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Designing Products Against Crime

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The Grippa research programme, mainly funded by AHRC, is a collaboration between the Design Against Crime Research Centre, Central Saint Martins College of Art & Design, University of the Arts London, and the UCL Jill Dando Institute of Security and Crime Science. Papers and other materials from the programme are at www.grippaclip.com and wider practical and research material on preventing bag theft at www.inthebag.org.uk

Chapter 8

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Introduction

Design against crime (DAC) uses the processes and products of design to reduce crime and promote community safety. As will be seen, the focus in this chapter is specifically on the design of 'movable' products as opposed to places, systems and messages, although, in so doing, many general issues are covered. The aim is less to review in detail the range of product design, to cover implementation issues in much depth or to assess the limited hard evidence of impact and cost-effectiveness, and more to communicate designers' ways of thinking and acting to researchers and practitioners of crime prevention. In earlier papers I have urged designers to *think thief* about their products (Ekblom 1995, 1997). Here, the emphasis is more on encouraging crime preventers to *draw on design*, both practically and conceptually. Mapping out the nature and diversity of design is important, too, because preventers have a range of assumptions about what it means.

The obvious relationship between DAC and situational crime prevention means that much that can be said about the latter will not be restated here (see Chapter 3, this volume). Instead, the chapter will focus in turn on defining and cross-linking terms and concepts in both crime and design; identifying what is distinctive about design; examining design processes; discussing replication and adaptation; and looking at cyclical processes in the life of designs, including 'arms races' with offenders. The chapter is able to draw on a range of 'first generation' reports and publications derived from DAC work funded from, and stimulated by, the UK government's recent Crime Reduction Programme and, to a lesser extent, the UK Foresight programme's Crime Prevention Panel.[1] Since the DAC field is rapidly evolving in terms of products, concepts and processes, the ideas set out here will not be the last word - rather, a contribution to that evolution. Indeed, a 'futures'-oriented approach to the topic informs the whole chapter.

The format of this book (and the tradition of criminological publications in general) places limits on illustrations. This is a serious constraint on

communication of design ideas, as Gamman and Pascoe (2004b) note, and attempt to remedy. Some of the concepts and examples presented here are, though, illustrated in several websites.[2]

Defining crime, prevention and design

Crime (and disorder) itself is, of course, extremely varied in nature, methods, offenders, targets and consequences, as the examples throughout this chapter illustrate. But design against crime is relevant to all: instrumental versus expressive or ideological; stealthy versus confrontational and perhaps violent; organized or individualistic; and professional versus opportunist.

Crime reduction is, simply, any activity to decrease the frequency and/or seriousness of criminal and related events. Mostly this is delivered by crime *prevention* - intervening in the causes of crime and disorder events to reduce the risk of their occurrence and the potential seriousness of their consequences. Prevention (or reduction) can be done in two broad contexts. *Enforcement/ judicial prevention* acts, as implied, through police detection and investigation and the criminal justice and penal systems. Although triggered in response to past crimes, it is intended to make future ones less likely - a function distinct from retrospective *justice per se. Civil prevention* acts through changes in everyday life. Enforcement/judicial prevention focuses on individual and occasionally corporate offenders; civil prevention covers both offender-oriented and situational interventions, acting at a range of ecological levels from individual victim, offender or place to family, peer groups, institutions and communities.

Causal frameworks

The causes intervened in can be simple or complex, remote (such as early childhood experiences or the market price for vehicle spares) or immediate. The latter are easier to capture and map out in a uniform framework. Familiar frameworks include the Routine Activities Theory of Cohen and Felson (1979), covering likely offender, suitable target and absence of capable guardians; the rational offender approach (Cornish and Clarke 1986) focusing on the offender's decision agenda of perceived risk, effort, reward and guilt; Wortley's (2001) additions of provocation and other forms of 'precipitation';[3] and various kinds of environmental criminology - for example, the 'crime generators and crime attractors' approach of Brantingham and Brantingham (1995). The Conjunction of Criminal Opportunity (CCO) (Ekblom 2000, 2001a) will be used here to bring together the above approaches,[4] and more. This is because it goes into greater detail on each cause *{'why* is the target suitable?), and offers a more differentiated picture of the offender than someone who is merely 'likely' or 'rational'. It thus provides an integrated framework to describe how factors in the crime situation come together with those associated with the offender to generate criminal events, catering, too, for both civil and enforcement/ judicial prevention. The result is a map of 11, generic, immediate causes of criminal events and 11 corresponding families of intervention principle aimed at blocking those causes.

Criminal events and their prevention are relatively narrow concepts and aims. *Community safety,* in contrast, has been defined in terms of the quality of life, a state of existence centring on people's individual and collective freedom from certain real or perceived hazards, their ability to cope with those that remain and their consequent ability to get on with life's social and economic necessities and pleasures- Delivering community safety obviously depends on reducing crime, but beyond this includes actions specifically aimed at intervening in the additional causes of fear (such as lighting levels), or mitigating the wider consequences of crime such as reduced enjoyment of local amenities.[5]

Design: scope and nature

The phrase 'design against crime' or equivalents such as 'designing out crime' have been in common currency in the crime prevention field since at least the publication of Poyner's book in 1983, initially covering architecture and environmental layout ('Crime Prevention Through Environmental Design', initialed by Jeffery 1977) and, more recently, embracing products and systems. But the full scope of *design* is enormous, potentially embracing all human productive and artistic activity in every material and immaterial medium. Focusing here on the applied rather than artistic side, design is a generic *process* of creating some new or improved product which 1) is materially possible to make (e.g. it does not fall apart, obeys the laws of science and respects the behaviour of its constituent materials); 2) is fit, or fitter than predecessors, for some specified primary purpose; and 3) does not significantly interfere with other purposes or with wider requirements of social and economic life and the environment, including in cost terms (adapted from Booch 1993). Under this broad definition there is much variety amongst processes or approaches to design. At one end of the scale, say, we could envisage someone hastily stripping a branch of leaves to fashion an impromptu defensive weapon; at the other, a complex and sophisticated vehicle immobilizer system developed over several years by several large professional teams whose work has to be integrated by explicit managerial processes. Links with *problem-solving* and a focus on *abusers* as well as *users* are obvious and will be discussed below.

The *purpose* of the designed product can vary from entirely utilitarian to aesthetic and the conveyance, for the owner, of image, lifestyle and value (see Cooper and Press (1995) for a comprehensive discussion of these definitional and functional issues). Playful and subversive designs are also possible.[6] The classic principle of 'form following function' can at times be supplanted by 'form following emotion'.

Certainly, which of these principles a given product emphasizes increasingly becomes a matter of designers' choice rather than engineering constraint. New materials continually emerge and blend with in-board electronics and actuators to detach form from function unless deliberately intended (as with retro-styled radios).

Process is discussed in more detail below; its outcome is *a* design. The noun has two interpretations. A design can mean some form of stored information - concept, blueprint, plan or 'genotype' (in biological terms - Ekblom 2002a) for *replicating* and defining real-world products. More loosely speaking it can

be the tangible, manufactured *end product* itself (or 'phenotype') which realizes the blueprint. Some designs are replicated industrially, on a mass scale and in high-fidelity detail, as discussed below; but at the opposite extreme, other designs are realized as a single instance, such as an individual building or landscape.

Designed products (and corresponding fields of professional competence) encompass:

- places, buildings and environments (both exteriors and interiors - see Press *et al.* 2001);
- electronic, procedural and organizational systems (see Chapter 10, this volume);[7]
- the 'two-dimensional' material of fabrics, banknotes and messages, such as posters; and
- solid 'three-dimensional' objects (although the boundary between the last two is increasingly blurred, with interactive website graphics, packaging and labels, fashion clothing bearing messages or, soon, 'wearable' IT, and graphical interfaces on items like music players).

Problem-solving processes and end products are not the only foci of design. Alternatives include the engineering approach, centring on how to exploit new technology (such as radio-frequency ID chips or new materials like kevlar) and user-centred approaches such as helping the elderly to avoid certain crime risks.

Given this wide understanding, *any* intervention in the causes of criminal events (or of feelings of insecurity) can, in principle, be improved by explicit and professional attention to design; conversely, any design which neglects crime prevention or poorly attempts it can be criminogenic. DAC's contribution to crime reduction, prevention and community safety can equally serve enforcement/justice and civil prevention, act at any of the ecological levels of intervention, realize and refine any of the 25 techniques of situational prevention (Clarke and Eck 2003), and more broadly, act through any of the 11 generic families of intervention of the CCO. Wootton and Davey (2003) extend CCO to provide a 'life-cycle' approach to DAC, as part of a programme of professional support for designers, which explicitly includes both post-crime *enforcement* issues such as design of products or places to capture fingerprints, and mitigation of the *consequences* of crime.

DAC can thus have a variable 'preventive scope', from making an individual item (or place) crime resistant, to stopping a wider set of future crimes. Thus it can deter or discourage people from stealing a given class/make/model of object (e.g. because they now know it is effectively property marked or becomes useless when stolen because of a dye-release fixture); or contribute to making them give up crime altogether because it no longer offers a niche or career where risk, effort and reward are acceptably balanced against the resources they have available to manage or exploit them.

Good design from a DAC perspective can make a better forensic field-kit, courtroom, prison, teaching pack for literacy (i.e. supplying criminals

with resources to avoid offending), body armour for police, computerized criminal record system or burglar alarm; a less criminogenic shopping mall, car or mobile phone; a youth shelter that diverts young people from crime situations and legitimately satisfies their motivation for somewhere to gather and entertain themselves whilst being resistant to mistreatment and misuse; a market resistant to the resale of stolen goods; a less fear-inducing car park; a chemical which changes colour in swimming pools to shame those for whom 'P is silent as in bathing'; a street that feels safe to walk down at night, thanks to products and landscapes which effectively favour legitimate activities; and an intelligently put-together set of laws and regulations which, say, control corruption in the construction and planning field *without* seriously hindering legitimate building work, or which help regulate excessive tobacco consumption *without* sparking smuggling (the aim of crime-proofing legislation).

Bad design from a crime reduction perspective can produce a housing estate where the facilities and shared spaces available mean that young people are seen as a nuisance when they hang about, or (as with 'Radburn' estates; Town *et al* 2003) make it easy for criminals to slip between buildings and hard to watch over parked cars; offer provocative targets such as blank aluminium surfaces on trains receptive for unwanted graffiti, or anti-graffiti posters that merely challenge offenders to greater excess; provide convenient 'mushroom heads' for interior car-door locks that are easy to snare and lift with wire loops; frustrate users and provoke damage (as with some older public telephones), leave loopholes in financial systems or computer operating systems that can be widely exploited; produce highly valuable products which are pocketable or otherwise vulnerable, or which can easily be driven away under their own power; and build courtrooms where prosecution witnesses and defendants' supporters have to wait in each others' company. In both good and bad instances, of course, the design is not the only contributor to raised or lowered crime risk, but adds to, or interacts with, other social and physical influences - 'design determinism'[8] is not being advocated here.

The rest of this chapter narrows the view. Although, strictly, all successful exercises of design yield a product in the wider sense, here the focus is largely on 'movable', and mainly industrially produced, material products of two and three dimensions (Chapters 9 and 10, this volume, consider places and management systems, respectively). Within products it gives less emphasis on security products - i.e. those whose primary purpose is crime prevention (such as removable locks for steering wheels, 'lock it or lose it' posters, handcuffs for prisoners or defensive weapons) - and centres on those where security is a secondary consideration.[9] For simplicity these are henceforward referred to as plain 'products'. They are made secure through a subset of situational approaches - that is, designing the product to make crime riskier, more difficult, more guilt-inducing and less provocative for offenders (Clarke and Eck 2003; Chapter 3, this volume). The emphasis also lies with *civil* prevention, although many of the perceived risks induced by situational prevention may draw part of their strength from enforcement/justice-based approaches. After all, the triggering of a car alarm or the designed-in capacity of a surface to capture fingerprints can sometimes lead to a prison sentence.

