FERAL ROBOTS: A SOCIAL TAPESTRIES EXPERIMENT IN EVERYDAY ARCHAELOGY

G. Lane,[1] C. Brueton, [1] D. Diall,[2] D. Airantzis, [2] N. Jeremijenko,[3] G. Papamarkos, [2] G. Roussos[2] and K. Martin[4]
[1]Proboscis, UK
[2]Birkbeck College, UK
[3]University of California San Diego, USA
[4]University College London, UK

ABSTRACT
The Robotic Feral Public Authoring (RFPA) project seeks to combine low-cost toy robotics with geo-annotation to create a novel public authoring approach around environmental issues. Adapting commodity toy robots and remotely controlled toy cars with a variety of sensors and uploading the readings on a spatial annotation database for visualisation, we aim to explore new ways in which the exclusiveness of pollution sensing and robotics can be dispelled and a new sense of empowerment promoted. In this paper we introduce the new networked version of the Feral Robot platform, a location-aware mobile wireless chemical sensor network node, which forms the core of the RFPA built around the Urban Tapestries platform. Finally, we report on our recent experiences during tests and community workshops at the London Fields in East London.

INTRODUCTION
Our everyday lives are increasingly infused with electronic and digital technologies – facilitating new modes of communication as well as shifts in private behaviour in public spaces. These technologies also have an environmental impact; from increasing levels of background radiation to producing mountains of *disposable* artefacts, for which there are few recycling initiatives, yet contain many serviceable components and parts.

Our work builds upon two distinct practices which are addressing the role of the everyday consumer in utilising emerging technologies for their own social and cultural benefit. Proboscis has been developing the Urban Tapestries (5) software platform since 2001 to allow people to annotate geographic places with multimedia information and share it among their fellow citizens through mobile and wireless technologies. At the same time, there has been increasing interest in developing adaptations of toy robots to sense environmental pollution (chemical, noise or radiation) – turning toys into tools of social activism.

Both hardware and software of the Feral Robots platform have been published as open source and are accessible via http://socialtapestries.net/feralrobots/

RFPA PROJECT
Hobbyist robotics and public authoring both enable people to use emerging technologies in detecting a wide range of phenomena such as carbon monoxide, nitrogen dioxide, solvent vapours, electro-magnetic emissions (mobile phone masts, electricity generators etc), light and noise pollution. These can be combined with other cheap electronics (such as toy robots) that engage people in evidence collecting in a fun and tactile way. Adding the sensor readings to online mapping tools, such as Urban Tapestries, suddenly brings the relationships between environment and home vividly to life. It enables people to feel they can learn about their environment and have the evidence to do something about it. By linking robot building and mapping workshops into traditional community events (village fetes and local festivals) a wide range of people can become involved in gathering and sharing knowledge about their environment.

We set out to investigate how toy robots can be augmented with environmental sensors and used to map pollution by grassroots communities. In the Feral Robots project (4) we have reconfigured low cost toy robots into vehicles of social and cultural activism, exploring how robotics could break out of the academic lab and how sophisticated equipment could be put into the hands of the general public by using the economies of scale of consumer manufacturers. In our current work we have designed and implemented a new generation of this technology and the software needed to enable it to sense pollution, add GPS location data and feed this back to the Urban Tapestries mapping platform.

Figure 1. The prototype mobile sensor network node with carbon dioxide and air quality sensors.

TECHNICAL DEVELOPMENT
The first generation of feral robots was developed using the very low cost PIC microcontroller family which provides computing power roughly equivalent to that of a remote control. The requirement for location annotation and wireless and internet connectivity for the new version implied that an altogether new design was required. We also wanted to be able to support a more extensive collection of sensors, several of which

required an extended period of warm-up. For this reason, we designed a new printed circuit board that provides appropriately regulated power to all components including the processor board, the data acquisition boards and the sensors; can be used to recharge the on-board battery pack; supports terminal access to the system console; and a mounting foundation for all the electronics.

