Bikeoff 2 – Catalysing Anti Theft Bike, Bike Parking and Information Design for the 21st Century: An Open Innovation Research Approach

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This paper outlines the issue of bicycle theft as it affects the achievement of sustainable transport objectives relating to increased cycle use. It describes the research activities of the AHRC and D21C funded Bikeoff Research Initiative and its methodology. It also discusses the relationship between this methodology and Chesbrough's model of 'open innovation'as a way of articulating the 'emergent' nature of the research process and its generative capacity.

Background

The Bikeoff Research Initiative (BRI) was established in 2004 within the Design Against Crime Research Centre (DACRC) at Central Saint Martins College of Art and Design, London (CSM).

Opportunities to reduce crime through more effective design have been progressively recognised by the UK Government. For example, the Home Office have recently announced the creation of the *Design and Technology Alliance Against Crime* as a means of bringing together various stakeholders to apply design in the crime-reduction enterprise. The DACRC is an initiative that has been running at CSM since 1999, supported with public funding from the UK Design Council, the Home Office, Transport for London (TfL), the Metropolitan Police Service and the British Transport Police, as well as various Research Councils.

DACRC aims to:

- reduce the probability and harmful consequences of crime including wider impacts on quality of life through the design of products, services, communications and environments that are ‘fit for purpose’ and contextually appropriate
- equip design practitioners with the cognitive and practical tools and resources to integrate crime in the design process
- prove and promote the social and commercial benefits of designing out crime to manufacturing and service industries, as well as to local and national government and society at large, and
- address environmental complicity with crime in the built environment to reduce crime and improve individual and community well being.

The philosophy behind DACRC at CSM is linked to a practice-led design research agenda and the understanding that design should address security issues without compromising functionality and other aspects of performance, or aesthetics. In everyday language, secure design has to be user-friendly whilst abuser-unfriendly; but it doesn’t have to look criminal or even ugly.

DACRC works closely with the UCL Jill Dando Institute of Crime Science (JDI) and the crime prevention community more generally. Similarly to ‘Design’, ‘Crime Science’ is a multi-disciplinary subject. Crime science refers to an approach that draws on numerous disciplines including psychology, geography and medicine in order to better understand and respond to causes of crime in an attempt to get upstream of crime and to proactively prevent it rather than merely respond to it.

This collaboration enables the convergence of multi-disciplinary approaches including user-and abuser centred (often qualitative) design processes and quantitative, statistical and empirical crime science processes to synthesise interdisciplinary outputs and outcomes that realise a strong, practical, public value focus on the integration of design and crime reduction.

The Bikeoff Research Initiative was set up to investigate how the design and provision of cycling related objects and environments can reduce the incidence of bicycle theft and in doing so promote cycle use. Initial aims of the initiative were to research, create and test design solutions that reduce cycle theft and to identify and disseminate best bike theft reduction practice to stakeholders and duty holders within the subject area including providers, specifiers, designers of cycle products and environments and the crime prevention community.

Bikeoff research began in May 2004 with a small AHRC funded study (£5000) ‘Design review and visual documentation of bicycle parking provision to catalyse future crime prevention design’.. The study aimed to observe and record bicycle parking practices and provision (including ‘fly parking’ activity, involving the secur-

ing of bikes to objects not designed for this purpose (Johnson *et al.* 2008) to investigate the link between cycle parking and cycle security, particularly in relation to considerations of ease of use and resistance to abuse (bike theft). Research findings were subsequently published (Gamman, Thorpe and Willcocks, 2004) receiving broad acknowledgement and support from stakeholders and were circulated widely by Transport for London's (TfL) Cycle Centre of Excellence (CCE) as benchmark research in this area. Another significant output of this scoping study was a weblog located at www.bikeoff.org that was set up to disseminate images of current cycle parking and security practice thereby enabling cyclists to contribute their own experiences and practices. This initial study and its outputs created a multi-stakeholder, multi-disciplinary network focused on the issue of cycle theft reduction and identified a number of research questions linked to gaps in knowledge and resources relating to cycle theft prevention. Stakeholder acknowledgement for the validity and relevance of the scoping research delivered and the potential value of further research in the area inspired the creation of the research project *Bike Off 2 - Catalysing anti theft bike, bike parking and information design for the 21st century* that was subsequently funded by the AHRC/EPSRC Design for the 21st Century programme. The network of stakeholders supportive of the research and existing extended networks of the DACRC demonstrated clear multi-stakeholder and multi-disciplinary interest and demand for the proposed research and the requirement and opportunity for multi-disciplinary collaboration, and potentially interdisciplinary working, in its delivery. The core research team included design researchers and practitioners: Adam Thorpe (Principal Investigator), Lorraine Gamman (Professor of Design Studies), Paul Ekblom (Professor of Design Against Crime) and Marcus Willcocks (Research Assistant and design practitioner) all of whom are based within DACRC. Also, crime scientists: Dr Shane Johnson and Aiden Sidebottom of the JDI; and crime prevention practitioner Ike Gray of the Metropolitan Police Service who, although not funded by the project, collaborated closely throughout its delivery. Significantly the network established during the previous Bikeoff research provided a collaborative 'stakeholder landscape' in which the project was to be delivered, enabling diverse disciplines to combine in multiple research, implementation and dissemination activities.

Context: Cycling and Cycle Theft

Bikeoff 2 aimed to catalyze a design revolution in secure cycling for the 21st century to overcome the adverse effects of bicycle theft on achievement of sustainable transport objectives within European cities (and realise the benefits that increased cycle use can afford society).

