on 15th January 2013.

The LIMINAL consortium will develop and test new tools which transform creative work and form the next-generation of multi-user language environments, delivering new capability for creative collaboration in professional life. Tale of Tales' interests are aligned with LIMINAL goals and thus is willing to get involved in this initiative in order to pursue the success and further sustainability of LIMINAL foreseen outcomes.

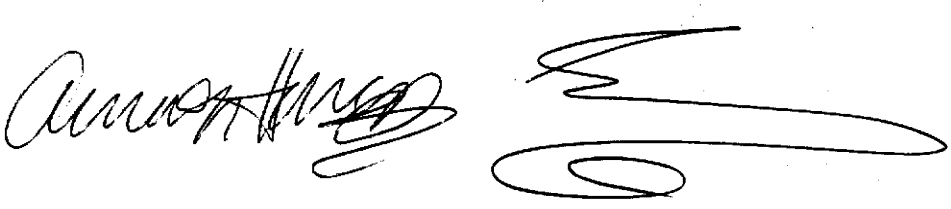
Specifically, we will participate in the following aspects of the LIMINAL project:

Contribute with our expertise to the external advisory board, offering consultation on interfaces for artistic creation of interactive software such as realtime 3D videogames.

Embrace LIMINAL set of tools to be obtained as major outcome of the project, acting as early adopter of the solutions to be provided.

Contribute to dissemination, communication and exploitation activities to maximise the impact related to LIMINAL project.

Strengthen the link with main stakeholders in creative industries, other professional fields and policy-makers, as well as engage new early adopters of LIMINAL technological solutions.



Auriea Harvey & Michaël Samyn.
Directors.
10 January 2013.

DEPARTMENT OF LANGUAGE AND COMMUNICATION
DIVISION OF PSYCHOLOGY AND LANGUAGE SCIENCES

11th January 2013

LETTER OF INTENT

To whom it may concern:

This letter is to confirm that UCL represented by Rosemary Varley is pleased to fully support the project entitled **LIMINAL: Live Interfaces for Creativity and Metaphor: Interdisciplinary support for new Algorithmic Literacy** to be submitted by the University of Leeds as project coordinator to the Objective 8.1 Technologies and scientific foundations in the field of creativity into the 10th Call of the Cooperation programme in the 7th Framework Programme (FP7-ICT-2013-10) that closes on **15th January 2013.**

The LIMINAL consortium will develop and test new tools which transform creative work and form the next-generation of multi-user language environments, delivering new capability for creative collaboration in professional life. *(UCL's* interests are aligned with LIMINAL goals and thus is willing to get involved in this initiative in order to pursue the success and further sustainability of LIMINAL foreseen outcomes.

Specifically, we will participate in the following aspects of the LIMINAL project:

- Contribute with our expertise to the external advisory board, offering consultation on (linguistic and non-linguistic communication)
- Contribute to dissemination, communication and exploitation activities to maximise the impact related to LIMINAL project.

Sincerely,

Signed by Professor Rosemary Varley

Division of Psychology and Language [illegible]
University College London
Chandler House
2 Wakefield Street
London WC1N 1PF

Professor Rosemary Varley
Department of Language and Communication
Division of Psychology and Language Sciences
University College London Chandler House
2 Wakefield St London WC1N 1PF
Tel: +44 (0)20 7679 4234 Fax: +44 (0)2- 7679 4238 Email: rosemary.varley@ucl.ac.uk
https://www.ucl.ac.uk/psychlangsci/research/languagecomm/people/langcomm-staff/r_varley/