How products feature in crime

Unsurprisingly, products can feature in crime in a myriad of ways. Approaching this systematically requires two linked frameworks. The CCO defines products' roles in causing criminal events, and the 'Misdeeds and Security' framework (Ekblom 2005; devised to identify crime and crime reduction implications of scientific and technological innovations) describes how, in those events, they feature as subject, object, tool or setting for criminal behaviour. Products can serve as:

- a *target* of crime. *Misappropriated* (stolen for itself, its parts or its materials), *mistreated* (damaged) or *mishandled* (counterfeited, copied, sold when stolen or smuggled);
- a *target enclosure* such as a car, shipping container or retail packaging. Mistreated by being broken into or even carried off for its contents; and
- a *resource* for offenders or crime promoters (Ekblom and Tilley 2000) or a 'facilitator' (Clarke and Eck 2003). *Misused* or *misbehaved* with for crime (a tool for burglary, a getaway vehicle or joy-ridden danger on the road, a mobile phone used in drug-dealing or taking illicit pictures of young swimmers, a weapon, an aerosol paint can spraying graffiti on a wall, a computer program that controls the re-chipping of stolen phones, a prop in a confidence trick). Some of these abuses involve design by criminals themselves or by 'backroom' crime promoters - such as mechanical tools for extracting cash from phone boxes, or artful add-ons to cash machines which harvest the card particulars and the PIN number.[10]

How product design *can prevent crime*

There are four broad ways of securing these products against crime. In most cases, such security is about reducing the *risk* of criminal events to a greater or lesser degree, not blocking them entirely; in each case this may work either by making the products *objectively* harder, riskier or less rewarding to exploit, or *perceived as such* by the offender. They can be secured by the following means:

- Designing the products themselves to be *inherently secure* - less distinctive, attractive or provocative targets to offenders; more resistant to attack or to misuse as *resources for crime;* more likely to attract *legitimate* use and hence being unavailable for attack or misuse; useful as aids to *crime preventers* protecting their own property (e.g. cafe chairs with slots on the front edge of the seat to park handbags securely under the owner's knees;[11] indicative of loss or tampering; or recoverable/restorable to owner.
- Adding on *security products* - *securing* against theft by anchor-cables for laptops, safes or after-market car alarms; *safeguarding* against damage by grilles; and *scam-proofing* by hard-to-copy packaging or identity chips (although these may sometimes count as designed-in components rather than add-ons).

- *Restricting the resources of offenders - when the product is the target:* locking any specialist tools used to damage or remove it, limiting knowledge of where the target products can be found and what their vulnerabilities are. *When the product itself is the tool or weapon: shielding* this resource from misuse by making once-only syringes, tamper-evident medicine containers (Design Council 2000; Clarke and Newman in press a) or colour copiers that recognize banknotes and decline to reproduce them.
- Otherwise *securing the situation* in which they are located - changing the target enclosure or the *wider environment* of CCO to limit access or facilitate surveillance; acting against *crime promoters* such as cracking down on handlers of stolen goods or alerting careless owners; mobilizing people in various kinds of *crime preventer* roles - guardians of targets particularly but also handlers of potential offenders or managers of places (Clarke and Eck 2003). How mobilization is achieved is discussed under 'design as process' below.

Securing the situation, of course, goes well beyond the design of the product in which we are interested - particularly in mobilizing preventers. This requirement may either be an on-cost of bad design, as with cars that are so vulnerable to theft that they need guarding, or a realistic admission of design's limitations in particular circumstances. But wider forms of design can intentionally help preventers, empowering them (e.g. through the design of a CCTV system) or directing them by a set of rules designed to promote acceptable behaviour of door attendants and guests at a club. (These are examples of *crime-preventive* design which are not in themselves *crime-resistant.)* And the preventers' presence, empowerment or direction could themselves be the result of some higher-level exercise in designing an entire *integrated security system.* An example is a retail security environment with an interior designed for surveillance, and where products or their packaging are fitted with tags which activate detectors at the exit if the sales staff have not removed or neutralized them, which bring security staff running and which provide legal evidence of ownership.[12]

In immediate prospect are cheap connections to Internet-based networks and 'pervasive computing' or 'ubiquitous intelligence' facilities which monitor, report, identify location, make decisions and exercise control of products or their environments.[13] The catch-phrase for the fairly near future is 'if my coffee cup needs a chip and an Internet connection, it will have one' (adapted from Department of Trade and Industry 2004b). In this, the boundary of the *product* and the *system* in which it is embedded becomes increasingly blurred. Indeed, with products increasingly able to configure and adapt, chameleon-like, to physical and electronic environments, what has seemed like a clear boundary between products, environments and systems (not least to the editor of this volume!) may not remain so.

A more loosely integrated approach can work in market reduction approaches to crime prevention (Sutton *et al.* 2001), where various actions on or through buyers, sellers, second-hand shops, etc., are explicitly combined with product identification techniques (which themselves could involve product or

packaging design). (Other examples of system design are in Tilley's chapter (Chapter 10), this volume.

Inherent security, at one extreme, is an essential quality of a product[14] - for example, the massive inertia[15] of current home-cinema televisions means they are unlikely to be carried off by many opportunist burglars. This could hardly be accredited to deliberate design as the weight is simply a by-product of other considerations such as the requirement to use cathode-ray or plasma screens.[16] In the middle of the range inherent security can be achieved via simple and clever system design, such as the lighting tubes on London Underground trains which use a different voltage from domestic supply, and hence are unattractive to (moderately intelligent) thieves, embodying the situational technique of lowering the value of stolen goods. At the other extreme one can include specialized security components, such as a holographic label for brand protection of vodka (Design Council 2000), or an anchor point on a laptop designed to receive an add-on security cable to take the force from thieves' tugging without being wrenched loose; or the integration of a security function into, say, a vehicle engine management computer.

Human preventers can be unreliable. Some security functions have been designed to take people out of the loop: for example, the car radio aerial that is built into the window glass, and that does not require the driver to remember to telescope it shut on leaving the vehicle. Removing human intermediaries more generally may be cheaper or more convenient, but is not always beneficial.[17]

Design as process

The *problem-oriented approach* (POA - see Chapter 23, this volume) is a process for identifying future crime risks and efficiently targeting, shaping, evaluating and improving interventions on these. In brief, POA tackles future risks based on past patterns of crime, which are characterized as the 'problems' to be solved - that is, reduced in frequency and/or seriousness. The name itself was coined (Goldstein 1990) to convey the central message that the response to a given crime (or policing) problem should not be determined by the nature of the solutions readily to hand - such as police squads or patrols - but by careful study of the problem itself, followed by a broader consideration of interventions. This 'preventive process' (Ekblom 1988, 2002a) has been variously characterized as a number of steps. The widest-known formulation is SARA (Scanning, Analysis, Response, Assessment - cf. Clarke and Eck 2003), but a more detailed latecomer is the 5Is (Ekblom 2002b, 2004a, 2004b), which will be used here to relate it to design:

- *Intelligence* is the collection and analysis of information on the crime problem and its perpetrators, causes and consequences.
- *Intervention* is applying generic principles (such as reducing the value of target products) through practical methods (such as by property marking).
- *Implementation* is making the intervention happen on the ground (e.g. by manufacture and distribution).

- *Involvement* is *mobilizing* other individuals or organizations to act as responsible crime preventers and to implement the intervention (e.g. getting people to buy secure cars and use the security features; getting designers to design in security; getting manufacturers and other *design decision-makers* (Design Council 2000) to accord crime sufficient priority); working in *partnership* with the 'professional' preventers (e.g. getting designers to work with police and others to make more secure products); and wider *climate-setting* to align expectations of, and pressures on, stakeholders such as manufacturers and consumers.
- *Impact* is whether the intervention succeeds in reducing crime on the ground, and how cost-effectively and acceptably.

Although these activities have been described as discrete stages, in reality there will be much iteration as a problem is understood in greater depth, thinking about solutions reveals new partners to be involved (who may bring fresh concerns and ideas) and initial monitoring of implementation or evaluation of impact suggests modifications are required.

The product design process

Many commentators on design, too, have emphasized its problem-solving side (e.g. Cooper and Press 1995),[18] although noting the tension between functionality and aesthetics (but, in effect, merely a different kind of problem to solve). Exploring the relationship of problem-solving in design and crime prevention is a fruitful way of trading ideas.

The product design process can be very simple and intuitive or extremely elaborate and explicitly structured (see, for example, Design Council 2000, and Clarke and Newman in press a), especially in the automotive industry, with diverse specialist teams, explicit protocols, decision gateways and so on. In explicitly attempting to draw design and crime prevention processes together, Gamman and Pascoe (2004c) describe what they call an 'iterative design process' for DAC of 'Understand, Observe, Visualise, Evaluate use, [unintentional] misuse and [deliberate] abuse, and Implement'. Cooper and Press (1995) distinguish a number of perspectives of the design process. More restrictive views centre on the *'internal creative process'* of design - the 'black box' of starting with problem and coming up with solution. More global, inclusive views cover the *'external productive process'*, involving strategic planning of product research and development, upgrading and perhaps disposal. The inclusive perspective maps across quite well to the preventive process as a whole; the internal creative process onto devising the intervention and (shading into implementation) converting concept into marketable product.[19]

A fairly generalized description of the design process is as follows:

- 'Market needs' are identified.
- Broader research is conducted into users and their context, and the requirements of manufacture, distribution and marketing.

- A product specification is drawn up (whether entirely new or an improvement on existing designs).
- Knowledge of materials, components and pre-existing usable design elements (such as gear trains) is brought together to generate trial solutions using a range of tools and techniques (see Design Council 2000) - first as concepts, then sometimes as computer simulations, and then detailed prototypes that are lab or field tested and adjusted or abandoned.
- Finally, prototypes are converted to products that are manufactured and put on the market.[20]

Many of these stages have (or should have) crime prevention counterparts, or are otherwise relevant to prevention, and the 5Is version of the preventive process can be used to explore the relationships step by step. The most distinctive and informative steps for present purposes are Intelligence and Intervention, which receive relatively greater coverage below.

Product *design process: intelligence issues*

Defining the *scope of'the problem'*

Often in crime prevention, the 'presenting problem' as reported to the police may not be the real, underlying one. Designers are trained in various techniques for eliciting needs, trade-offs and constraints from users at various stages of the design process - via simulations, mock-ups, focus groups, etc. A determined (but selective) effort to apply these techniques to solving crime problems may be rewarding, informing not only the preventive intervention but also its implementation and the involvement of other stakeholders (e.g. will they actually *use* the alleygates?).

But this critical approach to problem definition can be pursued at more radical levels. The Design Council research (Design Council 2000) drew an interesting lesson from 'eco-design', an approach trying to accomplish something similar to DAC in that it seeks to address environmental impacts of products without unduly compromising other criteria like performance and appearance. Eco-design distinguishes between an immediate focus on *products* - making existing products (such as washing machines) more resource efficient; results - producing the same outcome in different ways; and *systems* - questioning the need fulfilled by the object, service or system, and how it is achieved. These alternatives are ranged on scales of 1) increasing benefits, at the cost of 2) *increasing difficulty of implementation* due to the progressively more pervasive and fundamental changes in the market and wider society needed to bring them about.

From a DAC perspective this could translate into, say, improving the immobilizer on cars; choosing alternative ways of reducing car crime (e.g. focusing on the design of car parks or even where appropriate concentrating on catching offenders); or reducing the number of cars to be stolen by boosting public transport - 'dematerializing' the target product and providing the function through services. (Another example is replacing vehicle excise licence

discs, vulnerable to counterfeiting, with higher fuel tax.) In effect, whilst the outcome focus is the embodiment of POA itself (let problem determine solution), the system focus is more radical - zoom out to see if the problem itself should be redefined. In this respect it is worth noting that, whilst over-zealous adherence to *product* design may fall foul of the injunction to put problems before types of solution, applying this wider *design process* does not.