Cycle use contributes to urban wellbeing. It is quick (outperforming other modes for urban journeys under 5 miles), healthy (reducing risk of obesity/heart disease), affordable (and therefore inclusive), non-polluting (producing zero CO2 emissions in use), low

hazard (less damaging than motor vehicles in terms of infrastructural wear and accident), low consumption (studies of energy used per passenger-mile calculate that a bicycle uses only 35 calories to carry a passenger a mile, whereas a car uses 1,860), and quiet.

Presently across Europe, various policy targets have been proposed in an attempt to promote cycling as a cleaner, more sustainable form of transport. To date such policy targets appear successful: in London, cycle use has increased by 83 percent between 2000 and 2007 (Transport for London, 2007); similar increases have been observed in European cities such as Münster, Graz, Delft and Hannover (Oja and Vuori, 2000). From a crime prevention perspective, Sidebottom *et al.* (2009) argue that increases in the population of cyclists may stimulate a rise in cycle theft as opportunities for cycle theft increase. This is a concern as research indicates that bicycle theft is a common problem and a significant detractor from cycle use (Frayling, 1974; Mercat and Heran, 2003; Roe and Olivero, 1993; Gamman, Thorpe and Willcocks, 2004; Zhang, Messner and Lui, 2007).

For example, in 1997 17% of UK cyclists reported suffering bicycle theft – consequently 66% cycled less often and 24% ceased to do so. Nationally, the British Crime Survey – an annual survey asking a large representative sample from England and Wales their experience of crime over the last 12 months - estimated that some 403,000 incidents occurred in 2004-5. Between 2003 and 2005 National cycle theft figures were seen to be rising again and thus UK policing performance targets in 2005/6 acknowledged the need to reduce bicycle theft, making it a 'comparator crime' against which police performance was measured. There is some evidence to suggest that Bikeoff advocacy and scoping research contributed to this focus. The Home Office estimated the net cost of lost, damaged and un-recovered cycles in England and Wales for 1995 was £140m, increasing to £230m annually when adding hidden costs.

Internationally cycle theft is of similar concern. In Sweden, bicycle theft constitutes around 7 per cent of their entire reported crime problem (Svensson, 2002). In Holland, Weijers (1995) finds that 93 bicycles are stolen every hour. Estimates from the recent International Crime Victim Survey (ICVS) indicate that cyclists are around three times more likely to have their bike stolen than car owners their car or motorcyclists their motorbike (Van Dijk, Van Kesteren and Smit, 2007).

Bicycle theft is also found to routinely go unrecorded by the police because of a high degree of under-reporting. For example, results from the ICVS show that 56 per cent of bicycle thefts were reported to the police (Van Kesteren, Mayhew and Nieuwbeerta, 2000). Moreover, a comparison of police recorded statistics in England and Wales and estimates from the British Crime Survey suggest a four-fold difference in the extent of the problem. Interviews with cycle theft victims imply that this is because many believe the

police are unlikely to apprehend an offender or recover their stolen bicycle (Bryan-Brown and Saville, 1997). Even when incidents are reported, Gamman, Thorpe and Willcocks (2004) argue that many reported incidents fail to be recorded because bicycle theft is typically considered a low police priority.

To continue the promotion of cycling, and to secure the benefits of increased cycle use within our cities, the issue of cycle theft is suitably addressed. The scoping research delivered in 2004-05 revealed missed opportunities for effective bike theft prevention through the design of products, environments and services, and insufficient resources to inform and implement such interventions. The knowledge and resource gaps relating to the design, specification and provision of secure cycle parking facilities and situational approaches to cycle theft prevention included:

- Absence of any definitive and up-to-date design guidance or standards, or secure benchmarks that could effectively inform designers, specifiers, providers and the crime prevention community as to how to achieve secure cycle parking and reduce cycle theft.
- Lack of rigorous testing or evaluation of the security of bicycle parking furniture and facilities, or of bicycle security products, with the narrow exception of the Sold Secure accreditation for locks.
- Absence of a clear mechanism for dissemination of research relating to cycle security to inform designers, specifiers, providers of cycling infrastructure and the crime prevention community.

Bikeoff 2 set out to fill these knowledge gaps and in doing so increase the innovative capacity (ability to generate innovative cycle theft reduction designs) and the operational capacity (ability to improve the efficiency and effectiveness of cycle theft reduction operations) of those agents and agencies involved in provision of cycling infrastructure and cycle theft reduction and prevention.

Bikeoff 2: Approach/Journey

To do this, Bikeoff 2 was created as a research ‘portfolio project’. It sought to draw on initial shared research regarding cycle theft, its prevention and reduction, and combine iteratively the activities of three practice-led research projects in the creation of design guidance, design resources and design exemplars. This comprised three research streams, specifically:

- Design standards and design methodologies for the creation of secure cycle parking furniture and facilities.
- Design resources and design education relating to cycle theft reduction and design of secure cycling products, services and environments.
- User evaluation of cycle parking furniture and facilities.

Each project was delivered in collaboration and cooperation with many diverse stakeholders (many of whom contributed across the projects within the portfolio). Included were academics, police officers, local government officials, transport planners, police crime prevention advisors and architectural liaison officers, designers, engineers, architects, and criminologists – all of whom shared a concern with the problem of cycle theft.

Research activities were carried out in an inclusive and transparent manner, with findings circulated widely and open invitation to seminars and events facilitating an 'open innovation' process of research generation, dissemination and exploitation, often via application to design or crime prevention practice.

