Aiming High: Undergraduate Research Projects in Computer Graphics and Animation

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Figure 1: *Artefacts resulting from the Collaborative Research Project course. On the left the prototype resulting from the project "Procedural generation of non-urban outdoor environments", combining methods for the procedural generation of terrains at macro-level with those used for meso-level generation. On the right test renders from the project "Real-time rendering of translucent objects".*

Abstract

Among educators, the promotion of undergraduate research is a much debated topic, with issues arising from questions as to how it can be integrated with undergraduate degree programmes and how to structure its delivery. Undergraduate research is also considered important by employers, as can be seen in case of the computer game development and visual effects industries who demand that universities produce graduate software developers with not only vocational but also with rather advanced research skills. In this paper we present a successful undergraduate research course, implemented for one of our undergraduate degree programmes. It includes teaching and learning focussed on the nature of small team research and development as encountered in the creative industries dealing with computer graphics, computer animation and game development. We discuss our curriculum design and issues in conducting undergraduate research that we have identified through several iterations of the course.

Categories and Subject Descriptors (according to ACM CCS): I.3.m [Computer Graphics]: Miscellaneous—Research K.3.2 [Computers and Education]: Computer and Information Science Education—Curriculum K.3.2 [Computers and Education]: Computer and Information Science Education—Computer science education

1. Introduction

The importance of integrating some form of research component within undergraduate programmes – for various reasons – by now has been fairly well established [Joe13]. The reasons range from efforts to increase retention via the intention to deepen understanding of taught subject matter to attempts to entice undergraduates to embark on postgraduate research careers in academia.

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Research skills are also highly sought by industry [LH11] and Research and Development (R&D) is a big part of a modern life of practically all the companies whose main business is computer graphics (CG) and its applications, such as visual effects, which is especially true in the case of large international companies. Very often the research conducted in industry is project-oriented, i.e. its aim is to provide an implementation or an improvement of existing research, related to the specifics of a particular project which the company is working on. Different companies have different policies regarding the presentation of the outcomes of their research, from publishing many of their advances (e.g. Pixar) to keeping all the technologies in-house. At the core of this process, however, lie a group of software developers, who should not only be able to implement existing research for company needs, but also to advance the state of the art. Recently, this practice of visual effects companies to conduct research has even resulted in new insights in astrophysics [JvTFT15].

In that respect, a research course as part of an undergraduate degree aims to prepare students for further R&D in academia or industry. At the same time it can advance beyond that. The outcomes of graphics research themselves can be fairly useful for computer science education, as can be seen in the work of Matzko and Davis [MD06] who employ the results of fairly current graphics research as part of the introductory programming sequence in computing.

In this paper we present our experience of developing and conducting a R&D-oriented course for final year undergraduate students in the computer graphics, animation and effects field. We first examine undergraduate research and different approaches to implementing it (Section 2). In Section 3 we describe the undergraduate research course that we have designed, providing an overview of the course structure and curriculum content. We discuss the outcomes of the course in Section 4 and present our conclusions in Section 5.

2. Undergraduate Research

Many undergraduate programmes, especially in computing subjects, have for some time included such a research component, which in many cases is synonymous with capstone courses, such as final undergraduate dissertation projects [WS06, BBD*10, Eyi11]. This is also reflected by the curriculum recommendations for liberal arts computer science degree programmes that include a final year "independent research or development project with library, written, and oral components" [WS96]. Similarly Ip [Ip12] reports that research related topics make up 13% of the undergraduate final year course time in UK computer game development related degree programmes. Fewer undergraduate programmes though attempt to engage students with the type of research more commonly encountered in postgraduate research programmes.

Introducing this type of research to undergraduates tends to engage the high achieving students that would otherwise disengage due to a lack of challenge and therefore serves as a complement to the usual educational practice of improving the learning of weaker students [CWF*10]. A positive side effect that can be gained from undergraduate research is a benefit for faculty members who collaborate with students, resulting in an advancement of their own research [RKBC05]. Baldwin et al. [BBD*10] note that while research is beneficial for students in terms of learning and professional development, engaging undergraduate in research is often constrained by university resources and unfortunately "the extent to which a department can offer [...] student-faculty research is determined by the availability and interests of potential faculty supervisors".

