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'Useful' civic hacking for environmental sustainability: Knowledge transfer and the International Space Apps Challenge

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Civic hackathons have become a popular, experimental process through which to promote public access to open government data and enable innovative civic uses for the information. The International Space Apps Challenge, led by NASA, is a high-profile event, promoting the use of space-derived data with the aim of contributing solutions to 'grand challenges' such as environmental sustainability. Central to the civic hackathons are the concepts of 'stewardship,' and 'usefulness'. The study explores the promises and realities of civic hacking through analysis of the aims of the organisers, perspectives of participants and the event's outcomes, concluding that hackathon peer processes promote networks for knowledge transfer.

Introduction

As jurisdictions around the world begin to release large quantities of data and information under open government plans, one way in which the reuse of open government data has been promoted is through civic hacking. In the parlance of those involved, the term civic hacking describes the reuse of open government data to create new products and services, generally for the benefit of the public or to contribute a solution to 'grand challenges' such as social, environmental and economic problems (Tauberer, 2012). There is currently a growing movement of short-term, collaborative events at which civic hackers gather to develop content, and prototypes of hardware and software, utilising open government data. These events are described as civic hackathons (also codeathons, codefests, or hackfests).

The paper will argue that at the heart of the civic hackathon endeavour is a desire to be 'useful': governments release datasets and support hackathons with the stated aim of

encouraging the reuse of data in meaningful ways, and organisers and participants volunteer their time, skills, knowledge and labour.

'Usefulness' is, however, a contested concept, in that what may be defined as a useful outcome or activity by given individuals or groups will not be the same as every other. Contemporary debates about what constitutes 'usefulness' in civic hackathons can be seen as an extension of historical debates about knowledge, education and labour, such as those described by (Watkinson, 1990)

> *The concepts of useful knowledge and democratic education held by Benjamin Franklin and Thomas Jefferson in the eighteenth century differed considerably from those of worker-oriented early nineteenth-century reformers, such as Timothy Claxton and William Maclure, and even more so from those of Benjamin Silliman and Joseph Henry in the mid-nineteenth century. These shifts reflected basic changes in ideology, culture, and in American society itself."* (p.351)

The idea that 'usefulness' has been continually redefined by different communities is key to the arguments in this paper. The civic hackathon activity involves numerous stakeholders who are positioned within one or more overlapping spheres of activity, or what this paper will refer to as 'domains': *democratic* (government departments, citizens), *collaborative* (hackers, scientists, participants in crowdsourcing) and *popular* (general public, end-users such as non-governmental organisations).

Using these domains to contextualise questions about whether hackathons are useful, to whom they are useful, and how they are useful, this study engages with those questions using the environmental sustainability-related activity and outcomes of one high-profile civic hacking event, the International Space Apps Challenge. As a hackathon, it is attracting publicity and achieving longevity, having been held annually since 2012. The first event involved 2083 participants in 25 locations around the world, and the most recent event, in 2015, had 13,733 participants in 133 locations; 101 solutions (or projects) were created in the first event, and 949 solutions in the 2015 event. In its ambition, the scale of information exchanged, and international interest, Space Apps provides fertile ground for thinking about how the stewarding and usefulness of open data is conceptualised.

Background on Usefulness

Usefulness in the democratic domain

The concept of usefulness of information in the democratic domain involves knowledge transfer from stewards of information to other users. Liberal democratic governments globally are adopting open government principles to find solutions to problems. Releasing information to other agencies has begun to generate research on the meanings of usefulness. Dawes (2010) proposes that government organisations releasing datasets under open government plans keep in mind the principle of 'stewardship and usefulness'. Stewardship refers to the care with which government information is handled and "demands that government information be acquired, used and managed as a resource that has organisational, jurisdictional, or societal value across purposes and over time" and usefulness, recognising that there is value in the information governments collect, "[enhancing] public access to government information, [encouraging] public-private information partnerships, and [making] possible the combination or reuse of information for new purposes" (p. 380-1). In

keeping with Uhlir's (2010) assertion that "the value of data increases with their use" (p.1), usefulness in the democratic domain is therefore characterised by access to and the reuse of data by the general public, and by researchers and hackers to create something new which could assist government and their fellow citizens. As an example, the language on hackathon websites often foregrounds a desire to find solutions to civic problems and be useful to local communities:

> *"A rapidly growing global initiative… making the world a better place by developing practical, open source technology solutions to respond to some of the most complex challenges facing humanity."* (Random Hacks of Kindness, 2014).