The project sought to benefit from engagement with as many diverse stakeholder groups whilst applying a policy of 'working with the willing'. This approach helped avoid possible obstruction resulting from past 'politics' in the sector, and ensure project delivery. We refer to the 'project space' in which research was delivered as the 'stakeholder landscape' after Chesbrough's (2006) 'knowledge landscape', the term used to describe the arena of activity in which knowledge is transferred and shared. Our 'stakeholder landscape' is both the arena in which research knowledge is transferred and often that in which it is generated through research-led practice in a process akin to 'action research' (Reason and Bradbury, 2001). In this way the 'stakeholder landscape' relates to a 'multidisciplinary Community of Practice' in which knowledge from one discipline advances with collaboration and contribution from other disciplines.

This project structure seeks to ensure that theories, as well as data from practice led design activities, meet and are combined in a holistic way, iteratively, throughout the project. This process concurs with Thakara (2006) that design in the 21st Century involves 'complex systems that are shaped by all the people who use them, and in this new era of collaborative innovation, designers are having to evolve from solely being the individual authors of objects or buildings, to acknowledge their role as being the facilitators of change among large groups of people.'

Each project manager, (Dr. Johnson, Prof. Gamman, and Adam Thorpe) worked to deliver the tasks and work packages outlined in the original schedule of work that, theoretically, would lead to the successful delivery of the anticipated research objectives whilst being responsive to opportunities and issues that emerged as significant to the stakeholders within the projects.

Iterative review of research findings by stakeholders (advisors) informed the direction of new research, and practice, undertaken to produce outputs, connected to theories, empirical evidence, case studies, benchmarks as well as data sets generated from practice led design research activities. This emergent approach kept project outputs 'fit for purpose' in terms of relevance to stakehold-

ers, on target in terms of aims and objectives, and helped us to combine findings in a holistic way to meet the requirements of the project's anticipated key deliverables;

- Development of bike parking design guidance according to three different methodologies; a 'best of breed' guidance was created via a literature review and comparison of existing standards and guidance on the subject, Guidance was created using a knowledge management tool the 'Conjunction of Criminal Opportunity, and a wisdon of crowds approach was used to create guidance generated by stakeholders via online collaboration using a wiki and a weblog. This guidance was then combined to create a bike parking guideline/standard that sought to meet the needs of all stakeholders, considering both ease of use and resistance to theft/abuse of parked bicycles. This guidance was applied to the development of our own secure bike parking furniture, facility and communication benchmarks to test the "fitness for purpose" of the guidance material.

- The research, design, implementation and testing of a design resource aimed at "getting designers smart quick" about bike theft and how to design against it (see: http://www.bikeoff.org/design_resource/ABT_problem_introduction.shtml). This design resource supported a related design competition run with the Royal Society of the Arts to introduce to design education nationally, some of the learning from the project (see: http://www.bikeoff.org/design_resource/DB_brief1.shtml)
- Generation of a 'weblog' developed with users to include up to date information about bike parking on the bikeoff.org website to help promote secure bike parking design innovation. This weblog took the form of 'Bikeoff TV', a tool for creating and sharing user and abuser centred case studies of cycle parking facilities with cyclists, designers and providers of cycling infrastructure.

The project has been successful in achieving its original aims and objectives. In particular, in delivering design related outputs into the public domain that develop the innovative and operational capacity of designers and crime prevention practitioners. The original project proposal committed to delivery of 15 outcomes including publications, exhibitions, artifacts (design exemplars), and research dissemination via papers and presentations at conferences, seminars and events. In practice the project delivered over 115 outcomes including multiple unpredicted outcomes in all anticipated areas and significant additional unpredicted outcomes in several unanticipated areas, particularly, the delivery of additional collaborative projects. The project team attributes this increased output to the collaborative and iterative methodology and 'open' research innovation process developed and applied by the project.

Bikeoff 2: Methodology

DACRC's thinking about design against crime starts with the idea that interventions need to be 'user-friendly, abuser-unfriendly' (Ekblom 1997). This requires the extension of the concept of 'user driven innovation' to that of 'user/mis-user and abuser driven innovation'. Whilst this focus is specific to designing against crime, and for easy and effective use, it is relevant to a broader design context for the way in which it clearly aims to address and accommodate, sometimes conflicting, multiple design agendas and drivers as can be found in many design scenarios that address multiple user groups; typical of design for the public realm. Toward achievement of this objective we invite multiple stakeholders, to offer review of the findings, design briefs, prototypes, and other developments of the research undertaken. The design process therefore enables us to facilitate multi-agency working i.e. to identify who the crucial stakeholders are before the design process begins and to allow them to participate and contribute their expertise to the research – from problem definition, through to solution development and implementation.

With so many points-of-view contributing to the design process, the project team often play the role of 'facilitators' or 'information moderators' (Lester and Piore, 2004). They do this via 'open' seminars, workshops and information sharing opportunities that help make the design process accessible to the non-designers and enable them, as expert stakeholders, to introduce questions the design team may not have realized as significant, and knowledge the research team do not have. Of significance is how this knowledge is combined within this collaborative activity. Designers visualize the research and present it back to collaborators so that a common understanding can be reached. It is via this process of visualization that multi disciplinary research material is iteratively combined to achieve interdisciplinary synthesis of research findings. In this process 'design' skills (not just design 'thinking' or 'methodologies') are essential to co-design.

The Bikeoff 2 project applied the iterative design research methodology piloted and published at the DAC Research Centre (Gamman and Pascoe, 2005) and further developed it through iteration within the project (Gamman and Thorpe, 2008 and 2009). The evolved methodology better defines the research stages, and also the way in which practice-led research and research-led practice usefully combine within the process. We refer to this symbiotic process as a 'twin track' approach combining research and practice.