There have been various initiatives and approaches to realise successful undergraduate research. Ward [War04] describes a research course with a mixed undergraduate and postgraduate cohort of computer science students, with taught material structured to map to the different phases of a research project, starting from reading and understanding of research papers, continuing with an introduction to research methods and academic/scientific writing, peer review and presentation techniques and culminating in the development, presentation and defence of a thesis proposal. Similar topics of research and academic communication are covered by Peckham at al. [PSH*07] who developed an extra-curricular, multi-disciplinary and multiple-institution undergraduate research programme with a focus on computer graphics, art and interactive media in order to increase retention and to address the under-representation of female students in computer science. In this programme students were integrated into existing research groups to work on actual research projects, which resulted in the publication of project results. Especially the publication of results can provide a useful incentive for motivating students to engage with research [RKT*05], which is supported by initiatives such as the ACM Student Research Competition (`http://src.acm.org/`).

To facilitate undergraduate research, a suitable infrastructure for undergraduate research should be provided. Peckham et al. [PMRR08] discuss different strategies and sources for funding the integration of undergraduates into research programmes, for instance the Research Experiences for Undergraduates (REU – `https://www.nsf.gov/crssprgm/reu/`) by the US National Science Foundation, which allow undergraduates in programmes that do not provide a research related course to engage with research. A similar approach was used by the – now unfortunately discontinued – Nuffield Undergraduate Research Bursaries in the UK [Nuf14].

When undergraduates are introduced to research, care needs to be taken to prepare the students for the task. Holz et al. [HAH*06] discuss the need to introduce undergraduate students in computing programmes to the relevant research methods for the computing domains not simply to interest students in research but also to enable students to better understand and evaluate existing research. Eyitayo [Eyi11] is concerned with imparting students with the relevant ICT skills supporting research e.g. for conducting a literature search.

Many undergraduate research courses employ problem-based learning (PBL) [SD95] as their educational methodology, which is well suited to computer graphics projects [MGJ06] and lends itself well to undergraduate projects [APH*12]. In related work, the importance of communication for success of multi-disciplinary research, collaboration and public exposure and, consequently, its importance for student success and a lasting impact beyond the confines and duration of a degree programme, has recently been highlighted through the introduction of Expo-Based Learning [RTP*14]. There a number of R&D projects that students participated in were subsequently presented by them at academic outreach events and a trade show. The authors found that Expo-Based Learning lends itself well to course projects and project courses and not only aids the development of the students' communication skills but also serves as a motivator for students.

3. The Collaborative Research Project

The National Centre for Computer Animation (NCCA), housed in Bournemouth University's Faculty for Media and Communication, has been educating students since 1989. The NCCA has three undergraduate degrees of which the BSc (Hons) Software Development for Animation, Games and Effects (SDAGE) has been running since the 2011/2012 academic year, with two graduating cohorts to date. The NCCA, its undergraduate degrees and its philosophy ("Science in the service of the Arts") have been described in some detail by Comninos et al. [CMA10]. Its BSc SDAGE programme is at its heart a computer science/software engineering degree programme with a heavy emphasis on computer graphics techniques used in the creative industries. The Collaborative Research Project (CRP) unit (Figure 1) is a mandatory research course included in the 3rd (final) year of the BSc SDAGE undergraduate programme, which is separate from the programme's dissertation project.