> *"Collaboration on a massive scale is the key to addressing the most important challenges of our time – the ones that none of us can solve alone."* (National Aeronautics and Space Administration, 2014).

> *"GovHack is an event to draw together people from government, industry, academia and of course, the general public to mashup, reuse, and remix government data. GovHack is about finding new ways to do great things and encouraging open government and open data."* (GovHack, 2014).

This paper will consider usefulness of civic hackathons within the democratic domain by using the example of one of the grand challenges currently facing the international community: environmental sustainability. Environmental sustainability is a problem which requires earth observation data to inform decision-making at all levels, from the individual (for example, monitoring household energy usage, or making decisions about transportation for daily commutes based on estimates of an individual's carbon footprint) to the intergovernmental (United Nations negotiations and agreements such as the Kyoto Protocol).

A range of government organisations collect earth observation data for a variety of purposes including meteorological monitoring and forecasting, geological surveying, environmental monitoring, and disaster management. Ideally, these datasets, once released, would be available and readily accessible for reuse by researchers, hackers, and the general public. However, Reichman, Jones, & Schildhauer (2011) identify three key challenges with current methods of collection and storage of earth observation data, which make the reuse of data difficult in practice, thus diminishing their usefulness for the democratic domain: data dispersion, with datasets located in numerous locations; heterogeneity of the data collected due to the varied methodologies and terminology used by the numerous disciplines involved; and tracking data provenance, which is crucial for ensuring integrity of scientific results. These issues result in duplication of cost and effort, where people are unaware that datasets exist, and make it difficult to create something new by hacking datasets which might have been collected by different organisations or researchers.

Usefulness in the collaborative domains

What is considered useful in the collaborative domain will vary depending on the collaborative community in question. Two groups of interest here, considering the twin focus on environmental sustainability and civic hackathons, are the international scientific community and the open source development community.

Scientists are increasingly viewing the open science approach (consisting of open data, open access and open research) as a desirable way to increase the sum of scientific knowledge

through collaboration and sharing, and to increase the value of data by allowing it to be freely reused by other researchers (David, 2003; Uhlir, 2010). This has resulted in attempts at collating and standardising datasets to achieve greater interoperability and accessibility. The most significant of these initiatives are international efforts such as the Data Conservancy project, the Open Geospatial Consortium, and the Group on Earth Observations (GEO), an international project which currently involves over 80 member states of the United Nations. As an example of how these international initiatives promote open science, GEO's flagship project, the Global Earth Observation System of Systems (GEOSS), aims to be a comprehensive system-of-systems to link the data from existing earth observing systems through common standards which will allow greater interoperability between diverse datasets and a central point through which researchers can access data (Group on Earth Observations, 2014; Harris & Miller, 2011; Lautenbacher, 2006; Percivall, 2010)

The drive towards open science is underpinned by a reaction against those "scientific communities where by default data is not shared freely, papers are published in closed access journals and the scientific process operates behind closed doors" (Open Knowledge Foundation, 2014). While collaboration to some extent has been a feature of scientific practice historically, open science is essentially redefining usefulness in the context of the international scientific community, as it becomes more useful for those involved to share their research with peers globally (especially for global grand challenges such as environmental sustainability) than to keep the status quo bureaucracy and systems in place. Researchers involved in environmental sustainability issues are also broadening their definitions of what constitutes useful knowledge through the inclusion of multidisciplinary perspectives in their work (Uiterkamp & Vlek, 2007), thus potentially emerging as the 'critical friends' that Haklay (2015) encourages those who work in adjunct fields to become.

The international nature of contemporary scientific collaboration is facilitated by the ease of transcending geographical distance made possible by the Internet. The Internet is also the enabler for the open source development community, which, unlike the traditionally closed scientific community, has collaborative intent built into it, as source code developed by one person is available for others to develop further.

