Designing products against crime

Paul Ekblom[1]

Ekblom, P. (2017). 'Designing products against crime' in R. Wortley and M. Townsley (Eds.), *Environmental Criminology and Crime Analysis, 2nd Edition*. London: Taylor and Francis.

INTRODUCTION

Consider these examples of 'bad' crime preventive design:

- Distinctive earphones telling criminals 'here's an expensive music player'
- The player itself having little inbuilt security so it will play promiscuously for anyone who possesses it, legitimate or otherwise
- Frustrating-to-use ticket machines that provoke retaliatory vandalism
- Syringes which can be re-used, cross-infecting drug addicts
- A range of banknotes whose denominations look so similar that people unfamiliar with them can easily be short-changed

Consider, too, these 'good' designs from Central Saint Martins and University of Technology Sydney:

- The 'Karrysafe' bag range (Gamman and Hughes 2003) including this handbag (Figure 1), designed to look stylish whilst resisting perpetrator techniques including slashing (by anti-rip material), grabbing (by reinforced handle) and 'dipping' (by replacing the normal closure with a Velcro roll-top, which requires two hands to open, makes a noise when doing so, and indicates unambiguous criminal intent)
- The 'Stop Thief' café chair (Figure 1), following a classic style, with notches cut to enable bags to be secured beneath the knees, 'locked' in place by the user's legs, located where thieves find it risky to reach and users will be alert.
- The 'Puma Bike' (Figure 2) folding bicycle whose down-tube is replaced by a tensioned steel cable, which can be unlocked and passed round a stand to secure the bike; cutting the cable to release the bike destroys the bike's integrity and hence its use or resale value.

[1] p.ekblom@csm.arts.ac.uk Professor of Design Against Crime, Central Saint Martins, University of the Arts London.

- The ‘CaMden’ bicycle stand (Figure 3) that leads people to lock their bikes to it in a known-to-be secure way, i.e. with both wheels and the frame attached so the bike frame cannot be used as a tool to lever the lock apart.
- The ‘Grippa’ clip (Figure 4), for securing bags to bar tables, designed to match bar décor, and easy and safe to use for customers, hard to release for thieves.
- The counterterrorism trash bin (Figure 5) (Lulham et al. 2012) which not only reduces the opportunity for inserting and concealing bombs but makes false alarms less likely and easer to resolve, an important everyday consideration for the railway company that commissioned it.

Figure 1

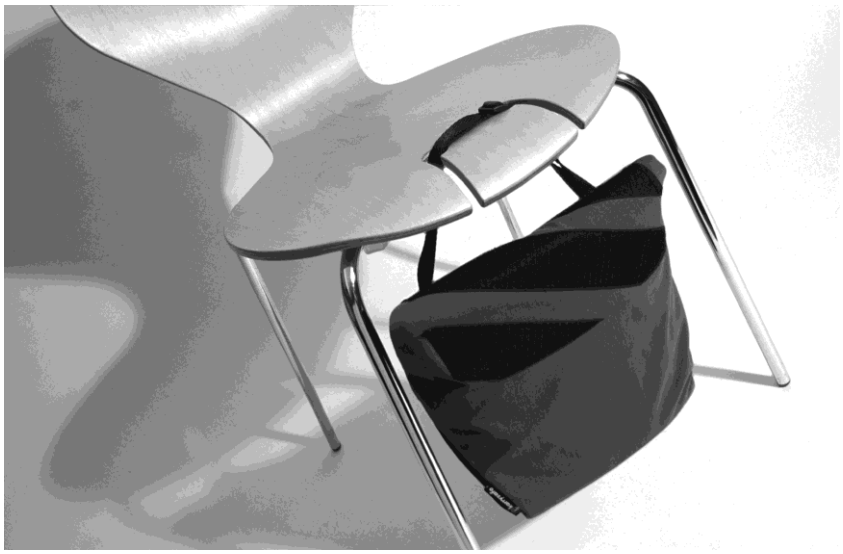

Figure 2

Figure 3

Figure 4

Figure 5 (UTS)

Further case-studies are at www.designcouncil.org.uk/resources/case-study/design-out-crime. Bad designs can sometimes lead to good – vehicle security greatly improved from about 1990 and vehicle crime markedly fell (Webb 2005), though clouds are gathering again as will be seen. In both good and bad instances, of course, the design is not the only contributor to raised or lowered crime risk, but interacts with other influences, like the kinds of place where it is exposed to crime hazards, and the behaviour of the products' owners. One-dimensional 'Design determinism' is invalid.