Our rationale for a dedicated research course in the SDAGE undergraduate programme is to counteract the emphasis on vocational skills, focussing on employability in industry. This emphasis is common for many undergraduate programmes that cater for the creative industries, such as computer animation and game development. It is also apparent in several other courses of the SDAGE programme, despite the fact that industry would greatly benefit from graduates with research skills. Furthermore, students on the SDAGE programme have few other opportunities to practice their academic communication skills – this is only the second course that requires them to produce a substantial piece of academic writing and there is no other course that covers presentation skills – that are not only useful but also provide them with confidence in their work and themselves. This is why it is fortunate that the nature of the CRP course lends itself very well to covering these skills and to providing students with a venue to practice these. Other courses often lack the deep learning and intensive engagement with the subject matter that research entails, which a research course can address as well as promoting research and potentially increasing the uptake of postgraduate study. We want to encourage our students to "aim high".

The aims of the CRP course (worth 20 credits/10 ECTS credits) and its learning outcomes therefore are that after completing the course, students should be able to demonstrate the ability to research and develop a software artefact solving a computer graphics research problem. They should create this software artefact and write an academic paper describing their problem solution by working effectively as part of a team, planning, managing and delivering the project in the given timespan. As such, this course could be considered an example for teaching computer science in context [CC10], focussing on CS research methods in the context of computer graphics research. This largely student-led project, supported by lectures, regular tutorials and frequent seminars, matches the activity-led instruction sequence [APH*12] fairly well.

The course, which runs in the 1st semester of the BSc SDAGE final year is organised in two parts. The first part is concerned with background and theoretical aspects of research, including the scientific method, research methods – especially those of most relevance to computer science and computer graphics – and research ethics. Students are also introduced to literature search strategies and academic communication techniques such as presenting and academic writing. This part of the course is delivered as a short lecture series. The second part of the course is the research project, which is supported by regular tutorials with faculty members and seminars in which students present their project progress and discuss this with the remainder of the cohort and their tutors. This provides an opportunity for students to further develop their personal and communicative competences, especially in relation to working in a team. The project that the students work on is set by members of the NCCA's faculty, who select current topics for small-scale research projects that are deemed of sufficient scope and challenge, and that are achievable in the timescale. At the start of the course the students have to select their project from a number of project proposals that they will work on either in a small group of up to two students or on their own, in which case their collaboration will be restricted to working with a tutor from the faculty. Their task is to conduct research into the chosen topic, propose a solution for the project and to implement this.

3.1. Introducing Research

A series of five lectures introduces students to the methodology and the practice of research, with particular emphasis on the specifics of the Computer Graphics, Animation and Games fields. Let us outline the content of each two-hour lecture:

- Lecture 1 presents summary description of the course. The students learn about the CRP course specifics and challenges involved in working on a research and development project in a team environment. The major challenge is to deliver not just a software artefact but also a report in the form of an academic paper. It is stressed that the real success of undertaking a research project means submitting a paper for subsequent publishing to an actual scientific conference or a journal. An important part of the lecture is outlining the NCCA's research in terms of its scope and main topics. This material is new for the students: whilst they know the NCCA's faculty members as those who teach them, they are mostly ignorant about research their lecturers and professors are doing. Finally, all the research proposals formulated by the NCCA's research staff are briefly outlined. The students are advised to investigate the proposal topics online to get a better understanding of what the projects might entail.
- Lecture 2 provides an introduction to academic research. This is mainly concerned with a definition of research from different perspectives and a presentation of methodology in general followed by a discussion of specific research methods depending on different research types (Basic vs Applied; Quantitative vs Qualitative; Experimental vs Non-experimental). The scientific method and its aspects seen through the prism of a research

process are covered in detail. Some recommendations are made regarding an effective literature search, especially taking into account the specifics of the CG domain. Finally, the main principles of research ethics are outlined.