Benkler (2006) describes the open source community as being part of a 'networked information economy' (as distinct from traditional 'industrial information economy' embodied in media corporations and television networks) which is a "system of production, distribution, and consumption of information goods characterised by decentralised individual action carried out through widely distributed, non-market means that do not depend on market strategies" (p. 3). The overarching theme in Benkler's description of the networked information economy is that it is a democratisation of cultural and social production, an example of which is the collaboration between programmers from all over the world. This concept, along with another major concept Benkler proposes, 'commons-based peer production', emphasizes the community-building that occurs around open source projects.

An attempt to define what is considered useful in the open source community must start with an examination of the aims of those involved in the community. Although the open source community privileges the free and open exchange of labour and information, Benkler concedes that open source production does not "mark a fundamental shift in human nature into selfless, community-conscious characters" (2006, p. 376). Participants in the open source movement cite a range of reasons for their involvement, as described by Ke & Zhang (2010),

including: "… enjoyment in helping others improve software, enjoyment in tackling complex programming problems, improving programming skills, gaining financial benefits, signaling competence to potential employers, improving future job prospects, gaining recognition from peers, [and] enhancing reputation in the field…" (p.785).

Within the open source development community are developers who subscribe to what Himanen (2001) describes as the 'hacker ethic'. These hackers embody "a general passionate relationship to work that is developing in our information age" which is at odds to the dominant 'Protestant work ethic'. Himanen proposes that hackers are driven by intrinsic passion about the projects they work on rather than the desire to increase material wealth, and underlying this passion is a conviction that information and technological resources should be shared and easily accessible. Others are less convinced of the inevitability of the benefits of broader Internet participation in say, achieving government efficiencies, pointing to a potential co-option to neoliberal agendas, and the possible exploitation of those who contribute labor, in a "semblance of agency", and express themselves through the group formation of identities which make it "hard to disconnect" from wider governmental agendas (Gilge, quoted in Haklay 2015).

Although there are differences between the international scientific community and the open source development community in terms of their fundamental activities and aims (including differences between sub-groups, and even between individuals within these communities), a common theme is the ability to collaborate through freedom of access to information. Usefulness in the collaborative domain seems to be characterised by the building of networks of people to achieve whatever the particular community, sub-group or individual defines as an end goal – whether it is the answer to a scientific problem or the production of the most 'beautiful' code.

Usefulness in the popular domain

Usefulness in the popular domain is linked to the ways in which the general public can engage with open government information, and to contributions made by citizens. A fundamental aim of open government is to make government information available to the general public, and usually, this primarily involves releasing information online.

Making government information available online is an effective strategy from the perspective of those who have the ability to access the Internet, as it allows potential users of open government data to access and search for the information regardless of their physical location. As more people around the world are able to access reliable Internet connections, making data available online seems to be the sensible approach to open government. However, for those on the other side of the 'digital divide' (without access, or with limited access, to computers or the Internet) and the 'data divide' (those without the skills and knowledge to understand and reuse datasets), online data can also reinforce existing social stratification by creating another avenue for the privileged to increase their privilege though better access to information (Dimaggio & Hargittai, 2001). A reasonable critique of Benkler's networked information economy is that, since it is only accessible to those with the resources of technology, time, and knowledge, rather than being democratic, the networked economy establishes its own form of exclusivity which is often unchallenged because of the optimism that surrounds open government.

The citizen science movement, to which civic hackers of scientific data could be said to belong as a sub-group, is gradually establishing that different forms of participation and collaboration in scientific knowledge production exist through the documentation of multiple international projects, and the proposal of definitions and principles. Bonn, of Germany's Citizen Science portal Buerger Schaffen Wissen (BSW), gives a contemporary overview of the movement at the 2015 Science 2.0 conference, defining the three main goals of citizen science as "active participation in scientific processes from data acquisition and processing to co-design and co-production" ; "increasing scientific literacy and empowerment by understanding, acceptance, uptake and implementation of transparent and responsive research in society"; and "innovation in scientific research by engaging with a variety of knowledge domains and introducing new perspectives and information, as well as partnerships" (Bonn, BSW, 2015.)