To some extent this represents the scale of tactics to strategy, which links nicely to recent UK moves to embed POA within the police's National Intelligence Model, where the scope and priority *oi* crime problems can be assessed and addressed by regularized organizational arrangements in the form of tasking and co-ordinating groups. But there is also a qualitative difference, which the authors of the *Design Council Report* (2000) propose can be reflected as follows: *reducing criminal events* (within DAC, a product focus, based, I would suggest, on correcting their revealed vulnerabilities); to *crime control* (outcome focus); to wider *community safety* (system focus).[21] A community safety approach might even occasionally lead to interventions which renounce the attempt to prevent crimes (where such efforts appear impossible or too costly or have serious side-effects) but concentrate on mitigating consequences and supporting victims.[22]

Intelligence for targeting action

Some types of property are misappropriated, mistreated or misused more than others. Crime prevention efforts (design based or otherwise) can efficiently be targeted on these, whether generic types (all portable music players) or specific makes and models. Those at consistently higher risk of theft were identified by Clarke (1999), from a thorough analysis of items stolen based on statistical and crime survey data, as *hot products.*[23] They include items such as banknotes, jewellery and compact consumer electronic goods.

Important information to guide the targeting is the 'exposure base', the number of products at risk of the relevant kind of crime at any one time (Clarke and Eck 2003). Without this, a high frequency of crimes associated with a particular product may not just reflect its characteristic vulnerability to crime but also the numbers of individual exemplars out there, and the kinds of situations in which they are placed. The UK Car Theft Index (Home Office 2003) uses readily available and reliable disaggregate data on individual vehicle crimes (the great majority of which are reported to the police). For the exposure base it uses, it filters out the numbers of each make and model, which are obtainable from motor industry and licensing data. (It cannot, though, allow for when and where different types of car are parked.) Unfortunately, this represents a uniquely convenient combination of circumstances, and serious obstacles thwart aspirations to emulate it in, say, consumer electronics. In ten years' time, widespread adoption of consumer electronics linked to and registered on the Internet may alter this; and satellite geolocation may supply when and where exposed and stolen. The time for trying to get security functions based on these facilities into the product specifications is, however, now.

Intelligence for designing products - MOs

One of the most useful kinds of information for designers of crime prevention interventions in the widest sense is the modus operandi (MO) of offenders. Gamman and Hughes (2003) describe how a range of secure handbags was designed explicitly to tackle the MOs identified with the aid of the police, namely 'dipping, lifting, slashing and grabbing'.[24] Obtaining feedback from MOs and on revealed vulnerabilities of design is often a haphazard process, and more could be done to channel the information systematically to designers. One example where it has worked (see Design Council 2000) is with the network of police liaison engineers set up through the UK Motor Insurance Repair Research Centre at Thatcham, to scout expertly for information on MOs and vulnerabilities to pass on to security testers and ultimately vehicle designers.

Product *design process:* intervention *issues*

Intervention, recall, covers the stage of designing what it is that actually blocks, weakens or diverts one or more of the causes of criminal events, as these converge on the Conjunction of Criminal Opportunity. It is therefore the core task of design and of wider problem-solving against crime.

Importance of a dear rationale

Criticisms of how the POA is applied in practice often centre on lack of analysis and evaluation (e.g. Leigh *et al.* 1993; Read and Tilley 2000; Bullock and Tilley 2003). However, another shortcoming has been the lack of a clear rationale from *problem to cause to intervention.* Personal experience of assessing entries both for the Tilley Award in Problem-Oriented Policing, the Student Design Award of the Royal Society of Arts[25] and in capturing good preventive practice for knowledge transfer (Ekblom 2002b, 2004b) reveals the 'leap to a solution', or at least the poorly articulated trail, to be a widespread shortcoming.[26] A similar point is made Laycock's chapter (Chapter 23), this volume. The consequences of an inadequate rationale are, obviously enough, solutions that are difficult to realize in practice, to communicate to stakeholders, to evaluate and to replicate. Supplying pressure to declare this rationale has been one of the aims of the Tilley Award and extensive efforts were made to do likewise as the Student Design Award gained experience on crime. But articulation is helped in both cases by developing a clear and consistent crime prevention language, and CCO, 5Is and their design variants aim to contribute here {Ekblom 2002a, 2002b).

Creativity

The most obscure part of the POA is the T>lack box' in which candidate solutions (strictly, interventions) are generated, selected and modified. The equivalent internal creative process of DAC is the stage at which requirements and other intelligence about the crime problem are brought together with knowledge of materials, techniques and design elements to generate the concept, and then the realization, of a crime-resistant design. Much has been written on creativity in design (see Cooper and Press 1995 for an introduction), and undoubtedly this is something that designers are explicitly trained for - and 'ordinary'

professional crime preventers could learn from. (They could also learn from the understanding of management structures, organizational settings and procedures such as 'innovation sets' to support and channel creativity.)

Lawson's (1990) description of the process is typical - insight (formulating the problem), preparation (understanding it), incubation (relaxation to allow subconscious thought), illumination (emergence of the idea) and verification (idea development and testing). As a sketch map this is adequate, but gets us no nearer opening the black box than restating the mystery of 'subconscious thought'.[27]

Generation, articulation and selection can be helped by causal frameworks such as the 'crime triangle' (Clarke and Eck 2003), and the more detailed CCO and its 'life-cycle' development (Wooton and Davey 2003), which could almost be seen as a generative, combinatorial grammar for describing, inventing and judging preventive interventions during and after the creative process. (This issue is revisited under 'replication', below.) It can also be aided by *theory* of criminal behaviour and an understanding of how specific theories interact to generate crimes.[28] But the challenge (or, rather, the *design* challenge) is to find ways of communicating these frameworks and organizationally supporting their use, so designers and problem-oriented preventers alike are willing and able to use them as a matter of course, in ways that boost, not stifle, then-creativity. As a counterpoint, it is worth noting that creativity and innovation are not so much *restricted by* requirements and physical constraints, as given a defining *'fitness space'* in which to work.[29] The next section takes this theme further.

Troublesome trade-offs

Despite public concern about crime as a whole, when it comes to everyday priorities of consumers, crime prevention is often way down the list. People want a car that is stylish, high performance, economical, safe, cheap and swift to repair - and oh, by the way, that does not get stolen or broken into. A major challenge, therefore, is how to design products that are secure without jeopardizing their main purpose or interfering with a range of other criteria. These cover its manufacture, safe and economic delivery through the supply chain, marketing, installation and ultimate disposal. Recognizing, and reconciling, a range of potentially conflicting requirements at (and between) all these stages is at the heart of the industrial designer's skill.

Aesthetics A familiar critique of design against crime as a generic approach is aesthetic - that it leads inevitably to the 'fortress society'. This originally applied to the built environment (blockhouses, heavy shutters, etc.) but could equally apply to movable products - hideous armoured computer cases, ugly moneybelts (which also scream 'my cash is here!'), chains on music players that signal 'uncool' concern about risk and so on. This can happen, of course, but again it is a question of thoughtless commissioning and bad or compartmentalized design. Perfectly aesthetic handbags can be designed which are secure in diverse ways against quite brutal damage such as slashing (Gamman and Hughes 2003), car radios can be designed without obvious protective engineering features (they can be distributed in parts around the car, or concealed with panels when out of use). To cite some place-based examples,

many local planning criteria now specify aesthetically acceptable designs for shutters on shops; many banks have abandoned their heavy screens without sacrificing security; and as Poyner (1983) noted, it is possible to make positive ornamental features of things like window grilles.[30]

Notwithstanding these points, fitness for purpose and context remain the leading principle in applied design. But in some circumstances it may be appropriate to go beyond *being* responsive and robust to crime, and deliberately *signalling* it - influencing offender perceptions as well as objective difficulty. Deterrent anti-theft lights wink in car interiors, warning off offenders with the aim of avoiding crime rather than resisting it and suffering damage, much like wasps' coloration (Ekblom 1995, 1999) deters predators. Street furniture may be designed to signal robustness and discourage vandals (Design Council 2000) and designed so that legitimate use is promoted, denying offenders unhindered access.

Legal and ethical issues Designers against crime must also consider whether their design violates privacy or unacceptably constrains freedom in some way - for example, a mobile phone which reports on someone's movements, whether tracking him or her for his or her own good or for other people's, without his or her awareness or free consent. Communicating lack of trust may also be an issue - whether it is the 'spy in the cab' tachometer or the often elaborately secure toilet-paper dispensers that seem to be installed in government buildings presumably to prevent civil servants walking off with the entire roll. In some cases such lack of trust serves only to provoke and perhaps to diminish guilt feelings. *Social inclusion* values dictate that designers should ensure the security features on their products do not exclude certain groups, such as the elderly or disabled who have difficulty operating certain kinds of lock or anti-tamper mechanism, or the poor who cannot afford them. Marketing-driven design practices which make people yearn for the latest fashion and status-conferring products which some cannot legally afford remain tabled for moral debate.

Environmental considerations Crime prevention requirements have to sit alongside environmental considerations. One approach to preventing shoplifting of small, pocketable goods is to put them in a big package, which militates against conservation of resources. One item to receive this treatment (Design Council 2000) was a small torch but, cleverly, the material for the package had come from spare plastic from producing the product itself. This example also makes a more general point - that there is far greater scope to handle troublesome trade-offs when crime is considered *simultaneously* with other design requirements rather than as a later add-on. Nuisance is another trade-off in the quality of the social environment. Whereas designing insecure cars may export costs of *crime* on to victims and the rest of society (Roman and Farrell 2002; Hardie and Hobbs in press), poorly designed car alarms export the costs of crime prevention.

Safety With efforts to stop drink-driving or to restrict weapon use, safety and crime prevention are on the same side (intelligent cars recognize and act on drink-diminished skills and intelligent weapons fire only for their registered owner). But safety (and failsafe) considerations often collide with security. Nobody wants a crime-proof car or a building that occupants

cannot escape or be rescued from. In all but extreme risks such as armoured cash-in-transit vehicles this is not really a trade-off with crime - there is no possibility of compromise. (In any case, this imbalance is reinforced by the existence of powerful fire safety regulations unmatched by crime prevention counterparts, as described for example in the *Design Council Report.)* But it is possible to make creative leaps which optimally serve safety *and* crime prevention. The last five metres of typical American fire escape stairs are normally drawn up from street level, and slide down under the weight of fleeing occupants.

Convenience Design against crime needs to be simultaneously user friendly whilst ofouser unfriendly (Ekblom 2001b). A major troublesome trade-off is security versus convenience, an issue taken up at various points below.

Cost Every additional feature incorporated within a design imposes some extra cost on the design process and/or in manufacture - and in fiercely competitive sectors such as automotive design even a few additional pence on the latter may be unacceptable. Costs of money, time and attention also fall on those who buy and use secure designs (or reject and neglect them). Some security features are expensive, of course - but others need only involve a little thought at the design stage. An example is the road sign for the River Uck, Sussex, which (as can be imagined) is quite provocative of graffiti. Presumably after wearying experience, the local council devised a rectangular sign with notches cut out of the bottom corners that denied graffiti space for the offending additional letter.

