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Evaluation Report for INRIA's Theme on "Interaction and Visualization"

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Executive Summary

The breadth, focus, and overall scientific quality of the INRIA research theme "Interaction and Visualization" is excellent. This theme consists of nine teams at different geographic locations that are part of INRIA's Field 4 related to the topic areas "Perception, Cognition, and Interaction". The main research focus of these teams is in Computer Graphics and Interaction and they constitute one of the strongest research groups worldwide.

All of the nine projects are addressing fundamental research problems in their respective areas, and making a strong impact. The research productivity in terms of quality and quantity of publications, software technology development, and external collaborations is excellent. All the scientific leaders are top-rated researchers and some of them are regarded amongst the very best in their respective areas. Most of the teams have good international visibility and strong ongoing collaborations with other research groups in France and worldwide. Moreover, they are attracting young talent from different parts of the world in terms of recruiting Ph.D. students and post-doctorate researchers.

The nine projects within the theme of "Interaction and Visualization" complement each other well and cover a large subset of research areas in computer graphics, human-computer interaction, as well as related areas including visualization and virtual reality. The research theme also successfully contributes to several of INRIA's strategic challenges, most notably to "combining simulation, visualization, virtual reality and interaction", but also to applied mathematics and scientific computation, development of next generation man-machine interfaces, including sound rendering, medical and surgery simulation, computer-based art, etc.

The projects are well connected to other groups, both on a national and international level, and there are several formal collaborations. These nine projects within "Interaction and Visualization" successfully participate in numerous EU projects and also receive funding from other agencies in France. The panel was quite excited to see a good number of partnerships and ties with industry, including many successful technology transitions.

The panel of evaluators suggested a few recommendations to further strengthen the scientific achievements of research teams in "Interaction and Visualization". Other than continuing the excellent work, these include increased investment in this thematic area, more resources allocated for permanent personnel in the promising projects, and more flexibility in the structure and process.

Introduction

This report summarizes the findings and recommendations of the panel of international evaluators who participated in the INRIA evaluation seminar on "Interaction and Visualization" in Paris on October 21-22. All but one member of the panel was present for the whole meeting. One of the panelists, Dr. Marcus Gross from ETH – Zurich and Disney Research was only present for part of the day on October 21, 2010 and had to leave early.

Organization

The seminar opened with a private meeting between the experts and INRIA Management on October 21, 2010. The INRIA's Management gave a nice overview of INRIA's research mission and emphasized research incentives to foster collaboration, inter-disciplinary activities, and also pursue high-risk projects. This was followed by a presentation by the Evaluation Committee, where the overall evaluation criteria were discussed. The main focus in terms of evaluation is on scientific achievement and development of technology, along with creativity, originality and relevance of the research to the overall theme of this group. Other criteria included innovation, technology transfer, and development of manpower in terms Ph.D. students and postdocs and relevance to overall INRIA's scientific strategy. Monique Thonnat, deputy scientific director, gave an excellent 30-minute overview of the entire theme and the nine projects. This included a broad perspective of INRIA's research mission in "Field 4" on "Perception, Cognition and Interaction", which is related to Computer Graphics and Interaction. At a broad level, four of the projects, ALICE, ARTIS, EVASION, and REVES are classified under computer graphics, while the other five projects, ALCOVE, AVIS BUNRAKU, IN-SITU, and IPARLA are classified as part of Interaction. In addition to giving an overview, Monique also highlighted the excellent collaboration among various teams. The rest of the day was devoted to plenary sessions where each project leader gave a 25-minute presentation with an overview of the project-team activities and its purpose. There was a special presentation on Project SOFA, which is a cooperative activity among multiple teams. At the end of the first day, there was a meeting between all the evaluators and team leaders followed by a private meeting among the experts. The second day included the opportunity to have focused sessions with each of the individual projects and project team members, with three evaluators reviewing any given project at the same time. The remainder of the day was spent in closed session among the review panel.

The overall seminar was well organized, and the research groups had made thorough and thoughtful preparations for the evaluation seminar. Each project team prepared a detailed report on the activities during the reporting period, including work progress, self-assessment, knowledge dissemination, external funding, and objectives for the next four years, as well as a list of publications. Some of the teams also gave demonstrations of their software systems on the second day. Some of the projects are coming to an end and the team leaders gave an overview of their goals for the next four years. The panel of evaluators has found the project reports and the format of the visit most helpful and wishes to express its appreciation to the management, scientific directors, research staff, and administrative staff for their generous efforts in making the evaluation seminar successful.

Overall Evaluation

The panel of evaluators was asked to provide a detailed evaluation of the following nine teams:

- ALCOVE (created in 2003)
- ALICE (created in 2006)
- ARTIS (created in 2003)
- AVIZ (created in 2007 from IN-SITU)
- BUNRAKU (evolved from Siames in 2007)
- EVASION (created in 2003)
- IN-SITU (created in 2002)
- IPARLA (created in 2003)
- REVES (created in 2002)

and a special initiative on Interactive and Medical Simulation called SOFA.

Some of these projects are coming to an end, while others plan to continue for the next four years. Many of these projects have grown over the last four years (2006-2010), hired top researchers, and obtained significant external funding. Some of the projects lost good researchers and are looking for appropriate replacements. Overall, the review panel was quite impressed with the credentials of the personnel involved in these projects and hopes that they continue to attract and hire the best researchers and increase their collaboration with local universities and industry.

The review panel strongly believes that scientific excellence should remain the premier evaluation criterion for these projects. The constant strive for scientific excellence and international visibility sharpens awareness of the state-of-the-art in their field, strengthens the projects' ability to select viable research directions, increases their impact, and strongly helps to create attractive employment opportunities for the PhDs they produce. This scholarship emphasis results in strong technology transition and outreach impact as well. The specific details and evaluations for each project are presented in subsequent sections. At a broad level, the evaluators would like to point out a few strengths and make the following recommendations:

1. The overall quality and breadth of research is excellent. The productivity and impact of INRIA's investment in "Interaction and Visualization" is very high, and we strongly encourage INRIA to invest more resources within this theme in terms of the current teams and scientific leaders. Some of the very high-impact contributions include the work of Project Alice on Finite-Element Computation and Applied Mathematics, IN-SITU's work of human-computer interaction and interfaces, REVES work on sound simulation and rendering, BUNRAKU's work on virtual reality and simulation, EVASION's work on animation and interaction with natural scenes, etc.

2. INRIA's organization, in terms of forming such teams with a clear focus and strong scientific leadership, is a great example that can possibly be emulated by other research organizations worldwide. The combination of tenured researchers along with partners from universities (including faculty and students) and industry is clearly resulting in very high quality scientific work and should be encouraged. The review panel was also impressed by the fact that the scientific leaders and the rest of team members were provided with enough flexibility

in choosing their research goals and collaborations with external groups. We would like to mention that some of the scientific leaders in this group are amongst the best researchers in their respective areas. As a result, these leaders should be given more flexibility in choosing their goals and research agendas, and not be repeatedly asked to present short-term plans in terms of two-year or four-year goals.

3. The research areas, including computer graphics and interaction, supported by these themes, are very important and fundamental to not only Computer or Information Sciences, but also related disciplines in Physical Sciences, Social Sciences, Engineering, Medical and Humanities. Furthermore, the economic impact on various industry segments including computer gaming, computer-aided design, digital movies and animation, computing devices (including mobile devices and handheld), training, etc is very high. We ask INRIA to consider allocating more resources in terms of permanent researchers, as well as staff support in terms of programmers, postdocs and students in terms of making a stronger impact. In this regard, INRIA should be more opportunistic and aggressive and try to grab top or senior researchers whenever they are available. Moreover, INRIA should be rather receptive to applicants who can open new scientific horizons and research theme. For example, Marie-Paul Cani is forming a new group (IMAGINE) and should be given full-support in terms of hiring appropriate personnel immediately.

4. Some of the members of the review panel felt that the current setup of INRIA is somewhat bureaucratic (as compared to other research organizations) and may not offer adequate flexibility to the researchers in terms of achieving their goals. More specific cases are pointed out in the detailed reports for each project. For example, it appears that the process of obtaining new positions and hiring can be slow and cumbersome and it can take a relatively long time to recruit personnel for interesting new efforts. Furthermore, there does not appear to be sufficient flexibility in terms of using external research funds. We understand that INRIA has excellent processes for "traditional" computer science research where funding is primarily required to pay for researchers, engineers, equipment in a laboratory setting, and travel to conferences. In contrast, the research in “interaction and visualization” often requires that research be conducted away from the laboratory, and the attendant expenses are vastly different from that incurred in more traditional computer science. For example when evaluating software or hardware artifacts with users in realistic usage settings in the field, a researcher might need to pay for internet connectivity at a user's home, buy computers and other equipment for use in the user's home or for mobile use, and also pay honorariums (or some compensation) to the users for their time. This is considered as part of the cost of performing “user-studies”, which are an integral part of scientific evaluation. Our understanding is that currently it is rather difficult for researchers to use their allocated funds for these types of expenditure, due to such expenses not being on the general "list of approved expenses" at INRIA. This panel strongly recommends that INRIA take steps to remove such bureaucratic impediments, and allow researchers to spend their funds as required for their research, rather than having to battle the bureaucracy at every step. If these sorts of impediments remain, it will be very difficult for researchers within this theme to compete effectively with their international counterparts, who work in organizations that have a more nuanced understanding of what constitutes computer science research and the expenses required to sustain such research.