The heart of the new design is the Gumstix small form factor system measuring 80x20x6mm, which incorporates the Intel Xscale network processor and supports an embedded Linux distribution including a full implementation of the IP stack. Wireless networking is provided via an extension board and the Netgear MA701 CF card. This component also provides Ethernet and Bluetooth functionality. Location information is collected using any NMEA compatible Bluetooth GPS unit – in our prototype we used an OEM version of the Socket BT receiver. Finally, we used two Figaro chemical sensors, namely the AMS-2100 which measures air quality and the AMS-4161 which measures the number of carbon dioxide particles per million particle of air. Such sensor readings are converted to digital measurements via the Robostix data acquisition board which includes a 10-bit analogue to digital processor. Two software applications were required: one to configure and maintain correct system operation, for example network discovery and connection to a network time server for timestamp synchronization, and a second application which polled the sensor boards, retrieved data, and packaged it in an appropriate format for transmission to the UT server. Although this new version can connect to any accessible wireless LAN, a mesh network infrastructure provides maximum coverage and flexibility. In the London Fields outing we used a portable WiFi mesh node from Locustworld.

Collecting and processing the data sent from the Feral Robot required a series of extensions on the existing Urban Tapestries backend system to fit with the very special needs of the robot client. A separate server component was designed and implemented that establishes connectionless communication with the robot. This accepts the robot's data packets which contain the robot's GPS position along with the corresponding value of the sensor measurement and the time this measurement was taken. After extracting the packet contents they are stored in the database, from where they become available for processing and visualisation.

The initial visualisations of the feral robot sensor data were made by processing a static high quality aerial photo of the area in which the measurements were taken, and overlaying it with an extra transparent image layer. The sensor values and each reading's position were fetched from the database, associated with a colour from the visible spectrum, and then drawn onto the image layer as a dot with diameter equal to the maximum GPS position deviation. This forms a dense coloured "cloud" over the subject area. Our next stage is to develop a dynamic mapping representation using Google Maps and associating the sensor data with other contextual knowledge.

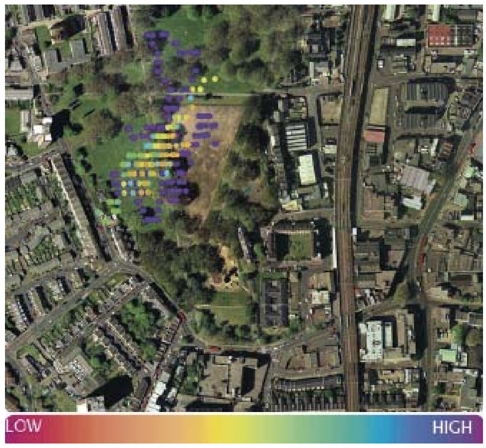

Figure 2. Visualisation of carbon dioxide measurements collected at the London Fields trial.

LONDON FIELDS AND COMMUNITY MAPPING

London Fields is a popular local park in Hackney, East London. Bounded by Richmond Road to the north, not far from Mare St (Hackney's busiest road) it is an important resource for local communities in a built up area. The park is used by local people for a variety of activities; as a space to play and socialise in (with two children's play areas), organised cricket and football matches, and many dog walkers. It is also a popular walking and cycle route. London Fields was selected as the location for this experiment because of its strengths as a public space used by distinct communities.

Collaborating with SPACE Media Arts enabled the utilisation of their local community networks. A group of 15 participants took part in a community pollution mapping exercise in London Fields in November 2005. In small groups, participants explored London Fields equipped with audio devices, digital cameras and Pollution Sensing eNotebooks to look for evidence of pollution. Information gathered was mapped on to a large aerial photograph of the area and became a starting point to explore wider concerns about pollution (both visible and non visible) and the potential application of technology by communities to detect it.

DISCUSSION AND APPLICATIONS

In the two years since we formulated the project we have seen its emphasis shift from `pollution mapping' to what we now describe as `everyday archaeology'. Our vision has been informed by the process of working on a site with local people, many of whom were concerned for their environment, but for whom the initial focus on pollution proved questionable. Gathering data on environmental phenomena such as pollution was seen as a major benefit for local people to campaign around, but others saw it more as a valuable creative activity in itself.

Electronic sensors are now cheaply available for detecting a wide range of phenomena such as carbon monoxide, nitrogen dioxide, solvent vapours, electro-magnetic emissions (mobile phone masts, electricity generators etc), light and noise pollution. These can be combined with other cheap electronics (such as toy robots) that engage people in evidence collecting in a fun and tactile way. Adding the sensor readings to online mapping tools (such as Urban Tapestries) suddenly brings the relationships between environment and home vividly to life. It enables people to feel they can learn about their environment and have the evidence to do something about it.