Optimizing trade-offs Ingenuity apart, the earlier in the design process that crime considerations are raised, the easier it may be to optimize or even to resolve troublesome trade-offs. Security features will be less obtrusive (and thus more aesthetic and less vulnerable to counterattack), operation may be more user-friendly, constraints on design freedom will be less, technical conflicts such as over 'electromagnetic compatibility' (Southall and Ekblom 1985) may be avoided, and costs may be reduced (if, for example, security functions can be incorporated into features required for other purposes, such as the engine management computer for cars). But sometimes even remedial design can be made to reduce crime at little cost. One of the Design Council case studies on DAC[31] relates to the prevention of a scam whereby large and expensive paint cans were bought, then returned for money-back, after the contents had been covertly replaced by water. The preventive principle selected was to help shop staff act as crime preventers by making the container tamper-evident. The practical design problem was that a remodelling of the can lid would normally require hugely expensive replacement of the metal injection mould. However, virtually zero-cost ingenuity came in the realization that shaving a microscopic layer off the surface of the mould in the right place would leave a thin telltale plastic membrane over the part of the lid where a screwdriver is pushed in to lever it off.

Sometimes, new technology can appear, or be developed on request, which relaxes these trade-offs. In cars, the arrival of cheap, reliable miniature electric motors has allowed the separation of the discriminant function of locks to be physically detached from the devices that latch the doors, removing all kinds of size, space and reliability constraints on the design of door security. But

technology and engineering must be subordinate to wider design requirements, not dominant, as the next section makes clear.

When is a design not *a design?*

The implication in the crime prevention literature has sometimes been that DAC is simply that part of prevention which is realized through *any* material changes in products - but professional designers would dispute this. When is a design not a design? When crime resistance is incidental rather than a deliberate adaptation (as with the heavy TV screens above); a *'techno fix';* or an *'engineering solution'.*

A techno fix could comprise a superficial, add-on, security product such as a D-lock holding a bicycle to a railing, where neither bike nor railing have been modified to facilitate the security function, and where only a single, exposed, line of defence is employed. In such circumstances, the defence is more likely to be defeated whether by attacking the exposed security lock itself, or its less than optimal anchorage on the protected product or the ground. Ekblom (1995) refers to this as the 'bolt-on, drop-off syndrome. Another common kind of techno fix could involve simply sticking a security component such as a radio frequency identification chip on to an otherwise vulnerable product or engraving a property mark on it, and hoping that it will deter or discourage offenders. If the rest of the security system was in place - detectors, registers of ownership, etc. - such a chip could be part of a perfectly well designed solution whose effectiveness was substantive and sustainable beyond the initial deterrent impact on offenders' perceptions; but otherwise it would not. One example of a superficial techno fix (Design Council 2000) was the video recorder protected by a simple PIN code, introduced by one manufacturer at the instigation of the police. The crime reduction benefits were never assessed, but there were costs to users who lost their code, and to the manufacturer's service engineers who were bombarded with requests to help with lockouts (to such an extent that the usual response was to tell callers - perhaps even enterprising thieves - how to bypass the control).

An *engineering solution* would not be superficial - technically, it would do the job well and might be sophisticated in design and materials. It might even reflect an anticipation of offenders' countermoves (see below) and of efficient and reliable manufacturing requirements (from an industrial design perspective); but (like Sinclair's notorious C5 electric vehicle of the 1980s) it may have neglected its homework on marketing and use. Where techno fixes are shallow, engineering solutions are narrow - clunky, clumsy designs that are not convenient or user-friendly. They fail to respect troublesome trade-offs such as aesthetics, weight, environmental requirements or even humanitarian priorities (the infamous example being the South African car which shot flames from underneath to scorch hijackers crouching beside the door to menace the driver). Designers of engineering solutions may also fail to set up an equitable division of responsibility for making the wider system work. Some of the entries in the Royal Society of Arts' Student Design Awards under the 'Less crime, by design' theme sought to protect property from theft principally by incorporating tracker devices. As such, they would export costs of location

and pursuit on to the police; thus they are 'bad' designs even if they had been technically successful at preventing crime.

It may sometimes appear that an engineering or technological approach happens to be exactly what is needed - such as more resistant glazing on vehicles to prevent illegal entry (e.g. Design Council 2000). However, this does not imply a bypassing of design - rather, much of the design task is shifted to that domain of technology - the glass itself has to be properly designed by materials technologists to allow for optimized impenetrability, visibility, cleanability, safety, weight, manufacturabiKty and cost.

Replication, innovation and design

Studies of the POA in practice (Tilley 1993; Ekblom 2002a; Bullock and Tilley 2003; Chapter 23, this volume) have indicated serious limitations in the ability to replicate 'success stories', and in particular to mainstream such projects in wider programmes. Apart from commonplace shortcomings such as practitioners' lack of project management skills, two related issues appear to underlie this. First, the interventions that appear to work in crime prevention are often highly *context sensitive* in their implementation and/or impact. Uniform solutions cannot be 'sprayed on' like pesticide. For example, Neighbourhood Watch may only succeed in getting implemented in communities where there is trust between neighbours (Laycock and Tilley 1995); and street lighting may depend for any tangible effect on crime, on how it interacts with street layout, pedestrian and traffic flow. Secondly, there is a distinction to be made between replicating an *end-product* 'cookbook' fashion, such as exactly copying the specific details of what was done in a successful burglary prevention project, and replicating the intelligent *process* of combining generic principles (such as 'creating a target enclosure') with practical methods (such as how to construct alleygates) and method 'elements' (e.g. how to survey victims, design locks or mobilize users) in the light of knowledge of problem and context. In fact, the 5Is framework was an attempt to redesign the POA so that the knowledge of 'what works' in one context can be captured and replicated in other contexts, and generic, transferable good practice lessons learnt. In this, replication is far from literal and detailed - it is more like *innovation* from generic principles (Ekblom 2002a, 2002b). As such, an injection of professional designers' developed, applied and controlled creativity can only be helpful to crime prevention practitioners. Interestingly, the analytical approach to capturing and describing knowledge through principles, methods and interchangeable elements could be exactly the basis needed to support a *generative,* 'combinatorial' approach to creativity that is both fruitful and disciplined (who would want a microwave cooker or a building designed by a team that was creative and undisciplined?).

In environmental and architectural design terms, the context/process issue translates into the need to configure places to their unique circumstances and use, by drawing together a range of principles and practical elements including crime prevention and other requirements (see ODPM/Home Office 2004). Product design, however, has to confront the question of mass production.

Mass production and adaptation to crime risk

Mass production could be said both to contribute to crime and to make its prevention harder. On crime, mass production has created more products to steal; and their identical and often (re)movable nature has made them readily disposable.[32] Arguably, it has also made the concept of property *per se* less respected. The capacity to exploit and respond to *fashion* industrially amplifies the attractiveness of products to legitimate and illegitimate owners alike. On prevention, if matching of solution to context is key, how do we nevertheless design *movable* products that are crime resistant in *most* circumstances? The earlier description of 'how product design can prevent crime' provided some answers from the crime prevention angle (from add-on security products to human and cybernetic protection); but further insights can come from the perspective of industrial design itself, and from wider consideration of the issue of adaptation.

Adaptation in the biological sense is about how living organisms are anatomically, physiologically and behaviourally fit for their purposes of survival and reproduction in the conditions they typically encounter in their natural habitat. In the case of products, it is ultimately about their survival as manufactured designs in the market, which depends on their fitness for their intended function, and a range of other requirements including {in fewer circumstances than we would like) their resistance to crime. The adaptation of individual products to crime can take several forms, in a kind of scale of sophistication:

- First, thorough research into offenders' MOs, and vulnerability and attractiveness of products, can lead to some designs for some products that are exposed to crime in sufficiently similar contexts, for a *fixed-design* approach to work and to be marketable. However, this may leave such products over or under-engineered to meet crime risks that depart significantly from the average, incurring unnecessary cost, inconvenience or weight, on the one hand, or excessive vulnerability on the other.
- Secondly, individual products can be designed for particular *niches* - to meet specific levels and kinds of crime risk - for example, fittings for public buildings may need to be more robust and better-anchored than those in private homes.
- Thirdly, *mass customization* (cf. Pease 2001) offers scope for incorporating progressively more secure components as 'optional extras' into the individual product exemplars as the judged risk increases or its nature becomes clearer to the individual purchaser and user - anchor points, armour, alarms, trackers and so on.
- Fourthly, designing *programmability* into the product after it leaves the factory. Here, the owner can activate or inactivate a security function according to perceived risk - e.g. activating a pin code on a mobile phone or - in a shorter decision cycle - the momentary decision in a particular situation whether or not to lock a vehicle or arm its alarm. One winner of the RSA Student Design Award (Ekblom 2001b) was a diamond ring with

a platinum housing which slid round to hide the jewels when prudence dictated, illustrating fine adaptive discrimination between showing off wealth and style (why have jewellery otherwise?) and concealing it for security - allowing dynamic adjustment of the troublesome trade-off, as circumstances, and priorities, change. Dynamic trading-off can be found in the natural world - for example, where gaudy and conspicuous male ducks retire into dowdy, but safer, 'eclipse plumage' after the mating season. Note, though, that designed-in capacity for post-production changes can also make prevention harder - swappable covers for mobile phones, for example, render recognition of stolen property difficult. But we have been here before - horse thieves often painted out characteristic features of stolen steeds until clear of the area.

- Fifthly, designing *active discrimination* into the product itself. This requires the capacity a) to sense and judge rightful and wrongful possession, appropriate and inappropriate locations, and patterns of use and misuse (which may be quite similar); and b) to make a decision and take some sort of action - whether simply shutting down and refusing to work, sounding an alarm, sending an Internet rescue-me message, or (with a fashion garment) destroying its own value by ink-flooding. In many cases this level of adaptability can at least partially rely on the human user to have the right fingerprint, possess and use the key or security code; or even to take the decisions and make the response. However, the more complex products become, especially as they incorporate active ICT with sensors, processor, actuators and perhaps locational and communications facilities, the more they move away from being simple targets of crime towards being *active preventers* themselves. (Ekblom 1997 notes the resemblance to the giant's magic harp which cries 'Master, Master, he's stealing me!' as Jack bears it off to the beanstalk.)

Additional adaptive strategies go beyond individual products, for example involving fostering *variety* of designs; these are covered below.

Active or passive discrimination is pivotal to all the above levels of adaptation to crime, whether this is achieved though a plain lock and key, the requirement for specialist tools for opening or removing a product, hi-tech sophistication or clever design related to differential value and enjoyability of the product to legitimate and illegitimate possessors (such as a mobile phone customized to fit the contour of the user's own ear). Badly designed discriminant functions can undoubtedly be inconvenient - Internet shopping sites with elaborate and time-consuming security procedures (Design Council 2000), the frustrating loss of video or car radio security code, and the annoyance to owners and others of false alarms. These annoyances may be sufficient to motivate people to bypass the security - by neglecting to lock the car or link the laptop to the library table whilst leaving them unattended for a brief moment, disabling electronic security functions or resorting to back-street workshops that recode locked radios.

Developing the means of discrimination and realizing it in ways appropriate to the product are therefore vital. However, it is challenging, since there

is usually little to distinguish between criminal and legitimate behaviour towards a given product (and in the case of car or burglar alarms, the simpler discrimination between a thief/ a gust of wind or the attentions of a cat). In a sense, getting discrimination right is almost more important with the lowest, 'dead reckoning' level of adaptation, because as far as the product itself is concerned there is only one opportunity available (at the factory) to make it inherently crime resistant - or otherwise reliant on other forms of protection discussed above. Once produced, it can't learn.

Well designed discriminatory features do exist - and developments in ICT and sensory technology promise to make them better, such as biometrics and integration of multiple signals like vision and sound. But 'sensory' capacity alone, and a focus on 'who you are', are insufficient to support discrimination. 'Where you are' and 'what you are doing' information may also need taking into consideration. The designer may therefore have to build in knowledge of legitimate and illegitimate use patterns, extending their expertise from predicting and blocking 'dumb user' behaviour (e.g. by incorporating safety interlock switches on power tools or raised safety prongs on carving forks to compensate for ignorant or risky usage), to something more subtle. An example is the colour photocopier designed to detect when someone is trying to misuse it to copy banknotes as opposed to, say, holiday brochures. The false positive rate is critical to usability.