This 'twin track' approach follows iterative stages that allow project stakeholders and 'expert advisors', including duty-holders and those Von Hippel (2005) refers to as 'lead users', to feed back on practice-led research (created by interdisciplinary teams and aimed at designers) as well as research-led practice (created by designers and design researchers and aimed at the crime prevention community and wider design audience). This iterative and consultative process has advanced and framed our multidiscipli-

nary team's ability to merge and develop ideas and evolve what Leadbeater (2007) has described as a 'We think' approach to investigating the contribution design can make to cycle theft reduction. Beyond the current project, we believe this model could be applied to improve the collaborative research enterprise of other multidisciplinary projects, and support a fresh interdisciplinary approach.

Scoping

This is the stage of the project in which the research area to be tackled is identified. The research team found it useful to ask themselves the questions: So what? Says who? and Why you? So what? refers to the need for the research in question – in this instance the issue of bike theft was identified as a topic that required address to enable the benefits of cycling to be realized. Says who? refers to identification of the stakeholders to whom the research is of relevance and value. Why you? requires the research team to consider if they are well positioned to tackle the research topic – are the specialisms, experiences and networks of the research team appropriate to the research topic? In this instance the initial research supported by AHRC small grants funding delivered the scoping work necessary for the Bikeoff 2 project to be created. It also identified the issues and research questions to be addressed and the stakeholder networks necessary for its collaborative delivery.

Research

The research team – design researchers, crime scientists and collaborators – gather information from diverse sources including literature review, empirical data gleaned from precedent practice, quantitative crime data and qualitative data relating to use (cycling and cycle parking) and abuse (cycle theft and vandalism). This information is 'pooled' and consolidated, often linked to generative (rather than analytical) creative / realization techniques such as visualization of research via collation and exhibition of exemplars, animation and graphic representation. The project managers are important here, and so is their design experience (what Malcolm Gladwell talks about as the ten thousand repetitions of experience that contribute to success). They start to pare down the most relevant sources of information to be used or visualized, also to correlate facts and identify gaps in knowledge. Initial typologies of use and abuse are created to frame the first of many iterative consultations with stakeholders to check accuracy and completeness of existing research data and establish new directions for continued research focus.

Observe

Ethnographic observation, or people watching, is conducted using recording protocols and methods that are informed by the preceding research. Precedent research also informs hypotheses that are

tested via the observations. Observation is often undertaken collaboratively, involving multi-disciplinary members of the research team so as to ensure that all team members have a first hand understanding of the issues and contexts being addressed by the research. Bikeoff 2 staged numerous observations within different contexts to generate empirical data relating to bicycle parking behaviour (user modus operandi) and cycle theft (abuser modus operandi), see Johnston *et al*. (2008). Such observation also generates understanding of the wider situational and contextual issues relating to cycle parking and security. Project managers start to refine the most relevant sources of information to be used (revisualised) as design briefing and crime prevention materials, again linked to stakeholder meetings and discussions.

As with all other stages of this method, observation stages are repeated by individual (or groups of) designers or crime prevention practitioners linked to their address to specific contexts. Over 10,000 separate observations were made during the Bikeoff project across ten different locations offering insights into various contexts of cycle parking use and abuse and understandings about the actions and interactions of multiple 'actors' in multiple contexts.

Visualize

Research is visualized to allow the multidisciplinary and interdisciplinary approaches to synthesize around clear themes agreed via iterative consultation. For example, we will visualize perpetrator techniques, often derived from observation; user, designer and provider accounts (in this case relating to cycle parking furniture and facilities); and other forms of information such as mapping of crime 'hot-spots' and visual typologies of infrastructure and con

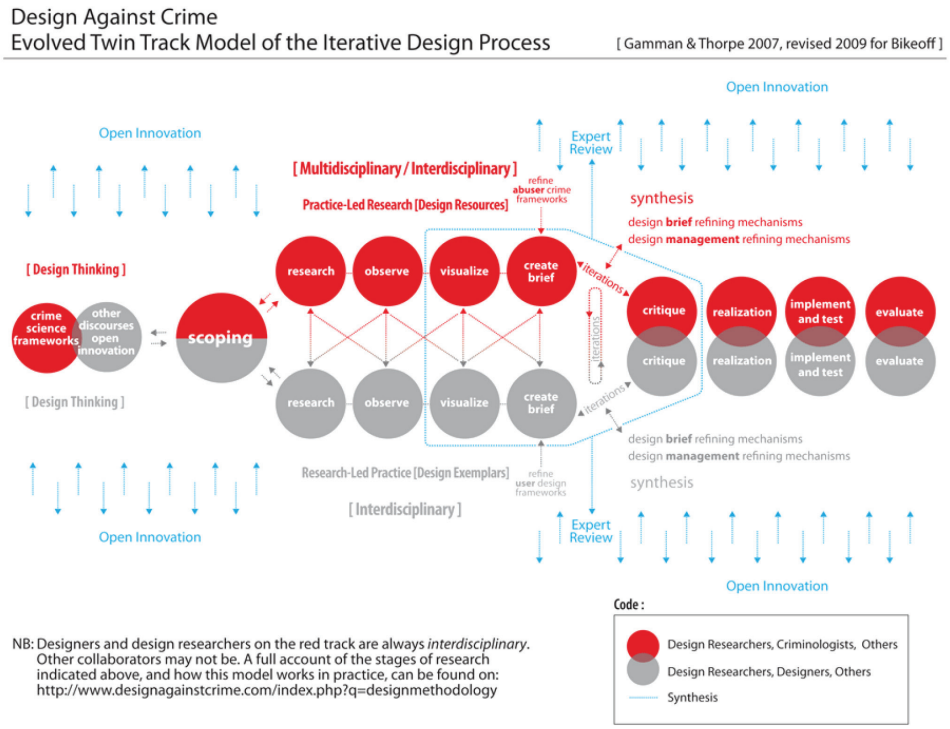

Figure 1, Design Against Crime Evolved Track Model of the Iterative Design Process Revised for Bikeoff (2009).