We think that the greatest potential for Robotic Feral Public Authoring lies in linking robot building and mapping workshops to existing community events such as village fetes and local festivals. This idea of embedding the practice into familiar rituals offers opportunities for involving a wide range of people in gathering and sharing knowledge about their environment. Through the concept of everyday archaeology Robotic Feral Public Authoring can tap into popular interests and past times – not only those of robotics hobbyists, but amateur historians and environmentalists.

The use of Robotic Feral Public Authoring as a tool for learning also represents a significant potential benefit. With some further technical refinement to make the `adaptation' of toy robots more accessible to people without specific electronics and engineering skills, and the creation of materials like activity and lesson plans, the project could quickly move into formal and informal education settings.

The benefits of this are multiple: from bringing children and other learners into direct contact with practical skills of making and building technologies and the representation of the data they collect; to stimulating the commercial production of new learning aids that are designed to enable people to develop their own creativity and analytical and communication skills.

It is possible to see that, just as the choice of toy robots was inspired by the ability to use the economies of scale of the toy industry to put sophisticated electronics into the hands of the general public, so Robotic Feral Public Authoring could inspire toy manufacturers to develop cheap `feral robot' adaptation kits. This could amplify the effect of the economies of scale whilst encouraging a generation of people to be co-creators, not just consumers of toys designed simply to entertain. Robotic Feral Public Authoring offers exciting new ways for electronics manufacturers and network providers to allow their customers to use their products in a socially and culturally enriching way – enabling new dialogues to be explored between industry and the people they create products for.

The greater the emphasis on participation at every level of society and culture, the greater the diversity of voices, ideas and knowledge can be contributed to society at large. Stable and healthy democracies are the product of wider participation and sense of responsibility. The vision of Robotic Feral Public Authoring is to contribute to a greater local sense of empowerment and impact of local people on environmental issues. It seeks to act as a model for how artists and engineers can collaborate to bridge the gulf between pragmatic technical solutions to social problems and the cultural interventions that artists bring to their communities. It is political is the sense that it inspires people to act; to investigate and collect evidence and use it to affect change.

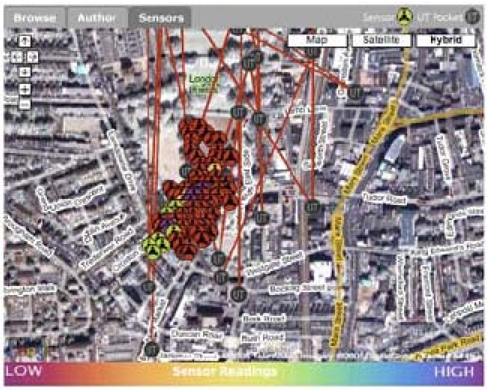

Figure 3. A visualisation of the data collected during the first London Fields trial on the Urban Tapestries platform.

This project has demonstrated that it is possible, using cheap electronics and publicly accessible mapping solutions, to create an exciting and engaging new form of environmental sensing at a very local level. Although our prototypes require a level of electronics and engineering skill above that of most people, it is well within the realm of the hobbyist and will not require a huge step to reduce the complexity of creating a feral robot even further as new platforms and products (such as motes) become more readily available and cheaper.

The next stage for Robotic Feral Public Authoring is to make this transition, focusing not only on the technical but, more importantly, on the social, cultural and educational uses and techniques needed to add the sense of purpose and context to environmental sensing. Designing the activity materials, whether for schools running geography and science projects, or campaign tools for environmental activists will provide the impetus for adoption and adaptation of the project's vision. Over the next few years it is easy to imagine a growing network of hobbyist data collectors springing up to help map our environment, learn about our effect on it and take action.

REFERENCES

1. Gemmell, J., Williams, L., Wood, K., and Bell, G. 2004, 1 ACM Work. Cont. Arch. Per. Exp, pp. 48-55.

2. 4. Jeremijenko, N. 2005, Emerging Technologies Conference, San Diego CA, 15-17 March.

5. Lane, G. 2003, Personal and Ubiquitous Computing 7(3-4), pp. 169 - 175.