To maximize discrimination between use and abuse of products requires a step up in the kinds of intelligence described in a previous section. Designers must go beyond obtaining detailed and comprehensive information about the crime risk and its distribution, and assemble knowledge about subtle differences between use and misuse, and identity of legitimate users. This information unfortunately may not always be available, reliable or up to date; nor command sufficient priority from the designer and design decision-makers to incur the effort and expense of acquisition. Cost and implementation issues also figure in discrimination - location and registration systems need considerable infrastructure to make them work beyond a superficial and short-lived deterrent effect. In turn manufacturers need confidence that enough users will buy their product for them to justify investing, individually or collectively, in such systems (market failure in this area may require government intervention to kick start the process); and police will have a range of concerns both technical and relating to the equitable management of demand on their time.

Product design process: implementation and involvement

These issues are well-covered for DAC in the *Design Council Report* (2000) and in Clarke and Newman (in press a); and more genetically in Laycock's chapter (Chapter 23, this volume). Product manufacture, marketing, distribution, sales and servicing are implementation fields in their own right and will not be covered here, although they each constrain DAC and may introduce crime risks of their own (e.g. hijacking of goods in transit or shoplifting).

On Involvement, DAC is frankly starting from a pretty low baseline. The *Design Council Report* (2000) showed that although there were best practice

examples in the automotive and transport sector, very few designers or their clients even considered crime in the development of new products, and there was only limited use of DAC principles by interior and architectural designers. Subsequent efforts since that work have begun to raise the profile and provide some of the know-how in designer-friendly form.[33]

On the mechanics of Involvement, the 'CLAMED' framework (Ekblom 2001a; Pease 2001) describes the generic process of mobilizing crime preventers, including designers and manufacturers, to take responsibility for implementing *any* kind of intervention.[34] CLAMED in fact arose from a reading of the *Design Council Report* (2000) and its rich discussion of enablers and constraints on DAC. It comprises several steps:

- Clarify the crime prevention tasks or roles that need doing (e.g. the intervention itself, alleviating constraints and supplying enablers).
- Locate the individuals or organizations best placed to undertake them, including designers, manufacturers, marketers and consumers. Then:
- Alert them that their product could be causing crime, or that they could help stop unrelated crimes.
- Motivate - by hard or soft incentives including an image of corporate social responsibility, naming and shaming, 'polluter-pays' taxes (Roman and Farrell 2002), awakening consumer expectations and pressures and imposing insurance costs, and legislation (Design Council 2000; Clarke and Newman in press a). Hardie and Hobbs (in press) and Laycock (Chapter 23, this volume) give good descriptions of how a combination of many of these pressures led to radical improvements in car security; the *Design Council Report* (2000) also reports results of focus groups on consumer motivation for, and expectations of, security in product design.
- Empower - by supplying designers with education, guidance on intervention (e.g. Design Council 2003), information on risks, and tools (Design Council 2000) and other resources, and opportunities for influencing designs at the right stage; and by alleviating a range of constraints (Design Council 2000).
- And, perhaps Direct, in terms of standards (such as BSI or CEN) and targets.

These specific actions to increase the take-up of DAC and the motivation and performance of designers cannot be undertaken in isolation. All the enablers and constraints interlock and may form a self-reinforcing system which is hard to shift from one state to another. And specific actions must be done in step with public and commercial understandings and expectations - hence the importance of climate-setting activities such as setting the tone for who is responsible for the diverse causes of crime.[35]

Such 'joining-up' has to take place *within* the design and manufacturing sphere too. Competition between companies inhibits collective solutions and governments must step in to alleviate such market failures (as happened with

mobile phone security - see Clarke and Newman (in press a). Fragmentation of design organization and the design process has happened (e.g. through privatization). The *Design Council Report* (2000) well describes the case of UK railway carriage security, which was formerly the responsibility of in-house designers and builders within British Rail, but which after privatization was divided between the railway operating companies and the manufacturers of rolling stock. In some cases the existence of third-parry carriage-leasing companies raised further barriers to the flow of concern and information about crime, the balancing of trade-offs, and feedback on crime-preventive performance from passengers to designers.

More generally there is a responsibility and requirements gap for security standards that has to be bridged between the final manufacturers of products such as cars and the suppliers of its components. (Vehicle manufacturers seem to have succeeded here, under sustained pressure from government and insurance incentives, an awakened consumer market and legislation.) With consumer electronics, too, large multinational manufacturers in a global market may find it difficult to familiarize with, and adjust to, local crime contexts for their products - especially if their designers are in Italy or Japan, for example. Incentives available to national-level governments may be puny relative to the global market - hence the importance of acting at a collective international level, as with the EU directive on mandatory vehicle immobilizers. Government action of any kind to boost DAC is complicated by the very different constraints, enablers and working arrangements of different industries, and sometimes even of different companies within a given industry.

The position of designers themselves must also be taken into account. Whether or not crime resistance is incorporated into a product may indeed depend on the designer's own awareness, expertise and attraction to the issue (as in the wider movement towards 'socially responsive design'). But it depends even more on how the designer relates to the *design decision-maker* (Design Council 2000). Artisan designer-manufacturers apart, whether professional designers work as freelancers, in consultancies or as employees of product manufacturers, it is normally clients or employers who determine the priorities or set the specifications.

Product design process: impact

Assessment and feedback from studio tests, field trials, and user and service engineer experience are of course an inherent part of the evolutionary process that is product design - and especially with ongoing product lines they are seamlessly linked to the intelligence issues described above. In traditional evaluation and cost-effectiveness terms, however, there is unfortunately little hard evidence to report that relates to product design as opposed to 'target-hardening' and other situational approaches in general (see, for example, Clarke 1997; Ekblom 1998; Welsh and Farrington 2000). Circumstantial evidence (Sallybanks and Brown 1999) points to the contribution of vehicle security technology to the substantial and sustained reduction of theft of cars in the UK in recent years and the concentration of the dwindling loss on older, less protected vehicles. Other evidence is much more anecdotal in conventional terms but, as Clarke and Newman (in press a) note, almost entirely *self-evident*

- or would be, with evidence from images and models {Gamman and Pascoe 2004b). For example, remedial plastic housing was recently put on the buffer beams of commuter trains, to stop boys from riding there, at mortal peril. The most superficial glance reveals that there is now simply nowhere for them to stand. One research project currently under way[36] is, however, attempting a rigorous field evaluation of anti-theft grips to clip customers' bags to café tables. The more such hard evidence can be obtained, the better DAC will fare in securing sustained funding and attention from government; and the evidence may also help convince manufacturers to use DAC and consumers to prefer products so designed, although any such benefits must of course be aligned with their interests.[37]

Product design in wider processes

So far, we have treated the DAC process as a more or less linear activity (albeit involving 'internal' iterations of testing and improvement) which progresses from identifying a problem to devising and implementing a solution adapted to crime. But this is only part of what can best be understood as a series of wider processes and cycles of dynamic adaptation that link products and manufacture, crime and its prevention over more or less extended timescales. Several kinds of cycle exist:

- An individual product exemplar (such as someone's mobile phone) has a criminal career of its own. It is manufactured,' sent down the supply chain, purchased, used and disposed of. Different kinds of crime can befall it at different stages, from trouble associated with obtaining raw materials (such as the 'coltan' alloy used for the magnet, which has been associated with environmental damage and even illegal eating of gorillas by freelance miners), hijacking of deliveries, commercial burglary, shoplifting and returned goods fraud at the supply chain stage; robbery, fraudulent use of services, misuse for drug dealing, football hooliganism or terrorism at the user stage; and fraudulent new-for-old exchange, littering or illegal dumping at the end of the product's life.
- The design itself has a lifecycle as a unit of marketing and manufacture (discussed below), as does the more generic concept of the mobile phone itself. (Perhaps the invention and spread of the motor vehicle over the last century or so introduced the most marked criminal lifecycle of all - which now seems to be waning. Whether we will have private motor vehicles, and thus vehicle crime, in 50 years' time is not certain.)
- Beyond individual criminal events *offenders* have their own crime careers, as do criminal networks or organizations which grow to exploit particular niches.
- And as will now be seen, wider social and technological changes and coevolution between crime preventers and offenders also drive the changing nature and scale of crime.

Crime harvests - criminal career of a product

The simplest cyclical issue is that of timing and lack of foresight by designers, a problem familiar to the military who have often failed to predict new forms of attack. A historical example was the world's first prepaid postage stamp, the Penny Black of 1840, which was initially cancelled with red franking ink. But at the time, red ink was soluble - so people started washing off the stamps and reusing them. The only indelible ink then available was black - so the Post Office had to do a quick about-face, and in 1841 came up with the Penny Red, which was franked with indelible black, and had the additional advantage of value reduction when immersed in water. Eventually, new technology in the form of synthetic dyes relaxed this constraint, but the striking design of the Penny Black was consigned to stamp albums (there, ironically, to become a target of high-value theft).[38]

Pease (2001) describes a related, and depressingly familiar, process which begins when a commercial product is designed naive to its risk of being a target or tool for crime. The product comes on the market and, as its legitimate popularity grows (Felson 1997), there is also a rush to steal it to meet unscrupulous demand - a *crime harvest.* Finally, if the crime harvest is significant enough to people with influence, it is followed, sooner or later, by retrofit solutions. Meanwhile, once every household possesses the product, the demand, and the theft, taper off unless manufacturers are able to revive honest and dishonest interest alike by 'must have latest version' tricks, or locking the item into cycles of fashion.

The classic modern example is the mobile phone. When these first arrived in significant numbers the handsets and the system were revealed to be extremely vulnerable to frauds such as cloning. As the theft rate took off, a host of technical, procedural and legal changes were brought in to stem the enormous financial losses, and they eventually worked (Clarke *et al.* 2001).

But (as the discussion of trade-offs above made clear) retrofit solutions are never as good as those done at the original point of design. More strategic problems must also be faced. The Penny Black problem was short lived and easily rectified; but vulnerabilities on cars and houses, say, have a *crime legacy* of years or decades. By then the problem may have become self-perpetuating through the emergence of a market for that particular kind of stolen goods, a 'tooled-up' set of offenders (Clarke 1995) and crime promoters with requisite skills and contacts, and perhaps the involvement of organized crime (Clarke and Newman in press a). One could also add that, over this timespan, means of coping with the problem and diffusing the risk (e.g. through insurance) may also evolve which harden the eventual task of motivating and focusing responsibility for change when it becomes public policy to do so. And arguably, manufacturers may come to depend on the demand for replacement goods generated by theft and lubricated by insurance policies.

Getting ahead - forecasting crime risk of particular products

Anticipation could avoid many of these problems of retrofit solution. Clarke's (1999) 'hot products' concept was conceived not merely as a means of explaining, but of predicting which new products were likely to be at risk of theft. This

locates it firmly within the product development cycle - whether of entirely new products or of variants of existing types. Hot products are those which are Concealable, Removable, Available, Valuable, Enjoyable and Disposable (CRAVED). Clarke and Newman (in press b) subsequently embodied this approach in a proposal for a code of practice for 'crime proofing' new products, in work for the UK Foresight Programme's Crime Prevention Panel. Research is currently under way (the EU-funded project Marc) to examine possibilities for an EU-wide system of crime proofing products alongside new legislation.

The hot products approach in principle seems a useful way to forecast and feed theft risk considerations into the DAC process, and (combined with modus operandi information) to focus designers' thoughts on the kinds of risk they may face for a given product (concealment, etc.). Complementary arrays of risk factors could be identified to cover the other generic misdeeds that products may face (mistreatment, misuse, mishandling and misbehaviour, as discussed above). And to match the largely empirical process of identifying such risk factors that led to the development of CRAVED, the more theoretical/ analytical approach of routine activities theory (Cohen and Felson 1979; Felson 1997; Pease 1997) and the CCO (Department of Trade and Industry 2004a; Ekblom 2002c, 2005) can be applied. Forecasting of crimes involving products in a wider context of 'pervasive' or 'ubiquitous' computing is currently under way in an EU-funded project on 'Future Threats and Crimes in an Ami [Ambient Intelligence] Domestic Environment'.