texts representative of those observed. It is at this stage, when most multi-disciplinary research findings have been integrated and visualized that broad stakeholder dissemination and consultation, and expert review of the design and crime issues, provides feedback on the research delivered and identifies remaining knowledge gaps. The practice of individual designers (either student-designers engaging with the information linked to studio projects drawing on research, or professional designers applying research findings to practice) may also introduce new forms of visualization into the account. The project managers are responsible for paring down the most relevant sources of visual information to be considered and refined. In short, we visualize multi-disciplinary research findings to make them accessible to all stakeholders and gain concensus. Visualisation, often aids multi-disciplinary research to become the subject of shared understanding and truly inter-disciplinary, facilitating the ‘We think’ approach described above.

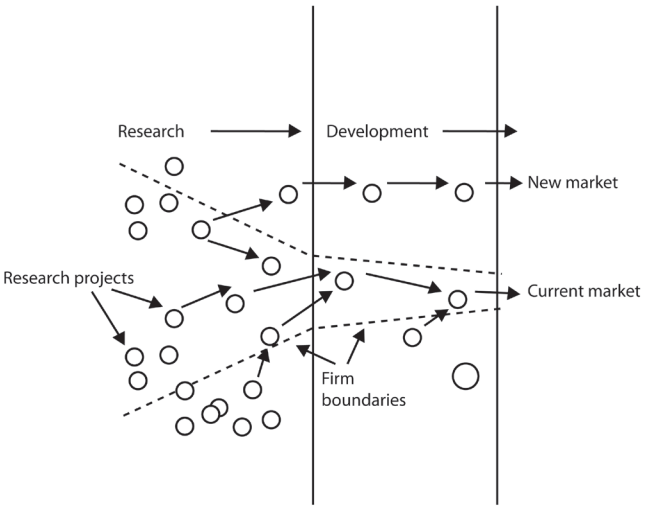

Figure 2, Chesbrough’s model of open innovation, 2003

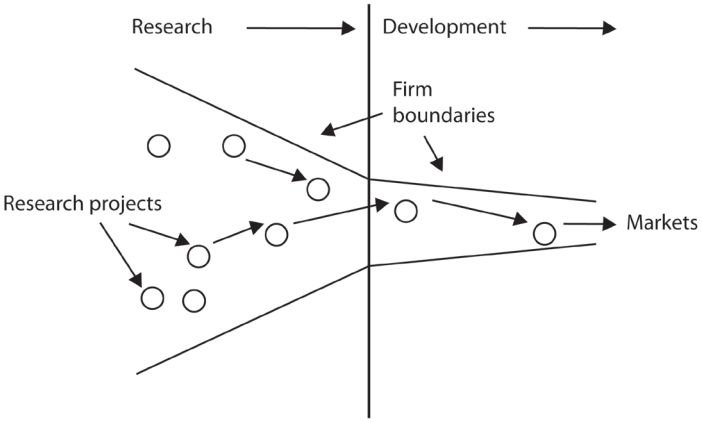

Figure 3, Chesbrough’s model of closed innovation, 2003

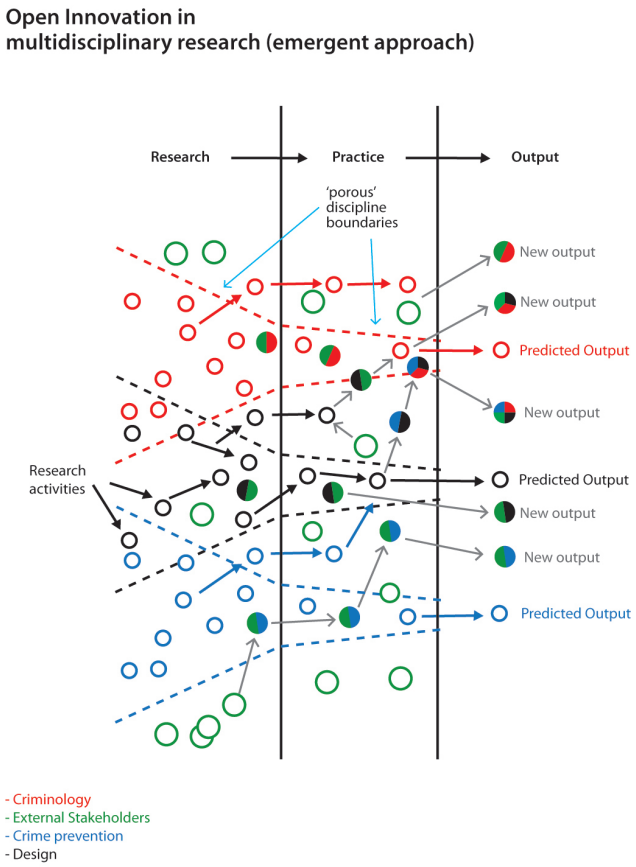

Figure 4, Gamman and Thorpe Model of open research innovation showing 'open' interdisciplinary working leading to unexpected outputs, 2009. After Chesbrough 2003.