Civic hackathons often encourage participation from non-coders, such as educators, designers, subject matter experts, and potential end-users. Those who choose to participate in these activities can be seen as intermediaries for those members of the general public who choose not to, or are unable to, participate. This latter group of non-coders are potential beneficiaries from the outcome of civic hackathons, and for these people, usefulness can be defined as increased access to government data, government processes, and new products developed from government data which will contribute to their lives in some way. From a wider perspective, non-coders may be fulfilling some aspects of citizen science goals outlined above, by becoming more literate scientifically and being involved in both bringing fresh perspectives to, and disseminating, responsive research across societies.

Methods

Recruitment of Participants

The pool of potential participants for this study was limited to those who participated in the 2013 Space Apps Challenge (as that was the most recent event that had been held at the time of the study). All participants were to be aged 18 and over, with basic English language skills[1].

In that event a total of 770 projects were created. These can be broadly grouped into themes such as space exploration, science communication, and environmental sustainability. While it would be worthwhile to conduct a larger study exploring the outcomes of the hackathon for all these themes (and perhaps over several years), this study was limited in scope by the time and resources available, so was conducted with a particular interest in the usefulness of civic hacking for promoting environmental sustainability.

Two filters were placed over the full list of projects to create a list of participants who would be approached to participate in this study. The first filter excluded any participants who did not work on environmental sustainability-related projects. In order to make the list more manageable for the limited scope of this study, the second filter excluded participants who had not qualified for the global round of judging for the 2013 Challenge. This resulted in a list of 26 projects from which the sample could be generated, as each project had already

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[1] The research project on civic hackathons received Human Research Ethics Committee approval (No. 2013-052) at the University of Adelaide in May 2013.

been judged to be robust enough to proceed. The nominated contact person from each project team was contacted via email, with an invitation to participate in this study.

The resulting sample of 9 participants (representing 7 projects) was internationally diverse, allowing for an understanding of the environmental sustainability-specific challenges from different perspectives. In addition to the Challenge participants, the perspective of the event's primary organiser and data provider was sought, through interviewing a NASA contractor (the only female interviewee) who had been closely involved in its inception and development.

The sample size for this project was small due to resource constraints and because the nature of the question (how useful hackathons are for environmental sustainability) limited participation to only those participants who worked on projects which were related to the environment. Despite a small sample size, recurring themes emerged from the data which create opportunities for further investigation. There is an opportunity to increase the validity and generalisability of this research through longer-term studies conducted over multiple events and with a larger number of participants.

Data collection and analysis

Data for this study was collected through 30 minute semi-structured interviews with 10 participants (nine hackathon participants and one organiser), conducted over Skype. After a request for background information about professional orientation and their reasons for participating in the Challenge, the interviews comprised the following guiding questions to capture a baseline set of data across all interviewees; additional data was gathered through follow-on questions, clarifications, and discussion which were generated by participants' responses to the guiding questions.

- Why did you choose to develop an app that addressed environmental sustainability issues?

- What challenges did you face during the event (for example, access to relevant datasets, having the requisite skills and knowledge to use datasets, etc)?

- How has your Challenge project developed since the end of the Challenge?

- Have you continued building on the work you/your team did during the Challenge weekend?

- Has your app been used by the general public, and if so, how? If not, why?

Interview transcripts were transcribed verbatim and subsequently analysed thematically, in keeping with the grounded theory approach to qualitative research with key informants by noting the perspectives and themes in the participants' responses. In addition, in order to contextualise the comments of interviewees, discursive analysis of other artefacts from the Challenge was also conducted, including participant videos, event websites and the 2013 International Space Apps Challenge post-event report.

Discussion

Participants were diverse in backgrounds, capabilities and histories of employment. They included experts or students in environmental research, software design or other information technology fields; others described themselves and members of their groups, for example, as start-up entrepreneurs, industry developers, or from the creative industry technology-enabled fields of music composition and graphic design. Well-educated and industry trained in many cases, participants described how they routinely deployed different but related skill-sets in employment or study. All but two had been involved in hackathons or similar events before. Several had travelled internationally for work or study, and had been invited to participate in the hackathon through a friendship or collegial connection in an existing network, or community of practice. The programming participants could be characterised as high-functioning practitioners: cosmopolitan, networked, articulate, and drawn to and accustomed to collaborative technology work.