5. From a personnel perspective, researchers in this theme are also hampered by their inability to hire, even on a short-term consulting basis, required talent in cognate fields like industrial design, visual arts, or psychology. If it is serious about developing and sustaining a world-class presence in this theme, INRIA should reconsider its current policies with regards to not hiring personnel outside computer science. Just as a software systems researcher might need to hire programmers for their team (which INRIA currently supports), a user interaction researcher might need to hire an industrial designer or a visual artist, in order to support their research endeavor. Several of the very best groups worldwide in this field (e.g., at Carnegie-Mellon University, Microsoft Research, Xerox PARC, Georgia Tech) have thrived, because they have embraced and integrated talent from outside computer science into their research agenda corresponding to graphics and interaction. We strongly recommend that at the very least INRIA consider allowing researchers in this theme to hire such required talent on a short-term basis initially, with the goal of considering full-time hires in the long term. Similar flexibility should also be offered in other aspects of conducting the research and the scientific leaders are the best persons to make these decisions.

6. It appears that INRIA compensation package may not be competitive with researchers working in other parts of Europe or North America. This can be a serious issue in terms of hiring young researchers or stars, including recent Ph.D. graduates. One possibility is to offer improved compensation in terms of hiring a high amount of housing allowance or other forms of compensation, especially in the early stages of their research careers.

PROJECT REPORT FOR ALCOVE

1. Primary Topics and Objectives

The project team, ALCOVE, aims at developing new methods and tools for interactive frameworks, addressing INRIA's scientific objective in "Interaction with Real and Virtual Worlds". In particular, the team focuses on physically-based simulation, virtual reality, and human-computer interfaces.

During the last 4 years, personnel changes had led to the restructuring of the group into a natural splitting of two new project teams: MINT, which focuses on the human-computer interaction; and SHAMAN, which focuses on physically-based simulation and the joint development of SOFA with other INRIA project teams (EVASION, ASCLEPIOS, MOAIS).

2. International Standing and Reputation in the Field

The problems addressed by ALCOVE are important. In particular, the area of tactile interaction is moving in a promising direction, and research on haptics appears to be scattered throughout different groups within INRIA. In comparison to these efforts, the ALCOVE team focuses on the device design and has also published in some Physics and Electronics journals. The most recently hired team members have good reputations within their respective fields, such as HCI, Medical Imaging, etc. and are excellent additions to the overall team.

SOFA, a large-scale INRIA partnership effort among multiple projects, has been gaining recognition for their software contribution to the physically-based and medical simulation and is poised to make greater impact in medical applications in the near future.

3. Major Achievements and Impact

One of the most notable achievements for ALCOVE is the development of SOFA and its applications, including training & planning for laparoscopic surgery, interventional radiology (e.g. laminar flows within the vascular system, flow of contrasting agent diffusion in the blood), virtual cataract surgery, and collaborative physical simulation.

There is a growing active community for SOFA. For instance, researchers in medical simulation and medical imaging communities are using SOFA, which has been ongoing for about 4 years. In fact, there were two papers in MICCAI, a leading conference in Medical Imaging Computing and Computer Assisted Intervention, which cited the use of SOFA in their research this year. This is a good indication that the software system, SOFA, is gaining recognition among this community of users and researchers.

Other scientific accomplishments include pointing techniques, human-computer interaction, and design and development of tactile devices.

4. Industry Transfer and Partnership

The MINT team is exploring various possible venues for more effective and faster technology transition, though there are clear challenges in rapid and convincing demonstration of their research ideas, as well as mass marketing and incorporation of new tactile devices that would be cheap, durable, and easy to adapt into existing platforms.

The SHAMAN team has collaboration with a surgeon on validation of liver modeling for laparoscopic surgery. SOFA project, a partnership among ALCOVE (mechanics & contact response), EVASION (architecture & C.D.), ASCLEPIOS, and MOAS, has made some notable technology transfers. For example, SOFA software has been used by Digital Trainer, a start-up company, for medical training.

5. Training of Personnel

The ALCOVE team is to be commended for its commitment to training and capacity building. The researchers within the group are currently advising and supporting 15 Ph.D. students. Several of the researchers within the MINT group are university faculty members and will likely continue the same level of training and advising. It is less clear how the training of personnel would continue with the SHAMAN group, which consists of mainly full-time researchers and full-time staff who may not have as much direct contact with students, after the re-organization of the ALCOVE team, though we believe they are well capable of serving as research advisors to Ph.D. intending students.

6. Principal Strengths and Weaknesses of the Project

The new project team, MINT, has a combination of HCI, graphics, and hardware expertise, and the research projects appear to span from hardware, software, algorithm, to experimental user evaluations that are generally related human-computer interaction without a coherently expressed vision or a unified challenge that binds the group members together. In particular, the panel also questions whether the prior research interest and background of Laurent Grisoni may be better aligned with the SHAMAN team, though he seems to be moving towards HCI. The quality of publications and intensity of international/national positioning within the MINT group is quite variable and perhaps should become more uniform with higher standards.

After the split of ALCOVE team, the SHAMAN group has assembled a much more homogeneous team of researchers with a common research pursuit in medical simulation and applications. The focus on the development of SOFA also helps in terms of honing their efforts and their longer-term vision. At the same time, it also presents some challenges in terms of splitting their time on fundamental scientific investigation vs. software development & support.

7. Plan for the next period (4 years)

The research plans for the MINT group during the next 4 years include a loosely connected collection of research projects, including (1) pointing & transfer functions (currently studied in 1D) with possible extension to 2D/3D, scrolling, etc. (2) design of tactile devices for generating feels of gratings and texture, as well as pointing; (3) continuing development of associated applications.

In the longer term, the SHAMAN group hopes to achieve image-guided surgery planning in 10-15 years. The short-term plans include (1) creation of organ models; (2) real-time simulation of organ deformation; (3) validation of simulation models; (4) deployment in a clinical environment.

8. Opportunities and risks/difficulties faced by the project

Demonstration of ideas and development of appropriate applications takes time. The researchers in ALCOVE have expressed needs to get more resources for application development. However, in comparison to other groups, this project team already has more permanent researchers and full-time staff. It will be up to INRIA to prioritize the resource allocation based on research productivity, the international visibility of the group, the impact to the community, human resources development, and technology transfer.

9. Recommended actions and suggested measures of success

In order to improve synergy, the MINT team is recommended to focus on some possible, larger group project that builds toward a common system or even a unified application framework. At the same time, it is important that the individual researchers are able to pursue their research interests. At this moment, several projects appear to have rather incremental impact without a cohesive vision within the group.

In contrast, the SHAMAN team, SOFA project and its connection to other INRIA research teams have a more clearly defined goal. Moreover, the SOFA group is on an excellent trajectory in terms of gaining more national and international visibility, particularly in medical simulation and computer-aided surgery. We would encourage this team to continue engaging in collaborative efforts with other INRIA and international teams, as well as explore novel applications of their work.

The impact of SOFA can be best achieved through community outreach to researchers, developers, and users. Such ambitious efforts can be very time-consuming and financially costly, with some possible risk of leaving little time for more exploratory research but greater focus on incremental advancement. We caution the SOFA team to continue the good work, while keeping a conscious effort to maintain a delicate balance among research, application development, and software enhancement.

PROJECT REPORT FOR ALICE

1. Primary Topics and Objectives

There are four main research topics pursued in the project team, ALICE. Three of them are in digital surface processing domain, namely, sampling techniques, global parameterization, and spectral mesh processing. Some of the works are also motivated by developing better solvers for finite-element meshing, which is one of the fundamental problems in scientific computing. In sampling, a faster relaxation method based on the Newton method was introduced recently, leading to a variational hex-dominant meshing method. The scope of these methods is large and can have impact on a wide class of algorithms beyond computer graphics. In terms of global parameterization, Bruno Levy proposed the first fully automatic global parameterization formulation, together with an algorithm to automatically convert mesh models into splines. Using spectral mesh processing, the team ported Fourier analysis into the context of 3D surfaces. The latter has raised a lot of interest and Bruno Levy has given several invited talks and courses on this topic. The forth topic within ALICE is the contribution of Sylvain Lefebvre in the field of texture synthesis. Sylvain introduced a texture retargeting method for architectural textures. Their method can be used to generate a large variety of textures from a small set of examples and enhance the visual richness of large virtual environments at a low cost.