- Lecture 3 covers project management. The typical project life cycle is outlined, and helpful planning and scheduling methods are presented with an emphasis on practical aspects. This is illustrated with some concrete projects of research-oriented software development.
- Lectures 4 is concerned with academic communication. First, the basics of academic writing are presented, both in general and specifically for the computer graphics, animation, games and (visual) effects domain. Concrete recommendations regarding the writing of a proper research paper are given, and the main conferences and journals of the domain are outlined. Different types of research publications are examined using concrete examples. This leads to a discussion of peer-review as the main means of self-regulating quality control employed by the research community. Students are warned against research fraud in terms of plagiarism along with other bad practices such as attempts to publish falsified and fabricated results.
- Lecture 5 consists of two parts: The first hour is devoted to providing detailed recommendations regarding the oral presentation of the results of research, specifically in the context of academic conferences. This topic is intentionally scheduled to be delivered after two of the seminars (see section 3.3. below) in which students undertake their first attempts of presenting their project progress. That experience, mostly not that successful, motivates the students to really engage with the subject. The second part of the lecture is concerned with the human dimension of research, e.g. user studies, as well as a description of available research careers. First, the students are briefed on opportunities to continue their education in postgraduate studies. This is not covered in an abstract manner but gives concrete examples of typical PG programmes in our domain, such as "Master by Research" and doctorate programmes. In our case this covers both conventional PhDs and a particular "EngD" in Digital Media which can be undertaken in the Centre for Digital Entertainment (CDE) – the CDE is a doctoral training centre run by the NCCA in conjunction with the University of Bath, in which students spend three years of a four-year engineering doctorate embedded within a company. These are outlined in practical detail, including the problems typical for doctorate students in the field as well as their career prospects both in academy and in industry. The concrete job description from R&D departments of some major companies are discussed and finally, some particular problems of team work and corporate ethics are outlined.

3.2. Scoping and Designing Research Projects

Faculty members who may take on the role of project tutor and collaborator must carefully prepare research project briefs for the course. The task for them when choosing the topic for the project is twofold. On one hand, the projects which they are suggesting need to be within the scope of their own research so that they can provide students with sufficient expertise and guidance in the chosen topic. On the other hand the projects should be both challenging enough and at the same time feasible for the skill level of final year undergraduate students. Although this could be perceived as contradictible, as all the supervisors are doing research at a level which is higher than that of undergraduates and their projects are usually aimed at postgraduate students, this can be resolved by narrowing the scope of the potential projects and simplifying the goals. Feasibility should be considered as one of the main points also because of the short timeframe of the project: it should be doable within three months taking into account that the students will have other projects and assignments at the same time.

The visual aspect of the projects is also an important consideration as the NCCA aims for a fusion of technical disciplines and art. The projects from past years of the course show that the majority of the projects which are chosen by students have a strong visual side, which is perfectly understandable, as outputs of the CRP feed the portfolio of the students. Therefore, while designing the potential projects, project tutors have to take into account both the feasibility and visuals of a project in order to convince students to choose it.

A typical process for developing project ideas is for the faculty member who intends to propose a project to first identify gaps in current research in his domain and to evaluate the demand to fill these gaps. There are different ways to achieve this, for example, a gap in the state of the art might be identified through communication with industry, it could be pointed out in recent research papers or by the researcher himself. The next step is then to estimate the feasibility of the ideas to be researched and implemented within the scope of the project. As the last step of this process the faculty member needs to decide if the project idea fits into the type of portfolio that students on the SDAGE programme are expected to graduate with, before finalising it as a project proposal which can be presented to the students.

The following are examples of project ideas that have been proposed for the CRP:

- "3D asset version control"
- "Automatic road and pavement modelling for the simulation of inhabited virtual environments"
- "Procedural generation of non-urban outdoor environments"
- "A nighttime illumination model for urban environment simulation including sky glow"
- "Acceleration of geometric computations with OpenCL"
- "Real-time rendering of translucent objects"

Figure 1 shows results of some of these projects from the previous two iterations of the course.