Project group sizes ranged from three to six. All groups were multi-disciplinary, including capacities among the members such as research capability, software engineering, data visualisation and remote sensing skills. The following foci emerged from analysis.

Organisational matters

Although participants noted that the fact that the hackathon was auspiced by the US National Aeronautics and Space Administration (NASA) had been a significant attractor, with one noting its future use on his CV, some found the organisation's information sharing about the event as off-putting and 'glossy'.

The lead organising agency for the International Space Apps Challenge is NASA but, in practice, the event is decentralised, with self-contained local events in cities around the world organised by local leaders with the autonomy to decide on the scope of their event (including the option to have local problems for participants to work on, and to decide if and what local prizes are available to participants). In order to foster the 'international' aspect of the event, the International Space Apps Challenge encourages participants to communicate with each other across cities and countries through Skype, Google Hangouts and similar technologies during the event, and even to collaborate with people in different cities (including 'virtual' participants who are not able to physically attend a local event). The further networking opportunities were appreciated by participants.

The International Space Apps Challenge is aimed at exploration, mass collaboration, community building, and finding solutions to a list of problems or 'challenges' that participants work on. These Challenges are collected from a range of sources including from within NASA itself, and are curated based on their appeal to a wide range of potential participants. The Challenges are, ultimately, supposed to be statements of real issues that participants can assist with:

> *"We did desire to have broader participation so that we weren't solely appealing to coders… but I would actually say it was more of a function of the NASA stakeholders for that time. So when Space Apps comes around, we make the rounds around to all of the organisations and directorates and say, "You know, what's your interest here?"… and so the problems we offer are solely based on who those people are and what kind of things they find interesting."* NASA Contractor and organiser, USA

This framing suggests that for organisers, usefulness is not intrinsic, it is arbitrarily constructed by the expressions of interesting problems identified by a wider expert community than the coders, and yet achievable by coders during the hackathon event.

Challenges

While the Challenges cover a broad range of topics, the ones of interest for this paper were related to environmental sustainability. All participants had identified environmental sustainability as an issue which they already saw themselves as affiliated with, or one that they were happy to prioritise above other potential Challenges. The Challenges in which the interviewees in this study participated included:

- 'Smart Cities, Smart Climate', which asked participants to develop ways in which to use low-cost sensor networks in cities to assist with planning for environmental management (particularly urban heat issues);

- 'Predicting Water Contamination', a Challenge proposed by a not-for-profit organisation called mWater, which has previously developed an open source mobile app which promotes open access to water and sanitation data. This challenge invited participants to extend the capabilities of the mWater app.

- 'We Love Data', which was an open-ended Challenge for participants to develop novel ways in which to promote public engagement with space-derived data.

Harnessing the desire to be useful

The 2013 International Space Apps post-event report (NASA, 2013) positions the event at the juncture of the democratic, collaborative and popular domains by highlighting the usefulness of engaging and connecting people who are eager to altruistically contribute their skills and knowledge in order to help solve grand challenges:

> *The more government enables people who fundamentally care about it and want to contribute to the future of our world, the better chance we will have to help our governments live up to their true potential and develop solutions to the grand challenges of our time.* (p.14)

and that:

> *The event demonstrated that thanks largely to the Internet, the kind of creativity and innovation that used to take place primarily behind closed doors within large institutions is increasingly taking place by people simply connected online.* (p.16)

The 2013 International Space Apps Challenge post-event report also highlights an underlying assumption with regard to civic hackathons: that at least some skilled and knowledgeable people want to be useful by helping others and contributing to 'the greater good' (Tauberer, 2012).

This assumption seems reasonable, as one of the recurring themes from interviewees for this paper was the desire to be useful by creating apps that would contribute to environmental sustainability in their local communities. One interviewee suggested the urge to be useful to

others by participating in non-market activities such as hackathons was enabled by the decreasing cost of technology, which allows people to consider exchanging their skills, knowledge and labour for something other than money (in keeping with Benkler's conception of the 'networked information economy':

> *What I see happening is there is this kind of post capitalist model that seems like we are transitioning into where… before, if you wanted to make something… it was fairly capital intensive. But now, because the cost of information technology is so cheap, and in some cases it's approaching zero, it enables so many more people to build and create things without the need for money… and without the need of making money off of it. So, time becomes the new money, and people, some people are willing to, look at everything in terms of quality of life, more than just, quantity of money.* Industrial Designer, Sweden.