2. International Standing and Reputation in the Field

The ALICE team is very much respected in France and worldwide. The project leader, Bruno Levy, is a classic scientist and gets a lot of respect in the community He is regularly invited to give talks and courses and also served as the Program Co-Chair for ACM SIGGRAPH/Eurographics Symposium on Geometric Processing 2010. ALICE is definitely one the leading research groups worldwide in digital geometry processing. Recently, Bruno co-wrote a book titled "Polygon Mesh Processing" published by AK Peters with a number of collaborators, which is becoming a standard reference in the field. Bruno collaborates with many colleagues in France and worldwide and also been successful in getting external funding for his group (esp. European Union). Since Bruno focuses on the continuous mathematical formulation of the underlying problem, it allows him to "talk the same language" as the applied mathematics community, and bring new mathematical tools to digital geometry processing. This brings a new angle complementary to other researchers working on these problems from a discrete viewpoint.

3. Major Achievements and Impact

The team has published a high number of papers in the most prestigious venues in computer graphics and geometric processing, and some of them are highly cited. Bruno and Sylvain have given tutorials at conferences, and Bruno was a co-author of a book. The team provided two open source software programs:

(i) *Graphite.* They released their Graphite research platform, and nowadays it is widely used in the geometry processing research community. Alla Sheffer (UBC) uses it for her class, Fredo Durand used it for computing texture atlases; and Paul Debevec used it for his "virtual parthenon" project. The *Graphite* system was used in some recent SIGGRAPH papers. See alice.loria.fr/software/graphite. Graphite received two prizes during the international "trophees du libre" software competition. This is noted as one of the highlights in INRIA's contribution to OpenSource, see http://www.inria.fr/institut/strategie/logiciel-libre. With several thousand downloads per year, Graphite is one of the most downloaded software from INRIA (see gforge.inria.fr)

(ii) *OpenNL/CGAL Parameterization package.* The OpenNL library is a set of linear solvers for sparse systems. It has been used by several open source as well as commercial software systems. See http://alice.loria.fr/software/opennl for more details. The latest version supports solvers on the GPU. The team also developed an extension package for CGAL (with P. Alliez) that implements several parameterization methods. CGAL is a very widely used library in multiple domains and has a large user base.

4. Industry Transfer and Partnership

In this respect, the team is doing extremely well: (i) they created the "Scalable Graphics" startup. They market solutions for high performance visualization that were developed in ALICE; (ii) they cooperate with the GOCAD consortium that develops a 3D modeler for oil and gas exploration. It uses several of their algorithms (geometry processing, meshing). GOCAD is widely used by the oil and gas industry (all the major oil companies are members of the GOCAD consortium); (iii) they develop texture synthesis methods in cooperation with the "Allegorithmics" company; and finally, they filled two patents in 2010 (one for their hex-dominant meshing technique, and the other one on "by example texture synthesis").

5. **Training of Personnel**

In the last four years of existence, ALICE hired permanent researchers and reached a critical mass. The coherence of the research projects helped the researchers in ALICE to apply for external funding. Some of the projects (GOODSHAPE, Physigraphics) provide the team with sufficient resources to avoid spreading the effort in applying to multiple grants; the software developed by the team (Graphite, OpenNL, LibSL) is both an indication of the team ``know-how" and a good communication vector for further development. The team has been trying to recruit good Ph.D. students to their group as well.

6. Principal Strengths and Weaknesses of the Project

The principal strength of the team is their solid mathematics and creativity which allowed them to significantly improve fundamental algorithms (like Lloyd's algorithm), solve important open problems (mesh to spline conversion, hexahedral-dominant meshing, by-example texture synthesis), and publish the results in major venues (ACM SIGGRAPH, ACM TOG, Eurographics). The team, however, mentioned the difficultly in attracting good PhD students (more below).

7. **Plan for the next period (4 years)**

ALICE team has a clear agenda regarding geometry processing. They plan to revisit various applied mathematics methods, used in numerical simulation and control. In particular, they plan to develop dynamic space discretizations used in Finite Element Modeling (FEM) that could replace a more static sampling method, which will self-adapt and represent the physical quantities with higher efficiency during a numerical simulation. The group members have already started implementing this vision; they have proposed a general mathematical framework that they call "Dynamic Function Basis" (DFB). DFB introduces additional degrees of freedom in the FEM formulation, together with a general algorithmic framework to solve for approximation and sampling simultaneously.

Currently ALICE team is already experimenting with the interesting problem of sampling an "unknown" object, described by the solution of a PDE. The ALICE team has concrete plans to study three problems: light transport equation, computational fluid dynamics, and anisotropic sampling for surfaces and volumes. Based on their past work and experience, we believe that these techniques and applications are promising. Some of the solutions investigated by ALICE team can have a major impact on the next generation FEM (finite-element mesh solvers). We feel that INRIA should provide more resources to this team (e.g. engineers or supporting staff) to explore rapid transition of their technologies to major FEM commercial developers in France and the rest of the World.

Another research direction that will be led by Sylvain Lefebvre is texturing and modeling. Their main motivation is "easy content creation", which remains an important challenge in computer graphics. Their plan is to contribute to this challenge by developing new methods for "by example" content creation. Their approach will also take the requirement of a both compact and efficient representation, which is also well suited to real-time rendering. We believe that easy content creation is indeed an important direction and given the expertise of Sylvain this direction is a good fit to the team.

8. Opportunities and risks/difficulties faced by the project

Team leadership and funding are not the major issues. As we understand, the main hurdles in achieving their goals are the difficulty in attracting good Ph.D. students and ensuring that they have enough senior personnel to supervise them. Based on our conversation with the team members (and we do not claim to understand these issues), there is no M.S. degree offered in ``"computer graphics" in Nancy. Furthermore, only Bruno Levy is able to supervise Ph.D. students at the moment. ALICE is somewhat isolated in this theme in Nancy. The strong connections with the community should make it possible for them to attract good post-doc researchers and applicants for permanent researcher positions, but this does not apply to graduate and Ph.D. students. They plan to give courses at several universities in France (including in Nancy) as means to access and approach top-level students. They may also try to recruit more international Ph.D. students to their research group (e.g. similar to ARTIS group). INRIA should provide more support and resources and make it easier for them to attract good Ph.D. students.

Another issue raised by the team is the limitation to employ developers and engineers for more than three years in INRIA. As mentioned in our overall recommendations, we suggest that INRIA should relax these rules and make it easier and more flexible for researchers to employ engineers or developers for a longer duration. Longer-term contracts for the staff would help improving and maintaining a higher quality of software systems that will offer better services to the community.

9. Recommended actions and suggested measures of success

To sum up, this is a strong team, led by Bruno Levy, who receives considerable respect in the community. The team is very much centered around him, but now with Sylvain Lefebvre joining, the group focus will change somewhat, and the group will enjoy the dominance of two strong members. Moreover, it seems that there will be a good synergism between the two senior researchers, with cross-fertilization of ideas, methods and concepts. The team had produced excellent research in the last four years, which has had significant impact. There is no doubt that this team is excellent shape and we expect them to continue making strong contributions to computer graphics, geometric processing, and scientific computing.

As mentioned above, the team also has promising directions for research. The team is well funded and has an excellent leadership. Perhaps a tough measure of particular success is to see more successful graduate or Ph.D. students emerging from this team. Other than publishing high-quality papers, the team should continue transition of their software technologies to industry or other research groups and try to attract high-quality Ph.D. students to their group.

PROJECT REPORT FOR ARTIS

1. Primary Topics and Objectives

The original and central focus of the ARTIS team has been in rendering and image synthesis. The group has been working on fundamental problems related to acquisition, representation and transformation. The ARTIS team was formed in 2003 under the leadership of Francois Sillion and has been headed by Nicolas Holzschuch since 2007. Over the last four years, this group has worked on the general framework for creation of synthetic images and developing techniques to generate realistic images, as well as real-time rendering on current commodity graphics processors. The specific problems pursued by this team include: model creation from multiple data sources, mathematical techniques for transformations between models, rendering and image generation algorithms, and modifying or fitting these methods to different applications.

2. International Standing and Reputation in the Field

INRIA Research Center at Grenoble Rhone-Alpes has a long history in research on rendering and image synthesis for almost two decades. It is regarded as one of the best research groups worldwide in these areas. The team has contributed to the field by proposing many new representation and algorithms along with training of the best researchers in the field. Over the last four years, this group has also worked with strong teams at Cornell University, MIT, Columbia University, University College London, Adobe Research, as well as other research groups at other INRIA locations, which has resulted in excellent publications. In addition, many of their students pursued summer internships at other universities, including Princeton University, University of Illinois at Urbana Champaign, University of Michigan at Ann Arbor, etc., and this has resulted in extended collaborations.