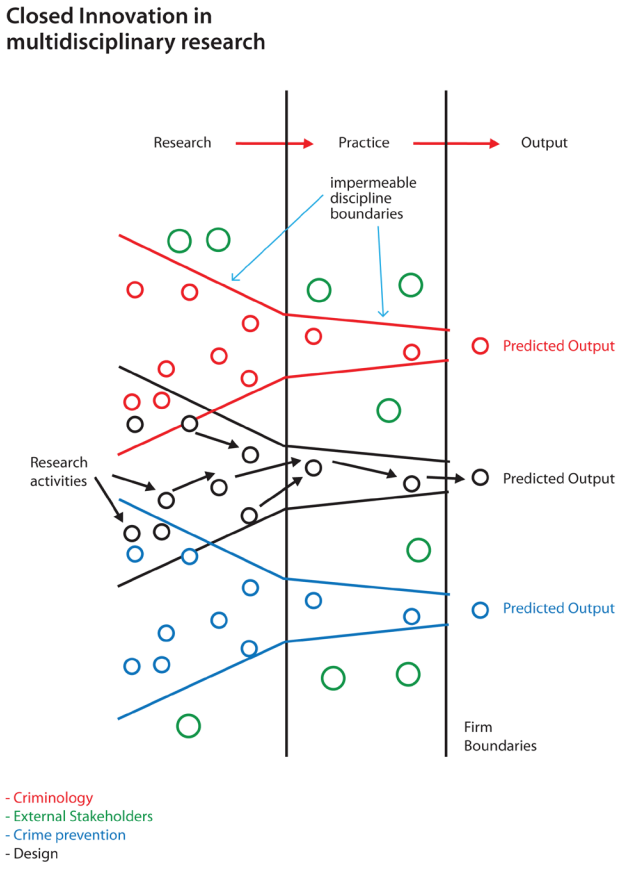

Figure 5, Gamman and Thorpe Model of closed research innovation showing 'closed' multidisciplinary working leading to predicted outputs. After Chesbrough 2003.

Create Design Brief

Brief creation is iterative and matches stakeholder agendas with clearly articulated research questions and findings. The briefing offers a generalist account that provides exemplars and case studies as well as promoting understandings about the multiple drivers that make up the context into which a design intervention is to be introduced.

Critique

Each iteration of a brief or visualization is critiqued by team members, wider stakeholders and experts, to ensure the designs or resources, or other outputs are ‘fit for purpose’ in all respects. This relates to use, abuse and management of the ‘troublesome tradeoffs’ (Ekblom, 2005) between accommodating the former and preventing the latter. Also, considered are wider economic, ecological and environmental factors that impact upon the sustainability of proposals

Realize

Proposals are realized, often in collaboration with stakeholders. For example industrial partner Broxap, the UK’s largest supplier of cycle parking furniture, collaborated in the design and prototyping of a range of secure bike parking stands.

Implement/test

Small batches of object prototypes are produced and installed in test locations. Or, when generating design resources, small groups of designers (such as student groups or designers from within stakeholder groups) are introduced to the resources, in order to allow us to test, and to strategically incorporate user feedback (and abuser feedback) into the finalization of designed outputs. Final implementation occurs once all are satisfied that address to user and abuser issues has been optimized as resources allow.

Evaluate

Project outputs are evaluated both quantitatively and qualitatively according to design hypotheses and requirements identified in the briefing stage.We evaluate from different perspectives (including ease of use and resistance to abuse in terms of products) and external assessment of the quality of responses to the design briefs and resources in the case of design resources. Ultimately we also draw on quantitative evaluation in relation to achievement of *intermediate* outcomes, such as improvements in security of user behaviour as well as, where possible, *ultimate* outcomes of reductions in bicycle theft and increases in cycle use.

New Knowledge and Understanding: Bikeoff as a Model of Open Research Innovation

Bikeoff 2 exemplifies a 'socially responsive design' approach, delivering *"design that takes as its primary driver social issues, its main consideration social impact and its main objective social change"* (Gamman and Thorpe 2006). The project addressed cycle theft, a barrier to cycle use, with a view to accessing the benefits increased cycle use offers society in relation to health, environment, economy and mobility. Bikeoff aimed to catalyse (and create) design, using the design methodology summarised earlier, that serves its community aesthetically *and* effectively, beyond but inclusive of the paradigm of DAC as a balancing of considerations of 'use and abuse'. To achieve this, design must consider multiple drivers, informed by research, and prioritised according to bias and context. The question is, whose bias and what context?

Whilst to imagine a design scenario without bias is as unhelpful as it is unlikely, it is useful to contextualise and democratise this design bias by applying a process of 'open innovation' (Chesborough, 2006) to the research process. One that openly shares research and development knowledge and thus enables a diversity of responses to design contexts. We have found that to access this plurality of design opinion and design experience (be it in creating new, or living with existing designs) requires research to be shared in a language that is accessible to diverse disciplines and communities, including the design community.

Within the methodology applied by Bikeoff [Figure 1] the processes of research 'visualisation', as discussed earlier, uses design skills to develop/ enable design thinking/ engagement with the widest possible audience of stakeholders, including those that have not engaged with design before. In such scenarios, 'design' facilitates 'co-design' (with those outside design disciplines) and enables a process of 'open' research innovation.

What this process offers to design in the 21st century is an ability to engage multiple disciplines (both inside and outside design) and multiple stakeholders in tackling complex design scenarios. It achieves this by sharing knowledge and experience. It also makes research available in accessible forms enabling a diversity of design responses necessary to address the multitude of contexts to be addressed. Chesborough's model of 'open' innovation [Figure 2] illustrates that open access to research and development leads to more and unpredicted market outputs, compared to 'closed' innovation [Figure 3].

The model of 'open research innovation' delivered via the Bikeoff twin track design methodology [Figure 1] also enabled interdisciplinary research and the inclusion of diverse stakeholder knowledge and practice to maximise research outputs. As mentioned earlier, the process produced over 100 'emergent' outputs in addi-

tion to the 15 predicted outputs. Figures 4 and 5 seek to illustrate this process.