All forecasting approaches, however, face a serious practical consideration in handling the *uncertainty* which by definition surrounds the estimated risk. It is pretty likely that on average, some broad types of product will be riskier than others. But can the forecast be estimated and particularized to a type or model of product, in its anticipated environment of use, with sufficient confidence for design decision-makers to say 'we accept this product is at exceptional risk of theft (and it is in our interest to reduce that risk) - we must raise its security specification in the following ways'? And can the nature and scale of the risk be further particularized to guide any available choice of adaptation strategy (fixed, niche, programmable design, etc.; inherent, add-on, rely on rest of situation, as above)?

The automotive industry has gone some way towards this ideal, with its systematic approach to intelligence gathering and product testing - especially at the UK Motor Insurance Repair Research Centre.[39] Its engineers are sufficiently confident to supply firm risk assessments and advice, and manufacturers sufficiently confident to use them {although in practice this readiness may not be directly motivated by awareness and concern for the reality of crime but by the more immediate pressure of raised or lowered insurance premiums for their model, determining which was the *raison d'etre* for the centre in the first place). But as for other product areas such as consumer electronics, there is clearly far to go before a skeletal framework of principle can be fleshed out with such strategic information. And circumstances may change (a point taken up below), sometimes in quite volatile ways, invalidating assumptions and decisions on cost and benefit. A few years ago, it emerged that 'set-top boxes' would soon appear on the market to enable current televisions to receive the new digital stations. Compact, lightweight, transferrable, with a wide market

in many households and apparently to cost around £100, these were obvious candidates for hot products. Until, that is, the television companies decided to do what turned out to be an exercise in inadvertent system-level design against crime - and offer the box free, whilst making their profit from service subscription payments. The extent to which products in general merge into services and licensing (including supply of material or software upgrades) is a major trend with wider implications for the definition of property, as is the whole issue of illegal copying and *intellectual* property (Department of Trade and Industry 2004a). The explosive growth of music downloads and peer-to-peer file copying suggests that 'natural' cultural controls on theft do not apply in the cyberworld.

Clarke and Newman (in press a) doubt the achievability of specific forecasting with entirely new products, and suggest that a problem-oriented approach might be better - i.e. to wait and see which products cause problems before reacting. But we may go some way towards a more forward-looking, yet still practical, approach to crime risk by developing improved ways of testing for vulnerability (including by simulation) and designing in higher levels of adaptability to cope, relatively economically, with a range of possible futures. Building up an intelligence and testing system, a body of generic experience of crime risks, MOs, etc., and a sustained working relationship with manufacturers has also proved fruitful within a specific field such as vehicle crime.

Whatever the case, some simulation or demonstration studies with designers and decision-makers might help to get a better understanding of what is needed to support the process. And perhaps we should not be too concerned about the uncertainties of forecasting *crime* risk, because this would be just one of a great number of imponderables that manufacturers routinely have to judge and take a chance on when launching any product into a competitive market. (Indeed, part of the designer's and manufacturer's role in creating is to anticipate and encourage particular modes of *use* - so the same skillset could readily be used to avert *misuse.)* Government efforts to get manufacturers to acknowledge and respond to this risk may be best received and acted on if they meshed with this process. Rather than specify some fixed strategy, the government (if it so decided) should simply set manufacturers some objective of reducing crime risk, advise them of the strategic alternative approaches and ensure a level playing field amongst competitors - and then it is over to them to analyse their uncertain market, make their risk-taking decisions and do it their way. As is well documented (Design Council 2003; Clarke and Newman in press a), wherever commercial companies or industries have been strongly motivated to address a crime problem (as with the rapid loss of revenue that occurred with mobile phones, or credit card fraud, described below), they have usually solved it one way or another.

Other product-related changes in crime

Products as targets of crime are not the only things that change. Products can also act as new sources of *readiness* or motivation to offend, such as conflicts over noisy music players in trains. Advances in technology (and even basic science) are also producing a steady stream of new *tools* or resources for crime

- the cordless drill, pocketable 12 V batteries (which can be used to energize car door locks - ingeniously, in one case, through the exposed power leads of the external rear-view mirror) and so on. Things that were once secure become vulnerable overnight. One fairly widespread DAC strategy uses esoterically shaped nuts and bolts to secure fittings in public buildings. The business end of the 'Gator Wrench' consists of a bundle of steel rods that can slide up and down to conform to the outline of *any* bolt head. At a stroke it disabled, and may render obsolete, an entire preventive technique. Tools as a whole become increasingly available - no longer confined to a limited professional 'guild' but easily obtained from DIY superstores and hire companies; ever more portable (oxyacetylene cutters used to come with huge and heavy gas cylinders, now some of them fit in a shoulderbag); and ever more 'universal' or adaptable. Interestingly, tools are frequent targets for theft - perhaps then to commit further crimes? Enterprising offenders have anecdotally been known to make false fire calls to steal bolt cutters from fire engines.

Nor are changes confined to the crime products themselves. Changing social patterns make for new opportunities and motives for crime. Twenty years ago, most homes were occupied for at least part of the day - now many whole neighbourhoods are empty from 8 till 8. Some of the opportunities that were once closed off by human presence and intervention now need technological solutions, offering fresh scope but also fresh challenges for design. Because human crime preventers are not immediately available to contribute to a secure system, this leads to greater reliance on inherently secure or even, in. the near future, artificially intelligent designs. By the same token, the assumptions made by designers about the presence of guardians or managers of places may no longer hold true in future, perhaps putting excessive load on the design.

Some attempts to forecast changes in crime stand in contrast to the very specific hot products approach, aiming to cover the broadest field of possibilities, often rendered as 'PESSTLE' or some anagram thereof (Political, Economic, Social, Scientific, Technological, Legal and Environmental). Two recent exercises of this kind in the crime prevention world have been led by the UK government's Foresight Programme - a wide-ranging Crime Prevention Panel (Department of Trade and Industry 2000) and a later, more specific, project on Cyber Trust and Crime Prevention (e.g. Department of Trade and Industry 2004a, 2004b). Another current group chaired by the UK Home Office (Ekblom 2005) is focusing on scientific and technological innovations and their implications for crime and crime reduction in the context of a policing science and technology strategy;[40] and more widely there is growing interest across the UK government in developing horizon-scanning approaches to policy, delivery and practice. Designers, for their part, should aim to make their products robust to a range of crime futures. All designs are a bet on the future - explicit 'futures' work just makes that bet a bit more explicit and robust, exploring assumptions about the present and questioning whether those conditions will continue to apply. At its simplest this could involve as straightforward a process as asking, for example, of each of the features of hot products, 'in future, will this product remain concealable? Removable? Available...?' and so forth, with reference to forecast trends and events such as 'increasing elderly population' or 'more power outages'.

Offenders fight back

People who design toasters certainly face problems, including the need to build in protective safety measures to allow for inexperienced users or children who try to toast toys, but at least the bread doesn't fight back. Criminals, of course, do, introducing an added loop to the cycles and changes already discussed. As every discussion of displacement acknowledges, offenders are potentially adaptable - able to circumvent crime prevention measures by changing location, target or (most relevant to DAC) tactics. The word *potentially* is significant, because reviews of the more conventional kinds of displacement over the shorter term (e.g. Hesseling 1994) show that it does not always happen, and if it does is never complete. In the DAC field, however, the wider picture of offender adaptation is not so clear, although it must be said at the outset that there is currently no *quantitative* evidence of the prevalence of the problem or its typical time course.

Offenders can respond to crime-resistant design at several levels. They can *make tactical countermoves in situ* - such as spraying quick-setting foam in a car alarm to deaden the sound. Offenders can also *turn crime prevention measures* to their own advantage - anti-shoplifting mirrors work both ways; communal CCTV in blocks of flats has been used not merely to spot who is coming into the building, but which neighbours are going out and leaving an empty flat.

Offenders can also turn designer themselves and undertake *strategic development of tools* and other resources as described above. Some even do sophisticated *reverse engineering.* Back in the nineteenth century, an American bank burglar called George Bliss grew tired of struggling with the new-fangled, and very successful, combination locks on safes. So he bought a lock and carefully dissected it to see how it worked. He then constructed a bent wire device he called the 'Little Joker'. He would break in and unscrew the dial of the combination lock, fit the Joker beneath it, and break out again. A couple of days later he would revisit the bank, recover the Joker and from the pattern of scratches on it, identify which numbers were dialled, drastically shortening the time to open the safe.

That was in the days of the clockwork revolution. Curiously, there is a close equivalent of grabbing the code in today's electronic world. A currently available watch memorizes the infrared signals from any TV remote-control device and plays them back when the zapper is lost behind the sofa. Some enterprising car thieves covertly used it during demonstration drives at a car showroom. They returned later to play the signals back, unlock the car and neutralize its alarms. Cars now have to use rolling codes that reset in a quasi-random sequence, like the spy's one-time pad.

The arms race

Social and technological change and offender adaptation make knowledge of what works in crime prevention a wasting asset. This applies to all kinds of situational prevention (and even to some offender-oriented methods), but especially to those involving design. This may simply be because design in most cases has been something that is 'created and left to do its job' rather

than continually adapted as with live human guardianship (although even here, even fairly alert humans can be parted from their money by unfamiliar forms of confidence trickery and fraud).

It is now widely acknowledged that crime prevention is a kind of arms race (Ekblom 1997, 1999) between those who aim to prevent crime and adaptive, and sometimes organized, offenders who innovate, exploit social and technical change and enjoy the obsolescence of familiar crime prevention methods. This is the most challenging cycle of all those described. A good illustration of an arms race is that cited by Shover (1996) who relates the unfolding technological history of safes and safe-crackers. A more recent one concerns techniques of credit-card fraud (Levi and Handley 1998) where the game shifts from one modus operandi (such as theft and misuse of card) to another (e.g. 'card not present', as with telephone or Internet ordering of goods) as each successive loophole is closed off, often with new technology such as, now, 'chip and PIN' identification.

But the term 'arms race' implies some steady progression towards greater complexity and sophistication on both sides - which may not always occur. Many of the countermoves adopted by offenders rely on spotting and exploiting security weaknesses and devising quite elementary countermeasures, such as shoplifters wrapping metal foil around products protected by radio-frequency security stickers. (This applies even to potentially sophisticated offenders like some terrorists (Roach *et al.* in press), who often engage national forces in 'asymmetrical warfare' using elementary equipment applied in unexpected ways and places.) Perhaps this co-evolution between offenders and preventers might be better described as an innovation race rather than an arms race. In the medium to longer term, crime levels depend on which side is innovating, and mainstreaming their innovations, faster than the other.[41]

Whatever the case, the process is accelerating - whereas in former times offenders would often learn their techniques in prison, now it is straightforward to find detailed guides on making bombs or picking locks on the Internet. Crime preventers often have to struggle to keep up for several reasons: the initiative is often with the offender; offenders have only to find one chink in the armour whilst preventers must cover all eventualities;[42] and preventers must confine themselves to civilized methods. But we can get ahead by being clever and learning from other 'evolutionary struggles' (Ekblom 1999), which all have a design aspect:

- The *military* is pretty obvious - stealth versus sensors, design of forts and how to undermine them; electronic countermeasures and counter-countermeasures. Capture-proofing weapons is another principle which could usefully be applied to restricting offenders' resources. Military designers are probably the only ones used to flipping perspective between attackers versus defenders, and these high-level skills would also transfer usefully to crime prevention (see Design Council 2000). Another struggle is *predator versus prey* - and it is not just about bigger claws and fleeter hooves. Sensors are important here too. If gazelles relied on the equivalent of contemporary burglar alarms to protect them from cheetahs they would be long extinct. They do not wait to feel the proximal crash of the cheetah

leaping upon them but use distal sensing. Vision has independently evolved many times in evolutionary history (Ekblom 2002a). But nor do the gazelles want to starve to death, unable to feed due to constant false alarms - so they use intelligent integration of multiple sensory modalities.