The team has been quite productive and prolific in terms of publications. They have co-authored a high number of papers, including 31 journal papers and 18 conference papers over the last four years. Moreover, the quality of their work is very high, including 10 papers in ACM Transactions on Graphics (including SIGGRAPH and SIGGRAPH Asia), 14 papers in Eurographics Conferences and Workshops, 2 papers in IEEE Transactions on Visualization and Computer Graphics, etc. These are regarded as the best venues to publish in computer graphics and related areas, and some of these conferences have an acceptance rate of less than 20%.

3. Major Achievements and Impact

Apart from very visible publications, it is worth noting other significant development and transfer of knowledge in the form of:

1) Many software systems for watercolor rendering, non-photorealistic rendering from 3D scenes, creating video games and virtual physical experiments, and global illumination.

2) The team has collaborated with many studios for transferring their technology for gaming or rendering software. The collaboration with Adobe Research has been incorporated into After Effect Plugins, which are widely distributed. In addition, they have also collaborated with many start-up companies.

3) The team members have played many leadership roles including chairing major conferences and serving in a high number of program committees. In addition, ARTIS team members have participated in many national initiatives and international projects. The group has been successful in attracting funding from many external sources to support a large team and transition their technology.

4) Strong fundamental results on light transport equation, watercolor rendering, expressive rendering and interactive rendering of very large datasets.

4. Industry Transfer and Partnership

As mentioned above, their record in this aspect is excellent.

5. Training of Personnel

The team has supervised 10 Ph.D. students and 1 postdoc during this period. Most of the Ph.D. graduates were recruited by top industrial organizations and movie studios, and some took up research or academic positions.

6. Principal Strengths and Weaknesses of the Project

The team's main strength has been in rendering and image synthesis, which are among the fundamental problems in computer graphics. Along with national and international collaborations, this team constitutes one of the strong research groups within INRIA. Their impact in terms of publications, technology transition, training good students, is very impressive. They have strong ties with local universities and continue to attract top Ph.D. students from France and other countries.

The team lost some strong researchers during the last four-year period, though they have the critical mass to pursue their research agenda. There was some concern among the members of the Evaluation committee that the field of rendering or image synthesis is regarded as quite matured. As a result, it is not clear how much room is left for fundamental improvements, though many incremental results could be developed. In that regards, the diversification of the group by adding some researchers from scientific visualization is a very positive step forward, as well as adding more focus on expressive rendering.

7. Plan for the next period (4 years)

They have asked for termination of the ARTIS project-team, and present a new INRIA research project (GraHumPf). The new project will continue the research on real-time rendering, but also include additional focus on expressive rendering and visualization. The addition of two researchers from EVASION team, Georges-Pierre Bonneau and Eric Bruneton, is a positive step and could lead to new research directions. Furthermore, the group wants to increase its scope in terms of dealing with large and diverse inputs including data fields, videos, images, and 3D geometric description, and this could lead to new, versatile representations.

8. Opportunities and risks/difficulties faced by the project

It may be important for the team to broaden their research agenda, as compared to the last four years. It is possible that more useful results may come from combining results in light transport equation with expressive rendering and visualization. Furthermore, a new set of applications related to creative processes or scientific datasets could provide some novel driving applications to the group to pursue their research agenda.

9. Recommended actions and suggested measures of success

The Evaluation committee was very impressed with the accomplishments of ARTIS and the proposed team structure and agenda for GraHumPf. The team has the critical mass to pursue their project goals and continue publishing at the top venues. As a result, the committee requests strong support from INRIA management for Project GraHumPf. At the same time, we also encourage the researchers belonging to GraHumPf to broaden their agenda and explore more collaboration with researchers working in modeling or animation or perception at other INRIA labs and international institutions.

PROJECT REPORT FOR AVIZ

1. Primary Topics and Objectives

The AVIZ group's research focuses primarily on Information Visualization, a research area that cuts across the broader areas of computer graphics, human-computer interaction, visual design, and cognitive and perceptual psychology. Major areas of focus include:

- Exploring techniques for interactively visualizing and navigating very large data sets. Examples in this domain include exploration of social networks such as Facebook.
- Building infrastructure for constructing complete systems for visual analytics that implement the various new techniques to search, visualize and analyze the large data sets of interest.
- Developing methodology for evaluating the efficacy of techniques and systems for Information Visualization, from both human usability and computational efficiency standpoints.

The group's approach is to combine these focus areas in ways that have generated, and will continue to generate, highly innovative and usable interactive information visualization systems. This is an excellent approach, and AVIZ is one of a very small number of groups worldwide that are approaching this problem area in such a holistic manner.

2. International Standing and Reputation in the Field

AVIZ is amongst the top 10 groups internationally in the broadly defined area of Information Visualization. It is without a doubt the top such research group in this area in France, and is amongst the top 3 groups in Europe. The strength of AVIZ is its unique ability to combine interaction with visualization, and in the sub-area of *interactive* Information Visualization, which AVIZ primarily focuses on, this review panel strongly believes that AVIZ is *the* top group in Europe by a wide margin. In addition to its standing in the Information Visualization community, AVIZ also contributes to the broader human-computer interaction community where it has significant visibility.

AVIZ's team leader, Jean-Daniel Fekete is an internationally recognized leader in the field, and regularly serves in leadership roles at the top conferences (e.g., as papers and conference chair for IEEE InfoVis). The more junior members of the team (e.g., Dragicevic, Isenberg) are also quickly gaining significant international research reputations and have been invited to serve on top conference program committees. The group regularly publishes influential papers in the top journals and conferences, and its work is regularly cited and used as the basis for other group's research.

3. Major Achievements and Impact

It is particularly notable how rapidly AVIZ has established itself as a top group in the field. Despite its relatively small size (just 2 full time researchers until the recent growth to 4), its productivity is outstanding. The group's publication record is outstanding, with numerous papers in the top venues and *five* Best Paper awards over the past 3 years.

Also notable is that the group makes its systems and toolkits available to the broader community, which has enabled other researchers and developers to us the group's research as a building block for their own work. This approach to dissemination of research results is highly impactful, but one that requires tremendous commitment on the part of the researchers.

4. Industry Transfer and Partnership

The group has released several toolkits and systems (e.g., InfoVis toolkit, ScatterDice, Diffamation, GraphDice, and GeneaQuilt) to the world, thus engaging in tech transfer in the broadest sense of the term. It is also a major contributor to the Taranis platform for crisis management training, the elements developed by the group are being extended by their industry partner MASA group.

The group is also engaged in discussion with Microsoft and Exalead.com in terms of commercializing their ScatterDice system. Overall, this team has an excellent record of industry partnership and tech transfer.

5. Training of Personnel

AVIZ has a strong personnel training record, with 10 trainees having moved on to excellent positions elsewhere. Particularly notable are that recent graduates Nathalie Henry, a research scientist at Microsoft Research in Redmond, and Niklas Elmquist, an Assistant Professor at Purdue University.

Group members are also in the process of starting a new Masters program in HCI/InfoVis in collaboration with the University of Paris and Ecole Centrale. The group is also developing connections with top schools in China and Germany in terms of international student recruitment.

AVIZ also has a good record of training postdoctoral fellows. It is internationally regarded as an excellent place to do a postdoc in InfoVis, and the group consistently gets many requests for positions from top graduates. However, its ability to accept these top postdoc candidates is constrained by funding in that the stipend offered is not currently competitive with international standards. Perhaps INRIA should offer them more resources to support such postdocs.

6. Principal Strengths and Weaknesses of the Project

The major strength of the project is the focus on integration of interactive exploration, visualization and modeling into real working systems. Also unique is that the group is targeting multiple different application domains for their visualization systems. This has the potential to impact how people in many fields (e.g., the broader public through social network visualization, and scientists through biological visualization) can access and manipulate vast quantities of data. This sort of broad potential impact is excellent.

The primary weakness is not due to the group itself (which is superb) but rather the institutional structures that will limit the group's ability to "move to the next level". One crucial weakness is that the group lacks sufficient engineering resources to develop and maintain the systems and toolkits that the researchers are developing. Another weakness is that although the group is highly attractive to top-notch international talent as a place to do research in InfoVis, its ability

to recruit the very best talent is limited by salary levels and limited resources that are not internationally competitive.

7. Plan for the next period (4 years)

The group's plan for the next period is ambitious, but given the track record of the group to date it should be realizable. Several key components include:

- Developing a deeper understanding of the findings and theories in perceptual and cognitive psychology to improve how information vitalization systems are built and evaluated. This is an appropriate direction to pursue, especially as the field matures beyond proof-of-concept prototypes to real-world usable systems.
- Exploiting emerging display technologies for visualization systems. In particular, the focus on multi-display and tangible interaction will push the research agenda on collaborative visualization into new directions. Here, the close proximity of AVIZ with the IN-SITU group will be a key advantage over other researchers worldwide, as the combination of AVIZ's strength in Information Visualization with IN-SITU's strength in broader human-computer interaction topics will be unbeatable.
- The group intends to continue its work on developing better techniques for evaluating information visualization systems. This is also a crucial agenda that is required to move the field into the next stage of maturity.