Bikeoff's 'open' research process accommodates the creative contribution of multiple disciplines and stakeholders in both multi-disciplinary and inter-disciplinary ways for example:

- designers helping to design randomised control trials, typically a criminological activity (interdisciplinarity)
- extensive modification of existing advanced criminological theory (Ekblom, 2009) by designers and criminologists to create a risk and design guidance framework adapted to design against crime (interdisciplinary)
- criminologists have applied crime science methods to the evaluation of data captured regarding design performance (multi-disciplinary).

We think that the visualisation of research knowledge (applying design) helps interdisciplinary synthesis happen. It aids communication and knowledge transfer between disciplines and stakeholders - facilitating greater creative contribution. This process of visualisation also helps to 'open up' the 'knowledge landscape' across discourses and disciplines by "showing as well as telling", and thus enables those typically unfamiliar with design language to engage via redirecting these visualisations to impact on the discourse.

We think (not some 'royal We' but a 'We' that describes the international multi disciplinary, multi-stakeholder bike theft reduction community referred to above) that Bikeoff's 'open' model of innovation ensures that research questions stay close to stakeholder needs and are responsive to demand pull over supply push. Thus research findings will more likely respond to the questions that stakeholders want addressed. We found also that research that is collaboratively realized with stakeholders is easily and readily applied by them. Thus, our research model appears to facilitate 'exploitation of research' and therefore 'innovation'.

We also recognize that this model is capable of generating 'social capital' in addition to 'fiscal capital' – of particular value in the 21st Century. Until recently most drivers for innovation in design have been market led. That is, the exploitation of creativity has been towards creation of products aimed at the generation of fiscal capital in the market. Bikeoff activities 'exploit creativity' both in the creation of products that have 'fiscal capacity' – the capacity to generate finance via immediate market introduction, and in the form of 'knowledge made accessible' that contributes to 'innovative capacity' – the abilities of others to exploit our research in the creation of their own designed solutions or crime prevention interventions. In turn realization of this innovative capacity develops 'operational capacity' for providers of secure cycling infrastructure and cycle theft prevention practitioners. Thus the 'market' for our 'products' (research 'outputs') is not limited to commerce but also

spans pedagogy and social well being (crime prevention/reduction) that contributes to social as well as fiscal capital.

Additionally, the model appears to have a contribution to make in address to the *'Common causes of failure within the traditional economic model of the innovation process in most organisations'* (O'Sullivan, 2002). Indeed the open research innovation model described above appears to be antithetical to these causes as follows:

- Poor goal definition: Bikeoff's emergent and inclusive approach to goal definition (or identification of research questions) is kept relevant via continual re-definition in collaboration with stakeholders who share the broader 'aims' or 'goals'.
- Poor alignment of actions to goals: An iterative practice led model means that performance of actions in relation to defined goals are evaluated throughout the life of the project to keep it in focus and on track. Also, as the project unfolds and understanding develops, any revisions to goals in the light of these developments can be mutually agreed because the researchers and stakeholders are in constant contact. The 'open' model we describe facilitates this. It may also suggest that research that is less consultative or 'open' is likely to find itself of less immediate value and therefore obsolete, in relation to stakeholder application of research findings.
- Poor participation in teams: Bikeoff's model accommodates individual contributions as well as 'team' contributions on at least two levels:
- We create teams of different stakeholders (including researchers) as defined by discipline, organisation, institution and professional responsibility (duty holders), who positively and collaboratively contribute to the project.
- We create teams of stakeholders (including researchers) as defined by their address to research questions and/or focus on particular research activities or research augmentation' projects, who positively and collaboratively contribute to the project.
- Poor monitoring of results: The iterative 'critique' and 'evaluation' phases of the Bikeoff twin track research model [Figure 1] provides monitoring of results, and can help to ensure that project findings are fit for purpose as regards stakeholder application.
- Poor communication and access to information: Visualisation of research facilitates communication across disciplines – design contribution enables research to 'show as well as tell' what is happening and thus makes research accessible and attractive and more easily understood, and engaged with, by others. This is a significant feature of Bikeoff research in that it exemplifies the way that 'design' skills facilitate design research.

At the heart of the Bikeoff project is an example of 'transformation design' (Burns, Cottam *et al.* 2006), not simply as an idea but as a pragmatic reality of outputs delivered to design out crime and encourage cycling. Outputs from the portfolio could lead to the creation of new roles, new organizations, new systems and

new policies as a result of the transfer of research knowledge and 'ownership' of research tools and networks created by the project to those stakeholders that participated in their creation.

Quantitative impacts include Bikeoff's commercially licensed product and communication design outputs. These have been valued by Price Waterhouse Coopers (PwC) as potentially worth £3.2 million (NPV) over 10 years. Additionally PwC account for £2.6 million p.a. of potential public value benefits in avoided cost and emotional stress and significant additional effects, e.g. health, from implementing the Bike Off measures nationally. (PwC/AHRC, 2009).

Qualitative assessment should include that of a key stakeholder in the project, Rose Ades, Head of Transport for London's Cycle Centre of Excellence (CCoE), who observed:

'... As Bikeoff [advocacy] started in 2004 bike theft went up but also so did the number of people cycling in London. And then something remarkable happened around 2005-6 – bike theft went down a little and cycling went up even more... there's still a long way to go ... but the work that Bikeoff, in partnership with multiple stakeholders is delivering, is making a difference...'
But perhaps the most significant Bikeoff outputs are:

*a design method that is 'innovative' in that it optimises "exploitation of creativity" (Foresight Programme, 2001) as a result of its proximity to, and engagement with, the community it serves, and;

* a design model that articulates this process.