3.2.1. Solving Real-World Problems

Project ideas can be inspired by the needs of the creative industries. For example, Visual Effects companies often employ fluid simulation techniques such as the Fluid-Implicit-Particle concept (FLIP) [BR86] or Smoothed Particle Hydrodynamics (SPH) [IOS*14]. These are known to be resource-expensive, especially if these techniques are employed on a large scale. After a conversation with the FX supervisor of a London Visual Effects company, the idea of trying to find a way to optimize fluid simulation from the point of view of resources as a student project was developed. Eventually this was presented as the following brief set in the 2014/2015 academic year:

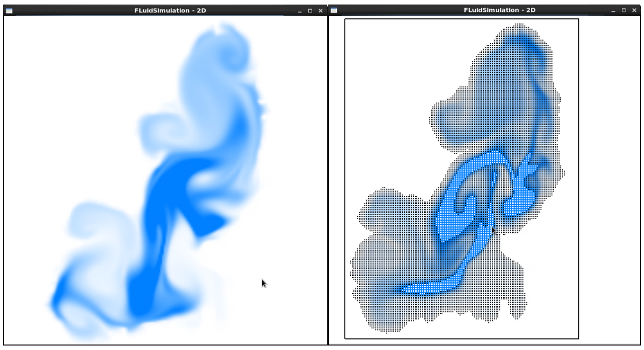

Figure 2: *Successful student project, demonstrating a grid-based fluid simulation that considerably reduces the amount of data being processed at each simulation step by culling unused cells from the simulation grid.*

> Reducing memory consumption in fluid dynamics: Currently there are two main methods for simulating fluids: SPH and FLIP. Both of these use Lagrangian methods to solve fluid equations. However, for large environments a large number of particles is required, and therefore the memory consumption for both methods is significant. Despite recent publications that try to decrease the memory requirements for fluid simulations (IISPH-FLIP method [CIPT14]), the problem still requires some investigation. The goal of this project is to investigate the current methods for fluid simulation and find ways to reduce memory usage without loss of quality in the final result.

This project was selected by two separate students, one of whom developed a successful solution that was submitted and subsequently published as a short conference paper [ALFA15] (Figure 2).

3.3. Show-N-Tell – Student-Led Seminars

During the course four two-hour long student-led seminars were scheduled. The main purpose of these is to monitor the students' progress with the on-going projects, to discuss problems that appear during the course and to provide an opportunity for the students to receive feedback from other faculty members and the other students of their cohort. The seminars also serve as an additional motivator by providing a competitive atmosphere – in the positive sense – in which students try to outshine one another.

- Seminar 1 happens only a few days after the first lecture which introduced the course and outlined the project proposals. In this first seminar, the faculty members who developed the proposals present these in detail to the students, who by then should have acquired some knowledge about these from the their online search. During this seminar students are given ample opportunities to ask questions and discuss the specifics of the projects with their potential supervisors. This will allow the students to make a more informed choice of their group or individual projects which they need to select a few days afterwards.
- in Seminar 2 the students make their first presentation in front of their coursemates and supervisors who usually are also present during the seminars. For many students this one of the first times that they present to a public audience and they frequently make beginners mistakes. The purpose of this first presentation is to demonstrate that the subject of their selected project is well understood by the students. They need to show that a research plan with main project milestones and deadlines has been made and that they are ready to undertake their chosen project.
- Seminar 3 is scheduled to be conducted three weeks after the previous seminar. It is expected that presentations at this seminar will include a detailed survey of related work as well as initial results which are usually achieved at this stage of learning a relevant new theory.
- the final Seminar 4 is scheduled to take place one month after seminar 3. By that time students already know from the lectures how to properly present their work; it is expected that their presentation will cover the current state of their projects which by that time should be in a rather advanced stage. The discussion of the presentation is rather detailed to model what will happen when the student will present the results of their research after submitting their formal outputs for assessment.

3.4. Running the Collaborative Research Project

Outside of the five introductory lectures (see section 3.1 above) and four seminars (see section 3.3 above), for the duration of the course, members of the faculty work collaboratively with the students/student groups to develop their projects. This unit requires a substantial time commitment by these supervising academics, much of which is not timetabled and hard to plan for. As described above, projects are proposed by faculty members who supervise and guide the students who select their project, but before students choose one of the available projects it is impossible to know who will be supervising them, which has implications for timetabling and departmental workload planning. This is somewhat ameliorated by the arrangement of a weekly two-hour timeslot in the timetable that has been reserved for the students and that has been kept free for several faculty members. This simplifies the arranging of regular meetings of students with the supervising faculty members that should ideally take place every week (and at least once every two weeks).