The group's publication goals are quite impressive, with their intent to pursue beyond the traditional publication venues and attempts to publish in broader scientific journals such as Science and Nature. This will significantly increase the exposure of the group's work to cognate disciplines that could potentially leverage these visualization systems for their own research.

The group's plan for PhD student and postdoc supervision is appropriate. We note that the group does not intend to grow significantly in terms of full-time personnel; this is fine, as it underlines the group's focus on doing the highest quality research rather than expanding scarce resources on managing an overly large team.

8. Opportunities and risks/difficulties faced by the project

As previously noted, the group is well positioned to execute on its intended plan. The opportunities in blending theories/findings from psychology and visual design with the information visualization expertise of the group to generate game-changing systems are clearly evident. The ability to use the web to disseminate working systems to the broader community and also to solicit feedback for iteration is also a key opportunity that the group is well positioned to exploit.

The main challenges that will be faced include engaging with collaborators in cognate disciplines who could be beneficiaries of the systems being developed by AVIZ. Such collaborations require much higher time investment, and there is a risk that a small team like AVIZ might not be able to devote the time required to fully leverage such collaborative opportunities. In spite of their size, the group's track record in this regard to date is quite good. Another challenge is to do with

INRIA's structures and ability to act flexibly to enable recruitment of top talent, as mentioned earlier.

9. Recommended actions and suggested measures of success

The group's research plan is sound and this panel recommends proceeding as intended. One key issue that needs to be addressed is the ability to recruit top international talent. As alluded to previously, the AVIZ group can be a magnet for top talent who wish to pursue PhD studies, postdoctoral fellowships, and full time employment in a world-class InfoVis group. However, the relatively low salary scales paid by INRIA in comparison to its international competitors currently hamper this possibility. The salary differences (in the 40-60% range when compared to the salaries in USA and Canada) are huge, and hence a significant deterrent for young international talent considering their worldwide options. If AVIZ is to further enhance its international stature (to become, for example, *the top* InfoVis group in the world), INRIA really needs to work on improving this situation.

PROJECT REPORT FOR BUNRAKU

1. Primary Topics and Objectives of the Team

The BUNRAKU team, led by Georges Dumont, is one of the largest research groups and is mainly working on virtual reality. Some of the research is related to real time high-fidelity rendering and the group members are also working on issues related to populating virtual world with autonomous characters as well as interaction with virtual worlds. These characters are either simulated at an individual level (e.g. autonomous characters driven by path planning algorithm) or simulated as a group using crowd simulation algorithms. In terms of interfaces with virtual world, the group is exploring Brain Computer Interfaces (BCI) and Haptic interfaces along with human perception.

2. International Standing and Reputation in the Field

The group has published a high number of papers in top international conferences and journals. The last volume of the "Traité de la réalité virtuelle" dedicated to virtual humans is mainly written by people from the team and directed by Stéphane Donikian. This book and the other volumes stand to be the state of the art and are produced by the French research community.

The BUNRAKU team, having grown from 36 to 48 people, is now leading the Virtual Reality research group in France. Bruno Arnaldi is the president of the French association promoting virtual reality and includes all the key players from academia and industry. The BUNRAKU team was one of the major animators of the European Network of Excellence INTUITION (Framework program #6). The team is a key player at the national and also at the international level in the 3 domains the team is involved in: virtual reality, graphic rendering, and animation.

3. Major Achievements and Impact

The research project BUNRAKU has produced obvious significant results in all the topics mentioned above. BCI and haptic interaction are complementary and results are important. Progress is shown in the domain of real-time rendering of complex scenes with global illumination calculation by the works on algorithm optimization, hardware based accelerations and use of perceptual methods to improve the computational efficiency. The creation of Golaem is the proof of maturity and skill of the team in the domain of autonomous characters animation. Interesting work has been done in automatic system for camera control, which could be linked to path planning and the control of the camera following a character).

The team is also quite active in terms of software system development based on their algorithms and other teams and the broad community are using these systems. Scientific achievements are important and largely used in the numerous relations with the industry (see section 4).

4. Industry Transfer and Partnership

The team was involved in numerous national and European funded projects that led the team to interact with heavy industry, automotive and transport industry, CAD software designer, etc. Industrial partnerships have always been important in the team, which maintains collaboration with the most advanced user of virtual reality facilities.

Some software has been published under open source licence (OpenViBE, OpenMask for the most important ones). OpenViBE is devoted to the Brain Computer Interface and is increasingly used, as it offers a new and modern platform to test BCI. It seems to be the most successful software produced by the team over the last few years. Generic Virtual Training (GVT), a software system designed in collaboration with the CERV (Centre Européen de Réalité Virtuelle) for training using is commercialized by Nexter Training.

Two thirds of the former PhD students are now working in the industry in France or elsewhere. Five engineers left to work in the Golaem Company (a spin-off created in 2009 and leaded by Stephan Donikian).

5. Training Personnel

Ten PhD theses have been successfully defended since 2006. The team includes 25 PhD students at the moment, along with two professors and 7 associate professors. Two thirds of the former PhD students are now working in the industry in France or elsewhere.

6. Principal Strengths and Weaknesses

There is a strong basis of collaboration in the team. Collaborations occur at two levels; at the scientific level where collaborations fill the gaps in this large domain, and collaborations with industry that its needs given many national or European funded projects. The team is a key player in the domain and is considered a leader in the corresponding research areas.

The team is large enough to allow diversity of skill sets, as long as the number of objectives is not too large in terms of overall focus. One could consider if the research on real-time rendering could be transferred to more specialized team working on rendering. Nevertheless, that skill is useful as BUNRAKU team is developing overall technology for virtual reality and working closely with industry partners.

7. Plan for the Next Period (4 years)

The BUNRAKU team want to continue reinforcing studies on Brain Computer interfaces and haptic interfaces while keeping two other objectives :

- simulation of virtual humans;
- real-time rendering and multi-view 3D display.

8. **Opportunities and Risk/Difficulties**

The BUNRAKU team appears to be pleased with its current size and structure, but anticipates a possible restructuring into two or three smaller groups that will closely collaborate with each other. These smaller projects appear clearly in the current organization of BUNRAKU with (1) Multimodal interactions (haptic, BCI), (2) High-level interactions with (expressive) virtual humans, and (3) interactive rendering. The sub-project (3) may rather merge with the (2), as high quality rendering is needed for realistic simulation of virtual humans.

9. **Recommended Actions and Suggested Measures of Success**

Collaboration with hardware companies designing virtual reality products could be strengthened. In the past, many significant improvements in terms of virtual reality have often been related to major hardware improvements. The team should be aware of the break-through technologies that may change the paradigms of interaction.

In the BCI domain, BUNRAKU team wishes to continue investigate the sub-area in signal processing. Stronger collaboration with teams working on different ways to observe the brain activity must be considered.

Coherence within the 3 main objectives for the next period needs to be reinforced, if the team is not restructured into smaller groups.

PROJECT REPORT FOR EVASION

1. Primary Topics and Objectives

The original and central focus of the EVASION team is the geometric modeling, animation, rendering, and interaction with natural scenes and phenomena. However, the proposed models and methods were not limited to natural scenes; the team also made some contributions in a much broader area of applications concerned with handling large, complex, and potentially dynamic data sets (hair, cloth, industrial & scientific datasets). The group has conducted excellent research in this area and produced excellent technologies which are widely used by other researchers and developers

Among the main thrust of research, the SOFA project offers an open-source environment for real-time physically based simulation of deformable models and medical simulation, and collaboration with other INRIA teams (ALCOVE, ASCLEPIOS, and MOAS). The EVASION team is responsible of the general software architecture and developing some major components. This is a great project which can have deep and broad impact.

2. International Standing and Reputation in the Field

The EVASION research group has successfully taken advantage of the complementary expertise of its members to achieve impressive results in all the topics mentioned above. The team ranks amongst the best international teams in its field in these areas. They have also established collaborations with other leading research groups (e.g. at other INRIA locations and UBC). It has maintained its high standards since the last evaluation. The quality of the publications has increased over the 4 years period with a higher number of major journal publications (ACM Trans. On Graphics, Computer Graphics Forum, IEEE Transactions on Visualization and Computer Graphics, IEEE Computer Graphics & Application, ACM Transactions on Applied Perception). In addition to the journals, the group has been consistently publishing in high profile conferences including ACM SIGGRAPH, Eurographics, Symposium on Computer Animation, Shape Modeling, etc. Some of these conferences have an acceptance rate of less than 20% and use a highly competitive peer review process. As a result, these conferences are often regarded as the best venues in terms of impact and prestige. Moreover, their papers are well cited by other researchers.