BIBLIOGRAPHY

BRYAN-BROWN, K. and SAVILLE, T., 1997. Cycle Theft in Britain. TRL Report 284. Crowthorne: Transport Research Laboratory.

BURNS, C., et al., 2006. Transformation Design. London:Red Paper, The Design Council.

CHESBROUGH, H., 2003. Open Innovation. Boston MA: Harvard Business School Press.

EKBLOM, P., 1997. Gearing up against crime: a dynamic framework to help designers keep up with the adaptive criminal in a changing world. International Journal of Risk, Security and Crime Prevention, 2(4), pp. 249–265. 24

EKBLOM, P., 2005. Designing Products Against Crime. In: N.

TILLEY (ed.), Handbook of Crime Prevention and Community Safety. Cullompton, Devon: Willan.

FRAILING, R. H., 1974. Bicycle theft—a serious crime. FBI Law Enforcement Bulletin, 43(6), pp. 7–10.

GAMMAN, L. and PASCOE, T., 2004. Design out crime? Using practice-based models of the design process. Crime Prevention and Community Safety: An International Journal, 6(4), pp. 37–56.

GAMMAN, L. and THORPE, A., 2006. What Is Socially Responsive Design – A Theory And Practice Review. In: K. FRIEDMAN, et al. (eds.), Proceedings of Wonderground, Design Research Society International Conference 2006, Lisbon, 1–4 November 2006. IADE.

GAMMAN, L. and THORPE, A., 2008. Less is More – What Design Against Crime Can Contribute To Sustainability. In: C. CIPOLLA and P. PERUCCIO (eds.), Changing the Change Proceedings, Turin, 10–12 July 2008. Turin: Allemandi Conference Press, pp. 59.

GAMMAN, L., THORPE, A. and WILLCOCKS, M., 2004. Bike off! Tracking the design terrains of cycle parking: reviewing use, misuse, and abuse. Crime Prevention and Community Safety: An International Journal, 6(4), pp. 19–36.

GLADWELL, M., 2008. Outliers – the Story of Success. Penguin Books.

JOHNSON, S. D., SIDEBOTTOM, A. and THORPE, A., 2008. Bicycle Theft. Problem-Oriented Guides for Police Series. Washington: U.S. Department of Justice, Office of Community Oriented Policing Services.

LEADBEATER, C., 2007. We Think – The Power Of Mass Creativity. London: Profile Books Limited.

LESTER, R. and PIORE, M., 2004. Innovation: The Missing Dimension. Cambridge, MA: Harvard University Press.

MERCAT, N. and HERAN, F., 2003. Bicycle Theft in France. In: R. TOLLEY (ed.), Sustainable Transport: Planning for Walking and Cycling in Urban Environments. Cambridge: Woodhead Publishing.

NICHOLAS, S., et al, 2005. Crime in England and Wales 2004/2005. Home Office Statistical Bulletin, 11/05. London: Home Office.

O'SULLIVAN, D., 2002. Framework for managing development in the networked organisations. Journal of Computers in Industry, 47(1), pp. 77–88.

OJA, P. and VUORI, I., 2000. Promotion of Transport Walking and Cycling in Europe: Strategy Directions. Tampere:
UKK Institute.

PwC/AHRC 2008 Fighting Crime Through More Effective Design. Bristol: Arts and Humanities Research Council.

REASON, P. and BRADBURY, H., (eds.), 2001. Handbook of Action Research. London: Sage.

ROE, L. and OLIVERO, J., 1993. Profiles in bicycle theft: there is a pattern. Journal of Security Administration, 16(2), pp. 17–24.

SIDEBOTTOM, A., THORPE, A. and JOHNSON, S. D., 2009. Using targeted publicity to reduce opportunities for bicycle theft: a demonstration and replication. European Journal of Criminology, 6(3), pp. 269–288,1477–3708.

Sold Secure is a testing and certification house for security. http://www.soldsecure.com

SVENSSON, R., 2002. Bicycle Theft. Crime Trends in Sweden 1998–2000. Stockholm: Swedish National Council for Crime Prevention

THACKARA, J., 2005. In the Bubble – Designing in a Complex World. Cambridge, MA: MIT Press.

TRANSPORT FOR LONDON, 2007. London Cycle Network [online]. Available at http://www.tfl.gov.uk/corporate/projectsandschemes/roadsandpublicspaces/3188.aspx

VAN DIJK, J. J. M., VAN KESTEREN, J. and SMIT, P., 2007. Criminal Victimisation in International Perspective: Key Findings from the 2004-2005 ICVS and the EU ICS. The Hague: Boom Juridische Uitgevers.

VAN KESTEREN, J., MAYHEW, P. and NIEUWBEERTA, P., 2000. Criminal Victimization in17 Industrialized Countries: Key Findings from the 2000 International Crime Victims Survey. The Hague: Wetenschappelijk Onderzoeken Documentatie Centrum, Ministerie van Justitie.

VON HIPPEL, E., 2005. Democratizing Innovation.Cambridge, MA: MIT Press.

WEIJERS, H., 1992. Government Policy for Reduction of Bicycle Theft in the Netherlands. In: R. BOIVIN, J. F. PRONOVOST and J. BERGERON (eds.), The Bicycle: Global Perspectives, Proceedings of the Conference Vélo-mondiale – Pro Bike, Vélo City, Montreal,13–17 September 1992. Montreal: Vélo Québec, pp. 388–390.

ZHANG, L., MESSNER, S. and LIU, J., 2007. Bicycle-theft victimization in contemporary urban China: a multilevel assessment of risk and protective factors. Journal of Research in Crime and Delinquency, 44(4), pp. 406–426.