When asked why they chose to work on an environmental sustainability related project, interviewees often expressed a desire to create something which was immediately relevant and meaningful for their communities (an urge to be useful within both the democratic and popular domains):

> *Because it had to do with the here and now. It had to do with local issues and making a difference where we were learning ... and it wasn't just sort of thinking about games or doing something playful, it was just... wanting to make a difference.* Composer, United Kingdom.

Participants spoke about the detailed challenges they faced, in some instances seeing their efforts as dovetailing with NASA research aims. One app developer expressed the implied understanding of usefulness this way,

> *NASA is really good at this kind of macro level of aggregating climate data, or the satellites. And they can get a view of the world at a high level…but they can't really zoom in too far on that data.So what we want to do is complement the macro level with the micro view.* Industrial Designer, Sweden.

Underlying all these motivations is the fact that anything developed during the weekend of the Space Apps Challenge must be released under an open-source license – which essentially means that participants are 'gifting' their weekend's work to anyone who wants to use it or develop it further (satisfying an urge to be useful within the collaborative domain).

If, as The New Hacker's Dictionary suggests, "...it is an ethical duty of hackers to share their expertise by writing free software and facilitating access to information and to computing resources wherever possible" [online], then it becomes a civic hacker's duty to mediate between the masses of open government data and the general public, who would, on the whole, not have and skills and knowledge to make use of that data. This is an especially acute distinction in those countries where the divide between those with access to wealth and education and those without is most pronounced. For example, one participant from Mexico describes how his team had to consider technological and knowledge constraints for the target users of their environmental monitoring app:

> *We thought… why not make [the water monitoring app] available to other people who may not have that knowledge but may be able to contribute to it. And so, instead*

of requiring a test to be performed at a water source, our app lets regular people like myself be able to look at a source of water that might be… potentially contaminated and will answer a couple of questions regarding its state, about how it looks, it smells... And that piece of information just from observing, we can deduce if it might be potentially contaminated and so it raises… a ticket so environmental organisations or health department in the government can have access to that report and go to the water source themselves and do a proper test and see if it really requires some kind of treatment... although people don't have that much access to computers, unexpectedly, there are a lot of people with smart phones so I thought that was pretty unexpected and amazing so, well, why not make it a mobile as well so people can participate with it. University student, Mexico.

The final comment shows that mobile phone users are being thought about as potential contributors to citizen-sourced scientific data. Notions of usefulness arise in the practices of making.

Stewardship: multiple owners

Exacerbating the issues of digital and data divides, and a major problem for the usefulness of government data (in the democratic domain), is that datasets which are relevant to a particular problem may be held by various branches of an agency, different agencies, or at different levels of security and confidentiality, making it difficult for International Space Apps Challenge participants to access and reuse them. This is similar to the problems that scientists face in the collaborative domain:

The problem is science at NASA is usually done in cooperation, usually with university investigators and so… usually the investigator has the data and usually is hosting the current location. And so, there's a lot of issues with making those things work and reconnecting them back together. NASA Contractor and organiser, USA.

In addition to the problem of dispersion of datasets, there seems to be some difficulty in convincing owners and managers of datasets to ensure they are of sufficient quality to be released for reuse:

We are encouraging NASA in the development process to evolve the data more and more... and the thing that's been extremely helpful is that we've needed the examples (we knew this was going to be an issue that people say, "oh, they don't need this kind of data, or they don't need that kind of data) to be able to say "do you see that because the data only work this far, this project can only go this far" NASA Contractor and organiser, USA.