The high research impact is due to the impulse of Marie-Paule Cani, who is regarded as one of the main authorities in this area, and the accomplishments of the senior members of the team (including those who have left). All senior members have contributed to high impact journal papers. We also want to point out the contributions of Francois Faure as one of the main architects of SOFA.

3. Major Achievements and Impact

Apart from the well-regarded publications, it is worth noting other significant transfer of knowledge is in the form of:

1) General public dissemination: La recherche, demos at SIGGRAPH, fete de la science. It was great to see that even the school kids can use their modeling package (based on implicit surfaces) and generate intuitive shapes. These kind of tools are great to excite the next generation of researchers towards these fields ;2) Threetents, some of which are evaluated by their industrial partners;

3) Three major software platforms: SOFA, Proland, Aestem Studio. The SOFA open source software is under the responsibility of François Faure in EVASION; its success is remarkable with more than 80,000 downloads, after only four years of software release. The platform has evolved from being a repository of algorithms used in completed projects to become the reference software framework for launching new projects. It has begun to be acknowledged by papers published in the MICCAI conference from independent research teams (MICCAI is a high quality conference in computer aided medical intervention). Furthermore, other researchers working in physically based modeling, finite-element modeling and collision detection are using the SOFA benchmarks to measure the performance of their algorithms.

4. Industry Transfer and Partnership

Multiple projects, including 3 PhD students, have been funded through industrial contracts (Axiatec, EDF, L'Oréal, MCE-5) or closely related entities (CEA-CESTA).

7. Training of Personnel

The team includes about 15 Ph.D. at the moment, 12 on average during the last four years. Three to four co-advised PhD students per researcher are an appropriate level. Five postdocs in the group were able to publish in highly ranked journals based on their work in the team. The EVASION team has benefitted considerably with their close ties with local universities**.**

8. Principal Strengths and Weaknesses of the Project

As previously stressed, the complementary expertise of the senior members has enabled the team to address complex large scale problem such as multi-resolution modeling and visualization of large outdoor scenes including ocean multi-scale rendering. Over the last years, their major focus was on "simulation of natural phenomena" and they have clearly achieved the goals. Past successes have also attracted highly qualified students and postdocs whom themselves have made excellent contributions. We believe this positive dynamic can continue given the excellent network of collaborations that has been established by Marie-Paule Cani.

However, the team leader, Marie-Paul Cani, feels that her team has become large and diverse. Instead of continuing for four more years, she has decided to reorganize the team and come up with new project goals for the next four years. The associated management load to keep the team in focus with respect to the initial goals seems not to be worth the effort, especially as the "diverging" sub-projects also produce very good contributions. Instead a new re-organization has been proposed as discussed in the next section.

7. Plan for the next period (4 years)

Marie-Paule Cani proposes to end the EVASION project and start a new, more focused project team called IMAGINE. She gave an excellent overview of her vision and motivation behind IMAGINE. The core members of EVASION presently active on SOFA and the Aestem software on sketch-based modeling would continue to be part of IMAGINE. Four senior persons would remain while two news researchers would step into the project: S. Hanmann & R. Ronfard. Both of them (Hanmann and Ronfard) have diverse and excellent background. In its proposed configuration the IMAGINE team has 1-2 full-time INRIA researchers, as all the remaining senior staff is from partner entities (e.g. INPG) and they have teaching duties.

The main objective of the IMAGINE project is to enable humans to communicate and create together more easily through digital creation (shape, scenarios, motion.). Its main goal is to offer intuitive modeling tools by combining 2D gestural input with high-level procedural models. A pertinent collaboration with the Bunraku team (Marc Christie) planned on cinematographic camera automatic placement (PEUPLADE). The Evaluation Team was very impressed with Marie-Paule's vision on IMAGINE and her goals. We also feel that she needs more researchers with strong background in Physics-based Simulation and HCI to form a complete team. As a result, INRIA Management should make a top priority to hire researchers in those areas. This is a great project idea which can make great impact, and it should be given maximum support in terms of resources by INRIA

Apart from the IMAGINE project, two personnel moves have been planned:

- G.P. Bonneau and E. Bruneton, who focus more on the multi-resolution rendering of large data sets, will join the follow-on project of ARTIS (where F Neyret already went before the present evaluation). Their long-term orientation towards scientific visualization and interactive rendering of large-scale data will strengthen this project in the complementary field. The Evaluation team feels that their background in Scientific Visualization brings an excellent new dimension to ARTIS team and could be of great benefit.
- Two other researchers L. Reveret and F. Hetroy would join the proposed MORPHEO group of E. Boyer where their expertise in computer Graphics should be highly appreciated on topics such as "motion from shape" and low dimensional control space, as they would interact with other researchers in computer vision. In the longer term, the work led by L. Reveret on modeling the locomotion of rodent for its tracking has a great potential in the pharmaceutical industry for improving medicament testing.

Overall, the Evaluation team was quite impressed by the reorganization of this group and composition of IMAGINE.

8. Opportunities and Risks/Difficulties Faced by the Project

Through the documents and the discussions it has appeared that the topics tackled by the IMAGINE project are highly challenging, in particular in the field of narrative design research that have been partly explored in the past. One specific difficulty is to identify the best leverage from the immediate sketch-based temporal input for editing a temporal narrative design at a drastically different temporal scale. The expected collaboration with art school and general public is a good opportunity for assessing any proposition in that field as it has a strong HCI orientation. However, we feel that IMAGINE group needs more researchers and critical mass, especially in physically based simulation and HCI. Without this expertise, they may not be able to meet their objectives over the four years.

9. Recommended Actions and Suggested Measures of Success

The Evaluation committee was very impressed with the accomplishments of EVASION and the underlying vision and goals of the new project, IMAGINE, as proposed by Marie-Paule Cani.

We feel that INRIA should make a top priority to recruit new permanent researchers with strong background in simulation, HCI, and related areas to ensure that IMAGINE would have sufficient personnel at the early stage of this new project to ensure that necessary human resources are devoted to help achieve its goals. This is particularly necessary as the IMAGINE team has only one single full-time INRIA researcher in its initial personnel configuration during the project formation stage. Furthermore, IMAGINE should try to build more collaborations with other leading research groups working in physics-based simulation and artists working in academia or industry (e.g. Disney Research).

PROJECT REPORT FOR IN-SITU

1. Primary Topics and Objectives

The group works on a number of areas:

- Engineering Interactive Systems – its output includes widely used toolkits
- Media communications – it has published a key paper on technology probes with over 400 citations
- Methods – along with articles and papers, they appear to be influencing teaching (multi-media materials used at GATech and Standford)
- Multi-scale pointing – it has been developed in collaboration with principle psychologists in the area and key theoretical breakthroughs such as the notion of motor space vs visual space and multi-scale Fitts' Law.

In the future, the group aims to create a fresh, integrated approach to devices and interaction techniques beyond the keyboard and mouse and desktop interface that we have seen for the last 30 years.

2. International Standing and Reputation in the Field

Members of the team are well known internationally including two members of the ACM CHI Academy (Mackay and Beaudouin-Lafon), one of the most prestigious honors within the human–computer interaction (HCI) community. Toolkits, teaching materials, and other outputs are used worldwide and the team has participated in the organization of the most prestigious conferences and journals in the field.

3. Major Achievements and Impact

The team has deliberately focused on producing a smaller number of high-quality publications and this is evident in their publication record with regular papers in the most highly regarded conferences in the field, including one of the most heavily downloaded papers in the ACM digital library and best paper awards.

The team has also been instrumental in the launching of two further INRIA groups, one of which has already established itself as a leading worldwide presence in its area (Aviz).

Toolkits are widely used, for example in the ZUI telescope in Chili. As another example, the Metisse window system is being distributed as part of the Mandriva Linux distribution, and hence onto ordinary computer users' desktops.

However, there is a broader issue here on how such software distribution, which is one of the target outputs of INRIA, can be supported in the longer term when it goes beyond research

prototype stage. This is no longer the responsibility for the research team, so ideally needs some other form of maintenance or a development team is needed and INRIA should support that.

4. Industry Transfer and Partnership

There have been clear success stories both in terms of direct and indirect connections with industry. For example, the mediated communications work, which created a radically different approach to intimate social networks, has led to a spin-off and there are collaborative projects with industry. Indirectly, several former students have moved on to jobs in high-end companies.

5. Training of Personnel

As noted, previous project team members and students have moved to excellent positions elsewhere both commercial (e.g. Microsoft Research, Disney Research) and academic (e.g. MIT Media Lab) and Fekete has gone on to lead a new INRIA Team.

6. Principal Strengths and Weaknesses of the Project

The long-term vision possible within INRIA enables a style of interaction research that is quite rare in HCI community. This vision has allowed, for example, the end-to-end process from user requirements through fundamental principles and empirical studies to the design, development and deployment of toolkits.