- *Pest versus farmer* and *bacteria versus antibiotics* both illustrate the impermanence of what seemed, at first, to be wonder solutions. There are simply huge numbers of bugs out there, constantly trying out new techniques against our countermeasures. But these are all a pale echo of the sophisticated evolutionary war that goes on all the time in our own bodies - that is, the immune system. Interestingly, companies like IBM have been developing so-called 'artificial immune systems' in their fight against computer viruses.

We might learn three kinds of lessons from these struggles: engineering lessons - trade-offs between weight and mobility, design details, materials; entirely new design against crime principles; and high-level ideas on how to run, and avoid, arms races.

Engineering lessons

Consider the case of seashells. It transpires that their glorious spines and flanges are defences against the crab - with whom they are in a co-evolutionary race in which progressively bigger spines are matched by bigger claws. Advertising brochures for secure containers for desktop computers speak of a hardened case, anti-jemmy flanges and bolt heads flattened to prevent prising off and bevelled to defeat pliers. This could equally be a prospectus for ambitious parent crabs interested in genetically engineering super-offspring. It certainly suggests that biomimetics is worth applying to crime-resistant design.

New technology can bypass trade-offs that have long put a brake on further improvements. In war, the trade-off between armour and mobility used to mean a stark choice between heavy castles and sluggish mounted knights, versus lightly protected but agile infantry. Then along came the internal combustion engine, the trade-off relaxed and it was suddenly possible to have armour and mobility combined - in the form of the tank. Such a major leap in crime prevention could be achieved, say, by central locking for homes. The arrival of remote wireless control systems, cheap processors, effective encryption, reliable miniature actuators can together support the development of a package which can relax the trade-off between security and convenience - also illustrating the need in forecasting to take simultaneous account of multiple and interacting trends. More generally, the shift from natural human controls to physical and electromechanical ones, and now to local and Internet-embedded cyber-controls, has begun radically to change the nature of the security game given that the constraints of space, material and inertia no longer inevitably apply to offenders and preventers (Department of Trade and Industry 2004a, 2004b; Wall 2005).

New *principles*

We might assume that we could learn many entirely new principles from nature

to apply to crime prevention. After all, nature has had at least 600 million years, since the Cambrian explosion of life forms, to experiment with designs for defence against predation, parasitism and grazing. In fact, although the search continues, it has proved almost impossible to identify any strategy that human society, in its ingenuity, had not already reinvented. One might think, for example, that the principle of the lizard's detachable tail (used to divert and distract predators) was novel, but the police have already designed clip-on ties to prevent strangulation by criminals.

Running and avoiding arms races

What these other evolutionary struggles do teach, though, is something of far more strategic importance than isolated bright ideas, or even detailed engineering principles. They indicate how to run the arms race and even, perhaps, how to avoid it. Avoidance is important, of course, because of the wasted effort and adverse impact on other aspects of life.

Running arms races There will always be arms races to run in design and technology - preventers have to be faster, smarter, more resilient, more scientific and more systematic at innovation and deployment, than the opposition. Ekblom (1997,2002a) describes this process as gearing up against crime, which involves action at several levels:

- *Catching up* with existing crime problems that we cannot yet adequately control. Applying evidence of what we already know is cost-effective, innovating, evaluating to extend the evidence base and mainstreaming the successful innovations.
- *Spotting emergent crime problems* and new modus operand!, like new diseases, and nipping them in the bud.
- Setting up *learning paths* by systematically collecting information on the vulnerability of products and feeding it back to designers and manufacturers.
- Through *foresight* or *horizon-scanning* forecasts of technological and social change (as discussed above), anticipating new causes of crime and preventing or mitigating them; or at least making explicit the assumptions the design makes about future circumstances and thereby ensuring the designs are *robust* to a range of possible futures. Anticipating entirely new possibilities for prevention, and making them happen.
- Building innovative, *evolutionary capacity* (in this case) amongst designers by devising and extending frameworks such as Clarke's (1999) 1iot products', professional guidance for designers (Design Council 2003), and techniques like crime proofing or crime-impact statements, similar to environmental impact statements (Ekblom 2002c).
- Building similar capacity in *science and technology,* and alerting, motivating and empowering hard scientists to contribute to prevention (Ekblom 2005).

- Fostering *variety*. People, and especially officialdom, like norms and standards - but these equally appeal to offenders. If, for example, landlords fit similar locks on all the homes in a housing estate, it is often a case of 'crack one, and you've cracked them all'. Agricultural equivalents abound - like the crop monoculture where the entire harvest falls prey to an invading fungus. So standardization must be tempered by variety. (Imagine if burglars had to obtain, familiarize with and carry 20 different kinds of picklock.) Standards are necessary; however, those that foster variety and upgradeability are not rigid construction standards but performance standards. This flexible approach is, sensibly, adopted by institutions like the UK Loss Prevention Certification Board. They may have the added advantage of allowing *design freedom* - enabling designers to optimize trade-offs with other functional, aesthetic and marketing requirements, and discouraging them from *designing down* to meet bare minimum requirements which will probably lag behind offenders' capabilities. But even performance standards - like the '10-second delay in entry' to cars that 'police believe is sufficient to discourage spontaneous theft'[43] - are so far probably based on little hard evidence.

- Developing and applying an understanding of *durability* issues by distinguishing between those products which have a short and disposable lifecycle (and can thus be remedially redesigned at point of production, as with mobile phones), and those with a longer existence (as with cars, trains or buildings, where inherent vulnerability can leave an enduring legacy of crime - but which can be adapted during their post-production lifetime).

- Related to the last, and to foresight above, *future-proofing* product designs by specifically making them adaptable and *upgradeable.* Imagine being left with a complex, costly and now obsolete security system that thieves have learnt to bypass, and that is impossible to update further. This is reminiscent of the biological concept of 'phylogenetic constraint' - highly specialized species often become extinct because they head too far down an evolutionary blind alley. Although superbly adapted now, when conditions change they cannot back out and advance along a different path. It may even be necessary to develop a succession of preventive measures in the pipeline, as do the banks and credit-card institutions, and the satellite TV companies. New ones can be swung into action as soon as offenders learn to defeat the old ones.

- As an alternative, encouraging the facility for designers to undertake 'turnabouts' in finding radical new solutions to replace those already 'done to death' in one direction.

Avoiding arms races? The contest between crabs and seashells described above only took off on one coast of North America. On the other coast, close-relative species have only modest claws and shells. Why the difference? Biologists are still arguing, but the answer will be worth knowing. Overuse of our most powerful antibiotics merely forces bacteria to evolve immunity, whereas restrained application and quite mild doses may paradoxically put a sufficient brake on infection to enable the immune system to overcome

them, without triggering a new evolutionary spiral. On the crime side, some electronic service providers decided *not* to go for state-of-the-art encryption systems for fear of provoking hackers into technological breakthroughs of their own. There are concerns (if no hard evidence yet) that effective security systems on cars and financial systems have precipitated a move from stealthy theft towards 'social engineering' including obtaining codes by deceit or even confrontational methods such as 'carjacking', where the human operator, who knows the security system, is taken along with the vehicle.

Tenner (1996) makes a general case for using low-intensity approaches to solving human problems, because high-intensity ones inevitably 'bite back' with unforeseen consequences. For the same reason Wortley (1996) argues for greater use of 'soft' approaches in situational prevention - involving the awakening of shame and guilt as much as hardening against attack. The aesthetics and semiotics side of product design could perhaps be turned to advantage here to signal emotion and personalized value (who would want to buy a stolen iPod with someone else's family photos embedded in the case?).[44]

The 'system failure' analysis of Chapman (2004) makes a related, but wider, point about the difficulties of influencing 'complex adaptive systems' (Bullock and Cliff 2004) - a whole ecosystem of adapting, adjusting and calculating agents who react to the policy-maker's or practitioner's attempt to move things in a certain desired direction. (A familiar example is the counterproductive effects of setting targets for hospital waiting lists.) Living with displacement and the longer-term forms of adaptation such as arms races requires, as Chapman would put it, a systems approach whereby our attempts to control (in this case) crime must be guided by an understanding of how the various agents and roles (preventers, offenders, crime promoters, victims) pursue goals of their own, perceive and handle risks, incentives, etc., interact and co-evolve. Obviously, this sets the pursuit of DAC through resistant products in a far wider and more demanding context than the above discussion of 'climate setting' implied, and warns us off reliance on any kind of 'design determinism' equivalent to architectural determinism (see Chapter 9, this volume).

To return to biological parallels, co-evolution between predator and prey, or grazer and grazed, has been likened to the Red Queen's Game, from *Alice through the Looking Glass* ~ you have to keep running just to stay on the same spot. Applied to crime prevention, we could take this to mean that coming up with new preventive measures is ultimately futile because, in time, criminals will inevitably find a way to defeat them. At the *tactical* level DAC and other situational prevention approaches are undoubtedly a wasting asset. Nevertheless, they cannot be abandoned. The long term can only ever be influenced via a succession of actions in the short term provided they are intelligently concerted. Viewed *strategically,* crime control is *not* about individual innovations and their sometimes limited shelf life; it *is* about maintaining a dynamic imbalance between creativity and innovation by preventers and that by offenders. To take a military parallel, in World War Two the Allies chose to deploy a particular radio navigation system for bombers, despite knowing that in six months the enemy would work out how it operated and develop countermeasures. The system was considered worth while because it bought

time before a successor was needed. Finally, natural limits on arms races are imposed by trade-offs - cheetahs cannot get any lighter and thus faster, or they become too weak to defend their bloody prize from hyenas; trees competing for light hit a height limit imposed by the physics of water columns.

Conclusion

Designing products against crime is a topic, the study and practice of which lets us view the familiar with fresh eyes. It also leads us into unfamiliar territory. Design against crime as a whole (including movable products plus environments, interiors, systems and messages) is simultaneously a relatively narrow domain of intervention within situational crime prevention, and a broad approach that can contribute to every kind of intervention and indeed to every stage of the preventive process.

Exploring the narrower domain of DAC *interventions* suggests that they can never be the complete answer to crime (although hard evidence either way is sorely needed). Implementation, too, is a major issue - how to get producers and users alerted, motivated and empowered to make the crime-resistant choice, and to realize it well. However, DAC is likely to continue to make major contributions within situational prevention, reducing all kinds of crime in ways which complement place management or offender-oriented interventions. The boundaries of its competence will surely undergo some drastic shifts as new technology and, especially, inbuilt or ambient, web-based intelligence increasingly make their presence felt in everyday products and the systems and places they are .embedded in.

Exploring the wider territory of *design as process* has revealed interesting and challenging lessons for developing the *creativity* that needs to be exercised within crime prevention as a whole, and understanding the related strategic importance of *innovation, adaptability* and *foresight.*

Acknowledgements

I am grateful to Dr Lorraine Gamman, Marcus Willcocks, Prof. Rachel Cooper, Dr Caroline Davey and Prof. Nick Tilley for helpful comments and information.