In order to mitigate problems with accessing datasets, the Challenges on the International Space Apps Challenge website have links to relevant datasets associated with them. The NASA website also has datasets categorised to make them more easily accessible. The struggle to make the data useable seems to have been fruitful, at least in some instances:

Because locally, first of all, we haven't… adequate enough data, and secondly, sometimes we cannot get access to this data, datasets. But using NASA options, it is very easy to get such data. Climate researcher/ University lecturer, Japan

Being at the point where the three domains overlap means that determining how useful the International Space Apps Challenge was in contributing to environmental sustainability is a complex exercise, and that the metrics by which the success of the event have to be judged must include the procedural (number of participants, number of locations, number of solutions developed) as well as hard achievements (for example, how many solutions have developed to the point where they are being used by the general public).

Perspectives on the outcomes of useful civic hacking

The recent proliferation of civic hackathons has instigated much self-reflection amongst those involved about whether the model as it stands is useful, and ways in which it could be improved (Detar, 2013; Eaves, 2012; Oram, 2011; Sasaki, 2012). These discussions are generally critiques of the lack of hard achievements from hackathon events and do not consider the value of other types of outcomes such as community and network building, which is a form of usefulness in the collaborative domain, or increased awareness of and access to government data, which is useful in both the democratic and popular domains:

> *"It can be argued that the impact of the applications and prototypes created in the hackathons is limited, and while some applications become new products and keep being used, many of them stay on a prototype stage."* (Zapico, 2014)

A lack of hard achievements from civic hackathons is also true in the specific case of the International Space Apps Challenge. Focusing on the environmental-sustainability related solutions (from the full list, not only the ones included in the interview sample for this paper), there is little evidence to show that a significant number of projects that were started during the 2013 event were developed further.

International Space Apps Challenge organisers were not expected to report against hard achievements in 2012 and 2013, which perhaps indicates that at least in the early years of the hackathon, this was not considered to be one of the most important outcomes. However, the list of suggested judging criteria for Space Apps Challenge projects (NASA 2015) demonstrates that organisers valued the potential for hard achievements, particularly based on the description of the 'Impact' and 'Sustainability' criteria:

- **Impact**: How much impact (quality and quantity) can this project have? Does it solve a big problem or a little problem?

- **Creativity**: How creative is the approach? Is the project new and something that hasn't been attempted before? Is it something that isn't being addressed by the market?

- **Product**: How well does this project fit the needs of the challenge it addresses? How user friendly is the technology? Is it a complete solution or does it have a long way to go?

- **Sustainability**: How good is the plan for next steps? How prepared is the project team to continue their work beyond the event? Is the project organized in a way so others can take the project to the next level?

- **Presentation**: How well did the team communicate their project? Are they effective in telling the story of the project and why it is important?

The lack of hard achievements can perhaps be traced to the tensions that arise when the hacker ethic of not being bound by traditional notions of time and labour meets the time-

bound, solution-oriented nature of civic hackathon events. The short timeframes of civic hackathons do not foster an environment for a community to be built. Kelty (2008) writes about hacker communities being a 'recursive public' which he defines as giving "precedence to a generalised openness to change, rather that to the following of shared plans, goals, or ideals dictated or controlled by a hierarchy of individuals". While not all participants in the Space Apps Challenge are hackers, one participant picked up on a similar issue in the Space Apps Challenge, as the event is essentially sponsored by a number of large organisations (such as NASA and other government agencies), and at the local event level, there is also a form of hierarchy with local lead organisations or individuals being at the 'top':

> *I suppose it's... this old issue of top down approaches, where, instead of things springing up on a grassroots level, there is... a huge organisation that's trying to create a grassroots movement and that... that often doesn't work. Probably most times, it doesn't work.* Composer, United Kingdom.

As civic hackathons become more diverse in terms of participants, however, more definitions of usefulness will have to be considered. The interviewees for this paper, the majority of whom would not define themselves as hackers, were enthusiastic about the creative and innovative potential of the event:

> *If we are talking about such events as NASA event, I see very important thing in these events. It's kind [of a] brainstorm event.* Information Science & Technology Professor, Macedonia.

> *It is good because you end up with these great ideas on a weekend, but they are all rough prototype.* Industrial Designer, Sweden.

But these civic hackers were also thinking about how the ideas from the event could be developed further:

> *This is something I deal with, actually, in my job… and my role is really to see how we can facilitate some of these really disruptive ideas and grow them. And it's a similar challenge... one thing that could be considered is… some sort of program in place where, if it's NASA or some other organisation, but they can take the outputs… and help nurture them.* Industrial Designer, Sweden.