The group covers a broad range of techniques and styles, but integrated. It is rare to see a group that is engaging in fundamental research (e.g. low-level pointing behaviour), but which also considers practical considerations (embedded in interaction techniques) and toolkit development. It is even more rare to see such a breadth of more fundamental/technical aspects to be married with techniques from social sciences. The group is possibly in a unique position worldwide to combine this range of perspectives establish a common language between diverse areas, including psychology, anthropology and computing.

The mediated communication work is a great example of this moving from social science fundamentals through a complete life cycle that has ended up with the establishment of a start-up company.

The main problems faced by the group seem to revolve around inflexibility in terms of resource use, including difficulty in spending money on honoraria and other expenses for participants in experiments and studies, and difficulty employing staff, such as social science experts, designers and non-academic computer engineers and technical support.

Another broad problem is global recruitment. This is related partly to salary levels and partly other factors (e.g. language). France is competitive with some European countries, such as Germany, Greece, but less competitive than others such as Switzerland (because of salary differences) and UK (because of language). While it is not possible to match US salary levels, maybe other aspects of a recruitment package, such as support for moving family, etc., might be less costly but make INRIA a more attractive option for top researchers.

7. Plan for the next period (4 years)

The key strength of the group seems to lie in their end-to-end integration of techniques, and integration in another sense that lies at the heart of their long-term vision, seeking ways to bring different devices and different interaction styles together in a post-WIMP interface.

The WILD infrastructure is one aspect of this project and perhaps the most visible. This infrastructure along with other work allows testing in real-world situations (scientists are keen to use it). However, this 32-screen, 16-computer environment is significantly different from normal single-screen desktop interactions; to create easy-to-develop and easy-to-use applications for this new hardware environment, novel interaction techniques will need to be developed. In contrast, the iPhone that seems novel as a mobile device uses ideas dating back 20 years, but is an example of good engineering implementation. For WILD there needs to be novelty in terms of both ideas and basic principles, effectively trying to create, for this new environment and interactions, the type of development that was seen in the early 1980s in terms of desktop metaphor and direct manipulation.

Another side of this is the recent work on the use of digital paper. Few places with the exception of Jim Hollan's group (a collaborator) are positioned to exploit the blend of fundamentals of interaction, technology, and field studies of real use. Particularly interesting is the focus on paper as an expressive and exploratory medium.

In discussions with the team, the ability to be able to articulate this vision was particularly impressive, it appears a team with not only a direction that it is following, but with a very clear idea of how this fits into a global picture.

8. Opportunities and risks/difficulties faced by the project

As noted previously, the team is well positioned to blend theoretical and practical techniques to emerging areas. Furthermore, the iPad and similar devices have awakened public interest in the fact that there can be different interaction techniques beyond the nearly 30-year-old desktop interface. Whereas some years ago there was simply the PC desktop, now we see three models traditional applications vs web page based applications vs. mobile phone / iPad apps. The team hopes to introduce a fourth 'reifying interaction' making techniques and devices ' hot swappable' - a grand vision.

The team faces two main challenges. One is technical – can they seriously make an impact in a world of rapidly changing technology and massive industry funding. However, if the team can leverage its combination of theoretical and practical expertise, then it has the potential to not only stay ahead of the curve but be transformative. The other risk is internal, whether INRIA can operate *flexibly* enough in terms of recruitment and financial controls to enable to team to work at its maximum potential.

9. Recommended actions and suggested measures of success

The team has a strong base of and a clear vision for the future. The team knows what they need to do to pursue this vision and there are no particular recommendations beyond this.

As measures of success, there are of course the existing measures of publications and impact through diffusion of software and ideas into industry and other sectors. If these are continued at the present level for the next four years, then IN-SITU can be considered a major success.

However, while it is not necessary to go beyond the current level, the vision articulated is far more transformative. If the team is successful in this grand vision, then we might hope to see either a key visionary paper that sets the scene for a strand of work of the kind seen in Shneiderman's direct manipulation paper in the 1980s or Weisier's ubiquitous computing vision of the 1990s. Perhaps even harder to achieve than these, but not impossible given the team's skills would be to see key technologies developed by the team in everyday systems used by ordinary people more akin to Berners-Lee and the web.

While not at all necessary, these are worthy goals for the team to aspire to in the final period of IN-SITU|.

PROJECT REPORT FOR IPARLA

1. Primary Topics and Objectives

Iparla is a project led by P. Guitton whose goal is to improve the experience of mobile device users when interacting with complex digital objects and environments. In order to achieve this goal, the group focuses on the entire pipeline from data creation or acquisition to display, interaction, and feedback. Ultimately, the team wants to produce practical solutions that can scale independently of the computation units, the display device and how they are connected. Practicality is achieved by staying closely connected to the industry and looking at end-to-end, integrated solutions. Scaling is explored along two axes. Firstly, distributed computations leveraging increasingly powerful mobile units (CPUs and GPUs) are available to complement powerful servers. Secondly, display units ranging from small mobile phones or tablets to large immersive walls or caves. Special attention is paid to the consistency of techniques when adapting to displays of very different sizes and resolutions and limited input devices.

The group explores five key steps in the process:

- Scalable and multi-resolution data structures.
- Progressive streaming for large amounts of 3D data, particularly geometry and lighting.
- Client-server architectures.
- Intuitive user interaction.
- Increased cognitive immersion.

2. International Standing and Reputation in the Field

The group published a large number of papers in international conferences proceedings (46) and journals (23), including the most respected ones such as ACM and IEEE transactions and symposiums as well as Eurographics CG Forum. Both the quality and quantity of publications demonstrates the dynamism of the group in their area of research. They also received 3 best paper / best student paper awards during the evaluation period.

In addition, the group organized 3 workshops, chaired several conferences and program committees and provided members for 20 international program committees, adding to the international visibility. They also participated to 40+ PhD jury including 4 foreign ones.

3. Major Achievements and Impact

During the evaluation period, the IPARLA group proposed novel methods in modeling and rendering focusing on user control and efficiency.

Most noticeably the work on Light Warping and Radiance Scaling allows users to exaggerate details, regardless of the original look or lighting. The recent work on appearance modeling provides alternatives to physically correct BRDF methods that are suited for direct user input.

These methods, as well as the improvements to soft shadows, have been developed to allow efficient implementation on GPUs. The Least Squares Subdivision Surface model proposes an elegant improvement to existing subdivision schemes, improving the surface quality while remaining computationally efficient.

In terms of user interaction, the group expanded its research from interfaces on mobile devices to large and immersive displays focusing on consistency of interaction. The Navidget UI demonstrates how the same model can scale for devices from handheld to power walls.

In addition to academic research, the group was also involved in dissemination initiatives by publishing large number of articles and giving demonstrations at national exhibitions.

4. Industry Transfer and Partnership

The group initiated several industry partnerships in the past 4 years. The collaboration with France Telecom on appearance representation resulted in 2 patents. The light warping and radiance scaling techniques were tested in various production software programs, with the support of major software vendors such as Autodesk, Illuminate Labs, Pixologic, and The Foundry. The work on diffusion curves involved joint research with Abobe and is being integrated in the SVG file format for a possible implementation in Inkscape.

During the evaluation period, the group was able to raise substantial external funding, half from industrial joint projects, and half from direct national grants. In 2010, the amount of external industrial funding increased, especially with the involvement of two large international companies, Adobe and Google.

A permanent member of the group, G. Guennebaud, is one of the two code developers of Eigen, an open source linear algebra project. This library is still actively being worked on and used by many projects including educational, research as well as some industrial products.

5. Training of Personnel

During the evaluation period, 7 PhD theses and 2 “Habilitations à diriger des recherches” have been completed. The permanent staff also holds teaching responsibilities in Bordeaux Universities and IUT.

6. Principal Strengths and Weaknesses of the Project

In terms of strengths, the IPARLA group has been able to build a team comprising individuals with multiple competencies (modeling, rendering, vision, and interaction). The benefits on core graphics research are visible, leading to modeling and rendering methods driven by user perception and user interaction.

The strong connection with local companies and the involvement in regional projects, in addition to the multiple competencies, is a strong point for the project that helps focusing on practical and

usable solutions. This setup has a good potential to lead to improvements in industrial content creation tools.
Another important aspect of the project is the involvement of the team in popular science. This activity is typically not recognized in the research community, as much as international publications. Yet this time-consuming and difficult exercise of explaining complex concepts in simple terms has an important role to play in terms of education and outreach.

On the flip side, there is a danger of being spread too thin in the various areas that the project wants to address. The group also seems to have strong connections at the regional and national level, but weaker links with international research labs and companies.

7. Plan for the next period (4 years)

The group sets itself a goal of exploring the entire 3D pipeline from content creation to display and interaction. Two guiding principles will be used for that research: remain practical and user driven. The group wants to define 3 major axis of research:

- Data acquisition, preparation and visualization; specifically for shapes, appearances and possibly motion.
- 3D content creation targeted at complex scenes and controlled by high level semantic or user defined style.
- Scalable 3D user interfaces.