Selected further reading

Literature in this new field is rather sparse. All publications described are cited in the references for this chapter. A good contemporary set of readings covering product design against crime and how to implement it is *Designing out Crime from Products and Systems* by Clarke and Newman (in press c). Gamman and Pascoe (2004a) have edited, and contributed to 'Seeing is Believing', a recent special issue of *Crime Prevention and Community Safety Journal* with an emphasis on visual communication and design process. An older overview of mine which bridges product and environmental design is 'Less crime, by design' (1995). An illustrated overview with the same title is www.e-

doca.net/Resources/Lectures/Less%20Crime%20by%20Design.htm. Ken Pease's (2001) gallop round the field for the Design Council, *Cracking Crime through Design,* is a good and pleasurable way of acquiring the flavour of the field. 'Classic' studies in this area are Ron Clarke's (1999) *Hot Products* and Southall and Ekblom's (1985) *Designing for Vehicle Security: Towards a Crime Free Car*. Research on the state of DAC in the UK by the consortium funded by the Crime Reduction Programme through the Design Council (Cambridge, Sheffield Hallam and Salford universities) provides an authoritative view of DAC issues in a range of industrial and educational sectors covering both product and environmental design. It is downloadable from www.shu.ac.uk/schools/cs/cri/adrc/dac/designagainstcrimereport.pdf.

As part of a follow-up 'how to do' package the Design Council (2003), drawing on the same team, produced *Think Thief. A Designer's Guide to Designing out Crime.* This is at www.designcouncil.org.uk/resources/assets/assets/pdf/Publications/Think%20Thief.pdf. Some accompanying case studies are at www.designcouncil.org.uk/webdav/servlet/XRM?Page/@id=6016&Session/@id=D_5tNN7DzIbDAh8FVsL8C5&Document/@id=1250.

Contemporary websites on DAC include that of Central St Martin's College of Art and Design (www.designagainstcrime.com) and www.designagainstcrime.org - the Design Policy Partnership involving members of the team that produced the original Design Council studies and material.

Futures-oriented works in this field include *Turning the Corner*, the Report of the UK Foresight Programme's Crime Prevention Panel (Department of Trade and Industry 2000) (downloadable from www.foresight.gov.uk/previous_rounds/foresight_1999__2002/crime_prevention/reports/index.html). Some specifically design-related reports are available from the same location. My own futures papers include 'Gearing up against crime: a dynamic framework to help designers keep up with the adaptive criminal in a changing world' (1997), 'Can we make crime prevention adaptive by learning from other evolutionary struggles?' (1999) and 'How to police the future: scanning for scientific and technological innovations which generate potential threats and opportunities in crime, policing and crime reduction' (2005).

Notes

1. Principally the *Design Council Report* (Design Council 2000), summarized in Learmont (in press) and www.foresight.gov.uk /previous_rounds/foresight_1999__2002/crime_prevention/reports/index.html. A number of these, plus some independently initiated studies, are summarized in Clarke and Newman (in press c). Other relevant work appears in Gamman and Pascoe (2004a) and, with a more technological flavour, Lester (2001).
2. Ekblom (2001b); further examples from the Royal Society of Arts Student Design Awards at www.rsa-design.net/sda/oe2003/20.htm and www.rsa-design.net/directions/2003-04/exh/awards.htm; Central St Martins' DAC Initiative www.designagainstcrime.com; and Design Council case studies at www.shu.ac.uk/schools/cs/cri/adrc/dac/casbrw.html.
3. See Ekblom (in preparation) on a wider understanding of the offender in situational prevention.
4. Further work is required explicitly to incorporate Wortley's precipitating factors.
5. Fuller statements of all these definitions are in Ekblom (2001a, 2002a, 2004a).
6. A creative crime preventive example was one entry to the Royal Society of Arts' Student Design Award, which disguised the real openings in a rucksack with false ones revealing apparent dirty underwear, etc.

7. A Council of Europe working group advocated a design approach to establishing crime prevention partnerships (Ekblom 2004a), and even *laws* can be considered the products of design, especially since they are shaped with the intention of coping with a range of future, potentially criminal, events whilst respecting a series of constraints on reasonableness, quality of evidence, etc.
8. As in 'architectural determinism', the simplistic and exclusive attribution of causation to architectural features, as opposed to taking simultaneous account of social factors - see Chapter 9, this volume.
9. Security *components* such as locks for incorporating in otherwise insecure products, however, blur the distinction - although this remains useful as a conceptual axis.
10. See Ekblom (2001b) and http://news.bbc.co.Uk/l/hi/business/4101391.srm.
11. Gamman and Pascoe (2004c); see also www.designagainstcrime.com/researchprojects.
12. The Chipping of Goods initiative (www.chippingofgoods.org.uk) piloted the use of RF chips to protect products right through the supply chain. Bryson (1994) notes an earlier, more modest, example. In the nineteenth century prices began to be set at, say, $5.99, less to convince customers they were cheaper than they really were, and more to require sales staff to give change. Therefore they opened the new-fangled cash registers and by the resultant 'ptng" alerted the manager to the transaction. This would reduce the opportunity for them to pocket the money themselves. Thanks to Mike Sutton for this example.
13. For an authoritative review, see the Cyber Trust and Crime Prevention project website at www.foresight.gov.uk/Cyber_Trust_and_Crime_Prevention/index.html.
14. One over-used term in siruational prevention is *target-hardening*. The target in question has come to include both targets and target enclosures, and inherent and added-on security.
15. Cf. Cohen and Felson's (1979) 'VTVA' concept, incorporating inertia as a theft-reducing feature of products.
16. Flat-screen technology is changing that - in future, displays could perhaps be rolled up and carried off under the arm. But even large and heavy products such as central heating boilers or antique fireplaces may be carted off if their value is high enough and demand is sufficient. Reliance on such natural security features would then have to be supplanted by deliberately designed-in ones.
17. As Pease (2001) notes, the move from chemical to digital photography removes the employee-based surveillance from photographic development services which once kept some paedophilic activities in check.
18. And see also 'user-centred' approaches to design as illustrated on the Design Council website at www.designcouncil.org.uk/webdav/servlet/XRM7Page/@id=6046&Session/@id=D_xFxoe61LlpNBvSoWwa8f&Document/@id=1109 (or search the site on 'user centred').
19. It is worth pointing out that *the* problem (i.e. the crime to be tackled) is not the only problem to be solved through application of design and creativity - every stage of the preventive process requires solving a succession of ever more tactical problems.
20. Advances in materials science may even mean that designers can specify materials with desired sets of properties (e.g. meeting weight v. toughness trade-offs). But as with POA, deviations often occur from this ideal process. For example, many a solution has been devised before looking for an application to meet, demand to satisfy or problem to solve. A classic case was the 'Post-it' note which was inspired by the desire to exploit a weak adhesive that had been unintentionally invented, and went on to demonstrate the power of 'latent demand' (i.e. that which people didn't

know they wanted until they were shown the product). Whilst in the POA world, such solution-led success is likely to be far outweighed by solution-led oblivion, in the technological end of DAC particularly, the whole field of industrial innovation is more evenly balanced between which leads - scientific discoveries, new technologies and new applications or carefully researched requirements. Whether there are any transferable 'process' lessons for POA on *haw* to start successfully from solutions is not certain, but this is important to follow up given the stream of new technologies becoming available. Criminals are surely scrutinizing these as potential resources for offending; crime preventers need a trained mind (with a stock of problems awaiting solutions at the back of their thoughts) to see the promise for prevention without getting seduced by the technology (cf. Ekblom 2005).

21. See Ekblom (2000) for an earlier discussion of crime control, etc.
22. Here, there are some links with the concept of primary, secondary and tertiary safety (World Health Organization 2004) - respectively prevent the event occurring; if it nevertheless happens, stop it and limit the harm; and stop it happening again.
23. Not all hot items are products - raw materials such as precious metals, or even rare and exotic animals and their products such as ivory can unfortunately be popular with criminals, with far less risk than dealing drugs.
24. See also www.arts.ac.uk/research/dac/web/techniques.htm.
25. See note 2.
26. The worst offenders in this respect are often those in 'social' crime prevention who sometimes can go no further than describing their intervention as 'working with young people'.
27. Detailed exploration of this fascinating but frustrating issue is not for this chapter. But I suggest that neuropsychological studies of how the brain generates thoughts are relevant and increasingly feasible, and the related evolutionary approaches to the generation and selection of ideas (cf. Blackmore 1999; Aunger 2000; Ekblom 2002a) can yield practical applications. To take a specific illustration, Lawson neglects what it is that helps designers generate good ideas (as an extreme example, Mozart generated streams of music that were brilliant first time and needed little revision - and lesser humans effortlessly utter streams of largely perfect grammatical sentences albeit not quite to the same high standard). Nor does he mention the competitive or selective processes that filter out less promising alternative solutions, or the 'prepared mind' that spots, and seizes upon promising solutions and lifts them out of the contest, refines them and repeats the generative process. This natural human process has been emulated in the 'artificial selection' embodied in genetic algorithms.
28. See Hapgood (1993) and Ekblom (2002a) on the generative role of a theory-based 'engineering science'.
29. If all designs are possible, and all equally valid, one could argue that what is being done is not design but random composition.
30. But even fortress design can be subtle. Designers of castles ensured the spiral stairs wind clockwise upwards, to force the attackers to use their left hands and enable defenders, coming down, to wield their swords in their right (equivalent attempts to incorporate asymmetry in castle design are seen in Japan, where many castle steps are set at 1.5 paces to hinder attackers coming up whilst offering no problem to defenders, running down with the aid of gravity; and where wooden 'nightingale floors' squeak to betray tiptoeing assassins). Englishmen's homes were built like castles, too - uneven burglar steps' were also apparently incorporated to trip intruders in the dark.
31. See note 2.

32. Unfortunately for crime prevention, even houses are often now mass produced, with only surface reconfiguration to meet local stylistic requirements - see the *Design Council Report* (2000).
33. Theprirtcipalactivitiesareviewableatwww.designcouncil.org.uk/webdav/servlet/XRM?Page/@id=6016&Session/@id=D_5tNN7DzIbDAh8FVsL8C5&Document/@id=1250, www.designagainstcrime.com/, www.rsa-design.net.
34. Note that *designers* and industriaj colleagues themselves Implement crime-resistant design interventions through manufacture, marketing, etc., whilst the government's task is to Involve these designers, and design decision-makers, through the CLAMED process, mobilizing them to act as crime preventers.
35. Sir John Stevens and Nick Ross (2000) memorably described mobile phone providers as 'pimping for crime'. A more radical view of the problematic nature of arriving at mutually agreed understandings of crime, and responsibility for dealing with it, is supplied by Vaughan (2004).
36. At Central St Martin's College, evaluated by the Jill Dando Institute.
37. An extreme counter-example is where manufacturers get more benefit from replacement sales of stolen products than they could from selling more secure versions.
38. For further historical examples, see Ekblom (1995, 2001a).
39. See www.thatcham.org/html/mspages/security/securmain.htm and *Design Council Report* (2000).
40. www.policereform.gov.uk/implementation/scienceandtech.html.
41. There are factors which make co-evolution a 'snakes and ladders' game. Besides the disturbances of new technology, changes in business models have design implications. The design of the traditional shop had reached a pinnacle of optimization between preventing shoplifting and facilitating trade (Ekblom 1997); the arrival of the supermarket overturned this and required the evolution of a new equilibrium. The cycle of fashion and style, and the detachment of form from function referred to above, also serve to attenuate the steady accumulation of permanently valid knowledge in the form of an ever more crime-resistant design - except, of course, at the level of generic principles and combinatorial elements. Further discussion of the 'evolutionary epistemology' of good practice and good design in crime prevention is in Ekblom (2002a).
42. Rather like the 'life:dinner' asymmetry between the consequences of encounters between prey and predator. The selective pressure is greater on the prey, which loses its life if it is unsuccessful, than on the predator, which only loses its dinner if it fails.
43. See www.solutia-autoglass.com/documents/pdfs/99IBECG-l.pdf.
44. Respecting troublesome trade-offs, note that deliberately spoiling the second-hand value of products goes against attempts to increase sustainability.

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