Organisations such as Code for America and Random Hacks of Kindness currently combine civic hackathon events with structured, longer-term programs such as technology incubators and internships to facilitate the ability of civic hackers to further develop their ideas. It is unclear if the organisers of International Space Apps Challenge have considered these types of programs, but implementation of something similar could meet the needs of some participants who are eager to continue work on their ideas but find that 'real life' took over once the weekend of the Challenge was over:

> *In the long run, I think, each of us has just been preoccupied with... with what we need to do on a day-to-day basis to keep our lives together. So, that, you know, we haven't, actually, formed a business venture, in the long run.* Composer, United Kingdom.

> *After that our team became busy… Other team member are professional… or they have own job… and also my own job…* Climate researcher/University lecturer, Japan.

In a few cases, interviewees reported that their teams kept in contact to work on other projects or found new collaborators to further develop their work:

> *I took this project and pitched it to a, not an investor, but like a grant place to get a grant… cause really, we needed some, seed money to, kind of, start scaling it. That didn't come through… but then I reached out to another group… and they're, kind of, doing the same thing, but they're much further along. So they already have, when this was going on they had just put their project up on Kickstarter to raise money, and they met their goal. So, now they are actually putting their kit together… so now it's a question of exploring some opportunities to collaborate… and leverage the work that they've already put into doing their project.* Industrial Designer, Sweden.

It can be argued that the Dawes' (2010) principle of 'stewardship and usefulness' should be applied also to the concepts and work undertaken during civic hackathons. Organisers of the International Space Apps Challenge are grappling with how to begin 'stewarding' from the start of event organisation process. For example, NASA organisers found that:

> *…the non-government agencies are often more… agile and able to integrate and continue to work with project teams in an on-going way.*

Another form of stewarding seems to occur when there is a traditional teacher-student relationship involved. A number of the participants interviewed were university professors who encouraged their students to be involved with the Challenge. The involvement of university students and staff has the potential to create more sustainable projects, as these projects could be further developed as student projects.

It is possible that this occurs because, when government agencies have achieved their definition of usefulness in the democratic domain (that their open data has been made openly available and reused), they are unwilling or unable to invest further resources to ensure that other forms of usefulness are achieved. Non-government organisations and universities who could benefit from the work of civic hackers could be involved from an early stage in future events to ensure they contribute Challenges which meet their own definitions of usefulness.

Conclusion

Although it would seem that gathering groups of passionate and technically expert people in one location and encouraging them to use their skills to create something useful for their communities would be a highly effective way in which to tackle grand challenges such as environmental sustainability, there are currently disconnects between the different framings of usefulness and the reality of hard achievements from civic hackathons. Most projects from these events are not developed further.

Positioning the International Space Apps Challenge within three overlapping domains of activity (democratic, collaborative and popular) has shown that some of the issues associated with civic hackathons, such as difficulty in accessing datasets, or the tendency for projects not to be developed further, arise from the sometimes conflicting definitions of usefulness in each

domain. The democratic and collaborative domains reveal that the less easily measurable goals of promoting environmental sustainability and establishing multidisciplinary communities for the re-use of scientific data, and the purposeful challenge-based local projects, seem achievable. In the popular domain, the hackathon appears also to be achieving a measure of success in the scaling up of event participation, the variety and number of project groups formed, and the participants' engagement with and ownership of the framing of solutions to local concerns.

If a narrow definition is adopted to measure usefulness of the civic hackathon activity (such as measuring how many apps developed at the International Space Apps Challenge are currently being used by the general public to contribute to environmental sustainability), then the inevitable conclusion is that civic hacking for environmental sustainability is not a useful activity. However, usefulness is a concept which must be examined within the context of society and the individuals and groups within it. With this in mind, this paper has argued that measuring the usefulness of civic hackathons is a complex undertaking due to the wide range of stakeholders, all of whom have their own definitions of what is useful, and while the hard outcomes from the Space Apps Challenge are few, civic hacking can be considered useful for environmental sustainability in a number of the other ways suggested.

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