These research themes make sense as the 3D scenes become dauntingly complex and the large number of input and display devices more and more difficult to manage, though an expertise in computer vision seems to be needed for achieving the first goal on data acquisition. The way the group proposes to tackle complexity by keeping the user in the loop is very much aligned with the needs of the industry.

8. Opportunities and risks/difficulties faced by the project

The idea of running user interface and core research on geometry and shading at the same time is quite attractive. It has a stronger potential of leading to practical solutions that can be transferred to the industry than the work done in other specialized labs. In particular, advanced shading effects or geometry processing methods tend to be difficult to implement in a general-purpose application, which often needs to be able to combine all those algorithms together.

The user-driven methods, like light warping and radiance scaling, are good candidates to change the way traditional content creation tools are designed. Most authoring tools on the market use explicit low-level functions to manipulate the underlying data. The industry lacks more artistic tools where the user can indicate the final look desired and worry less about the actual intermediate computations involved.

A similar evolution is about to happen in user interface where mouse and keyboard input is becoming more and more obsolete, but no direct manipulation standards have emerged yet. With the objectives defined for the next review period, the IPARLA group has an opportunity to make a real impact on 3D content creation.

Nevertheless, the plan for the next period covers a very large scope. One of the dangers might be to dilute too much the effort and be less competitive than other specialized teams. P. Guitton's departure and C. Schlick stepping up as the new project leader may add to the difficulty of the task.

9. Recommended actions and suggested measures of success

The group is reaching an important step with a new 4-year period starting and a change in leadership. While the new organization is put in place, it will be important to keep in mind the positive points that the team demonstrated in the past to make sure they do not get lost in the process:

- Keep the close connection between interaction and graphics researchers which helps find less conventional ways to solve the problems.
- Keep the focus on practicality and artistic control of the algorithms; reinforce the partnerships with 2D/3D software vendors.
- Continue to be involved large audience publications and events.

In terms of artistic control, the committee feels that an easier access to professional graphic artists would be beneficial. The ability to contract free lancers for short periods of time would be a better choice than trying to hire a permanent member. This will guarantee that the artist remains trained on the most recent professional authoring tools, and will facilitate the testing of plug-ins in real production conditions.

One of the main challenges ahead will be to stay focused on the new project goals during the change of leadership. One step has been taken already by reducing the number of goals from 5 to 3 during for the upcoming period. Even if the benefits of having researchers with different focuses are shown to be productive, it may be the right moment to think of splitting the group in two.

Finally, the team has been quite successful in making connections with French companies, and recently managed to get the attention of international companies including Google and Adobe. It is felt that IPARLA's position would be strengthened if they could increase the international collaborations both with research institutes and the industry.

PROJECT REPORT FOR REVES

1. Primary Topics and Objectives

The main objective of the REVES group during the evaluated period was to produce high-quality research on perceptual and cross-modal rendering, on simulation with data-driven parameters and on deriving well-founded and efficient algorithms to fill the gap between high-quality and plausible rendering algorithms. The integration of visual and audio rendering with perceptual issues require both the development of new audio and graphics algorithms that take advantage of the limitations in human perception and a multi-disciplinary research with neuroscientists and acoustics experts. The goal in data-driven simulation is to use visual and audio data from the real world (like images and sound recordings), to create 3D contents and to render them.

2. International Standing and Reputation in the Field

REVES is a small size group, led by George Drettakis. The group has done seminal work on audiovisual multisensory interaction, by taking advantage of the cross-fertilization between graphics, audio and perception. They have also proposed novel and advanced solutions for interactive global illumination and procedural textures.

George Drettakis was IPC co-chair of Eurographics 2008 and the SIGGRAPH Asia papers chair in 2010. He was nominated Eurographics Fellow in 2007. George Drettakis received the Eurographics Outstanding Technical Achievement Award in 2007. Sylvain Lefebvre obtained the Eurographics Young Researcher Award in 2010. This group has achieved an international reputation in the graphics and sound communities. George Drettakis is a widely respected world-class researcher and international leader in the field.

3. Major Achievements and Impact

The research work of the REVES team during the evaluated period has resulted in a significant number of high-quality publications with unquestionable impact. In spite of the moderate size of the group, they have published four papers in the ACM Transactions on Graphics (SIGGRAPH), two in the IEEE Transactions on Visualization and Computer Graphics Journal, and seven in the Computer Graphics Forum Journal (Eurographics Conference and Rendering Symposium). The topics range from single-mode and cross-modal perceptual rendering and sound rendering to the new and attractive anti-radiance concept for interactive global illumination, also including the development of interactive solutions for contents creation, sound re-rendering with grain synthesis or texture synthesis for rendering. This is one of the few groups that has done excellent work in sound simulation and rendering over the last few years.

4. Industry Transfer and Partnership

Apart from producing top-quality international publications, the research of the team has been collected into a stable software platform, APF, and into two research libraries, LibSL and GaborNoise. LibSL is a generic graphics library that has been used for over 10 papers during this evaluation period. GaborNoise is a small library with Gabor Noise functionalities.

The Grain-based synthesis software has been transferred to EdenGames studio. The software on Facade Texture Synthesis has been filed for a patent, with the final goal of transferring the technology to Allegorithmic.

5. Training of Personnel

Four Ph.D. theses have been successfully defended during this period. The team includes now four Ph.D. students, Marcio Cabral, P-Y. Laffont, E. Chapoulie and G. Chaurasia, under the supervision of the two permanent researchers: George Drettakis (DR1 INRIA) and Adrien Bousseau (CR2 INRIA). Two postdoctoral fellows, Peter Vangorp and Carles Bosch, are now working in the group. Former project team members are now continuing their work in other research groups in INRIA, Nancy, British Columbia, Karlsruhe, or Cyprus, and in a number of companies, like Dolby Research (CA, US), Autodesk, and several start-ups.

6. Principal Strengths and Weaknesses of the Project

The REVES group is unique in France, regarding its combined expertise in graphics, perception and audio. They have created a strong network of multi-disciplinary collaborations with leading universities (Berkeley, Yale, MIT, ETHZ, etc.) and companies (Adobe, EdenGames). The group has a clear international visibility, with top-level publications, and worldwide recognition. Two members of the group (one of them being the group leader) have been distinguished with significant international awards. However, two of the top researchers working in sound rendering and texture processing have departed and the project is now in a weaker situation due to this reduction of permanent faculty. The current group size is rather small to achieve the future research agenda. INRIA should make it a top priority to find appropriate replacements.

7. Plan for the next period (4 years)

The long-term goal of REVES is on real-time multi-sensory interaction, by developing advanced multisensory tools for the interaction with seamless integrated virtual and real environments. For the next period, the plan focuses on leveraging 3D computer graphics algorithms to sketch material and lighting effects, on finding appropriate image representations (from stochastic to fully structured), on combining perception with interaction and rendering, on combining grain-based rendering with modal audio-visual synthesis, and on building simulation parameters from data: texture creation by example or simulation of weathering processes.

The research plan is solid and challenging. The project is unique in France, regarding its combined expertise in graphics, perception, and audio. The level of achievements will however depends on the possibility of recruiting new experts and on having new permanent positions. The optimal project size would include 4 permanent researchers, 2 Ph.D. students per faculty and a total of 2-3 postdoctoral fellows.

8. Opportunities and risks/difficulties faced by the project

The opportunity of the combined research in graphics, audio and perception is evident. Team leadership is not a problem. As we understand, the main difficulty to achieve the proposed goals is connected to the small number of permanent experts in the group, together with some difficulties in attracting good Ph.D. students. Other issues raised by the team include potential funding shortages (depending on the evolution of EU FP Calls) and the need to show that audio increases presence.

9. Recommended actions and suggested measures of success

REVES is a small group that has done excellent work in visual and sound rendering. The group's publications are high quality, and some of the technologies have been also transferred to the industry. The group leader has been playing a great leadership role, including the PC chair for SIGGRAPH Asia, 2010. Two members of the group have been distinguished with significant international awards. Moreover, this is the only research group in INRIA that has done great work in sound simulation and rendering, a new and emerging area that fits with the multi-modal theme of the entire INRIA program on "Interaction and Visualization". The team had produced excellent results in the last four years, which had significant impact. The quality of this team is unquestionable.

The recommendation for REVES is to continue in the same way during the next four-year period renewal, with outstanding publications and strong collaborations with academic and industrial partners. The departure of N. Tsingos has limited the capacity of the team for impact in audio research. Considering the scientific standing of the group, INRIA would be best served by providing REVES as much support as possible. We encourage the group to find and appoint the right expert to continue the work in audio, sound and multimodal interaction and rendering. INRIA could achieve international leadership in this area through REVES expertise and future work.