These working meetings are student-specific and are not simply an opportunity for feedback on the students' progress, but they are very often shaped to accommodate the students' needs in any specific stage of the project. Thus, during the early stages of the project support can focus more on research aspects that can be done during these meetings, while in later stages aspects of implementation and presentation of the research outcomes can be discussed in more detail.

After submission of the coursework there is a final seminar-like session in which the students present the results of their project to members of the faculty and the other students of their cohort. Although currently not directly assessed, this final presentation can aid faculty members who will be moderating the marks of projects that they were not directly involved in to get some understanding of the projects, especially as they can ask questions of the presenting students to clarify their work (if necessary). We conduct this session in a manner that gives it the feeling of an actual scientific conference, albeit small-scale and local. As the students have few opportunities for this during their studies, we consider this an important aspect of the course. The presentation session provides a further learning experience for the students, who will very likely have to publicly present projects in their future professional lives irrespective of their chosen careers – in industry as well as in academia.

3.5. Assessment of the Collaborative Research

The CRP course is assessed by a single piece of coursework consisting of three elements. These are a software artefact, the exact nature of which depends on the project brief chosen by the students, a portfolio consisting of supporting documentation (meeting notes, system specifications, design documents etc.) and a report in the form of an academic paper describing the project with a length of up to 3,500 words (multiplied by the number of students collaborating on the same project).

The weighting of the coursework elements is 50% for the student's individual contribution to the artefact, including overall quality, how close the artefact matches the project brief, the scope of the work conducted and its novelty/contribution to knowledge, and 50% for the student's individual portfolio, including the individual contribution to the project report/paper and the quality of that contribution in terms of academic writing. A first class (in the grading guidelines of our university defined as achieving a mark of 70% or above) award is made to projects that are deemed to be publishable by the supervising faculty members.

From the grading academics' point of view, the assessment of the projects is similar to the reviewing of conference submissions, obviously taking into account the fact that the students are undergraduates without previous research experience.

4. Evaluation and Discussion

The BSc SDAGE undergraduate programme in which we run the Collaborative Research Project has so far had three iterations with quite small cohort sizes. Most of our evaluation therefore is anecdotal, based on observations and the limited evidence we could gather as well as verbal feedback received from the students. Consequently our discussion here is constrained to that limited evaluation and the most important elements for consideration for future evaluations. On the other hand, given the small cohorts, we were able to exercise and to emphasize an individual approach to each students with a lot of informal discussion in a rather relaxed atmosphere which, in our opinion, is almost always beneficial for a research environment as this requires by its very nature a free exchange of ideas without much subordination.

The feedback received from the students so far suggests that they have enjoyed the course and students whose work has been submitted for consideration of publication have generally been excited about the possibility of getting published. The seminars have also been successful and the friendly competition among the students that they generate seems to reinforce their endeavour to "aim high", a similar effect to the one observed by Anderson et al. [APH*12].

The greatest difficulty that students on this course seem to have encountered appears to be the open-ended nature of research projects, which they were not used to. Coursework assignments in the other courses of their degree programme tend to be fairly narrowly framed and prescriptive, i.e. the criteria that define the assessment to be complete are usually unambiguous. In a research project, however, the end result may not be as clearly defined – it may not even be known before the work has been conducted – and it can be much harder to determine when the work is complete, which is confusing for some of the students. Some students feel uncomfortable when they are asked to search the available literature and to find their own solutions to problems, and instead hope for explicit instructions and clear guidance from their tutor. Once this hurdle has been overcome and the students have developed a solution to the research problem, the implementation of a software artefact as proof of concept is usually straightforward.

Another difficulty arises from the students' lack of academic writing practice, as reports in other projects of the degree programme often have little impact on final grades awarded. The result of this is that reports are often considered nothing more than "paperwork", which leads to students underestimating the time and effort required for writing the project paper.

A few students have also found it hard to understand the assessment scheme, as without any prior exposure to or experience with research, grasping the nuances and intricacies of judging the quality of academic writing or the novelty of a method or technique – something that even experienced academics will find hard to quantify – is anything but trivial. A wide ranging literature review of work related to the students' projects providing examples of different types of publications can ameliorate this. Apart from these there do not seem to be any noteworthy issues arising from the students' feedback.

In a recent student satisfaction survey, modelled on the UK National Student Survey [Hig15] and conducted by the university at course level, the students of the current cohort were asked a number of generic questions regarding the course, such as the availability of library resources, the timeliness of feedback, support from faculty members and clarity of coursework assignment briefs. Most of the questions (presented on a 5 point Likert-type scale ranging from 1 "Definitely agree" to 5 "Definitely disagree") were answered with high average at levels 1 or 2 with an overall course average of 1.9, indicating that the students are generally satisfied with the course.

With the current cohort (six students) we also conducted a limited pilot study to measure learning gain, using pre- and post-surveys inspired by the surveys conducted by Koppelman et al. [KvDvdH11], Brannock et al. [BNN12] and the self-evaluations described by Weinman et al. [WJL15]. Given the small cohort size, which does not provide a sufficient sample size, there is not enough data to draw any reliable conclusions. In terms of learning gain, the students' responses were inconclusive, however the self evaluation responses suggest that the students' understanding of research and their confidence to present their work has benefitted from their completion of the course. We currently plan to conduct the same evaluation again with the next cohort to hopefully provide a more conclusive evaluation.

5. Conclusions and Future Work

We have presented an undergraduate research course that includes teaching and learning that is focussed on the nature of small scale research and development. Lectures also cover the legal and ethical context of economic and cultural exchange in contemporary digital products as well as the necessary professional foundations of good practice. Despite of the constrained evaluation that we have been able to conduct – we also attempted to contacted alumni of the previous two cohorts with a survey based on Koppelman et al. [KvDvdH11] that only resulted in three valid responses – we are confident that the course can be considered successful. The greatest strength of this unit is that it engages undergraduate students in the type of research more usually experienced at postgraduate level.

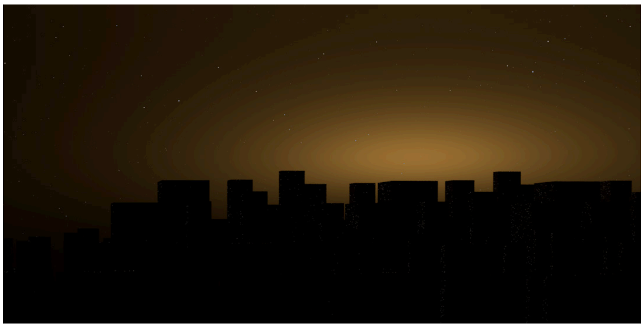

Figure 3: *Successful student project, extending existing methods for nighttime illumination to integrate light pollution from artificial light sources in urban environments resulting in sky glow.*

With the previous two cohorts there have been a few conference submissions that have resulted from the work produced by students, one of which resulted in publication of a paper at an established computer graphics conference [ALFA15], and another student has embarked on a doctoral degree programme. Several students in the current (2015/2016) cohort have successfully submitted their work (Figure 3) for presentation at UK undergraduate research conferences (including the British Conference of Undergraduate Research – `http://www.bcur.org/`) and we hope that there will be additional submissions – not just restricted to undergraduate conferences – over the course of the current academic year.

As mentioned above, our evaluation so far was limited by the insufficient number of students, however we are planning a longitudinal study to gain better results. Recently the undergraduate framework for our computer animation programmes has undergone several changes, however the research course has stayed mostly intact – the main change is an aim for greater industry involvment in the design of project proposals – which will allow us to continue to deliver it as well as to collect more data to study its impact on the success of our graduates both inside the university as well as outside of academia.

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