Design Against Crime (DAC, also known as designing out crime) uses the tools, processes and products of design to work in partnership with agencies, companies, individuals and communities to prevent all kinds of criminal events – including antisocial behaviour, drug abuse/dealing and terrorism – and to promote quality of life and sustainable living through enhanced community safety**.** It does so through designs that are 'fit for purpose' and contextually appropriate.

The term 'products' can encompass 'anything that has been designed' – places, systems, procedures, services, communications etc. This chapter however focuses on the design of 'movable' or freestanding items in two dimensions (like banknotes or street signs) or three (e.g. cellphones or handbags/purses).

The review begins with history. The next part discusses the nature of design; the following one covers the role of products in crime, risk factors identifying which products feature in crime, and how product design can prevent crime. The part after reviews some challenges posed by design against crime: how to make the *designs* work and keep working in diverse contexts and changing circumstances; and how to make the *designers* (and the design decision-makers who call the tune) work on DAC in terms of their awareness, motivation and capacity. A brief review of impact considerations precedes the conclusion.

This chapter mentions various practice-oriented conceptual frameworks. Information on many of these is at www.designagainstcrime.com/methodology-resources/crime-frameworks/#forms-of-knowledge; also http://5isframework.wordpress.com. Specific angles on product design are covered in Ekblom (2012a) on the private sector; Ekblom (2012b) on the relationship with situational crime prevention; Ekblom (2014a) on security; Ekblom and Pease (2014) on innovation; and Ekblom (in press) on technology. Edited collections on product design and crime are by Clarke and Newman (2005) and Ekblom (2012c).

History Ancient and Modern

Designing products against crime has a long history closely intertwined with technological progress and commodity prices – well-illustrated by the evolution of money. Shortly after the Greeks introduced silver coinage in c600 BC, someone produced a silver-plated bronze forgery (James and Thorpe 1994). The anti-counterfeit design feature of cryptic micro-marks on coins is of equal antiquity. The potential harm from undermining the currency, for example by clipping the edge from hammered silver coins, provoked harsh punishment. However, technological/design interventions like milled edges had greater impact (Sir Isaac Newton, as Master of the Mint, simultaneously pursued counterfeiters relentlessly whilst introducing the new designs, thereby undertaking both offender-oriented and situational prevention). Interestingly, monetary design has long incorporated self-evident 'help-the-user' security features culminating in today's foil strips besides arcane 'help-the-bank' ones.

Changes in material composition have also made coins more secure – silver was removed to repay British wartime debts to the USA; inflation removed much of the remaining symbolic value relative to the risk, cost and effort of counterfeiting. However, as commodity prices fluctuate, even bronze coins' intrinsic value can outstrip their symbolic value making them targets for melting down in their turn – increases in copper prices (Sidebottom et al. 2014) have seen recent UK pennies stick to magnets due to incorporation of a cheaper iron core.

Other historically 'hot' products have included jewellery and clothing, motor vehicles and more recently, consumer electronics and fast-moving consumer goods (Gill and Clarke 2012). Like legitimate demand, criminal demand follows fashion (there is even a clothing brand called Criminal, doubtless sought by wearers of Police sunglasses). This applies to phones as much as to fancy trainers. Both legitimate and criminal demand for a new product peak, then diminish with market saturation when everyone owns one (Felson 1997; Pease 2001) – until, that is, fashion-changes revive both by imparting artificial scarcity value to the latest model. This serves neither security nor sustainability.

Preventing vehicle crime through design has come far since early ordinances required drivers to leave cars unlocked should they have to be moved. Specific interventions on steering column locks (Mayhew et al. 1976) and speculative ideas on 'crime-free cars' (Ekblom 1979) led in the UK to research on the practicalities of mass-market vehicle security (Southall and Ekblom 1985) and, on the motivational side, through publication of a car theft index (Houghton 1992): naming and shaming lax manufacturers whilst awakening and guiding consumer choice. To this was added pressure from insurers who increased premiums for insecure models.

More strategic interest in designing products against crime lagged behind the emergence of the place-oriented Crime Prevention Through Environmental Design. That changed in the late 1990s in the UK at least, with initiatives under the national Crime Reduction Programme. These included research into the state of design against crime (Design Council 2000), and case studies and guidance building on that (e.g. www.designcouncil.org.uk/resources/case-study/design-out-crime; student design competitions through the Royal Society of Arts; and an interest in products in the UK Foresight Programme's Crime Prevention Panel (Department of Trade and Industry 2000).

Around the same time Clarke (1999) published the seminal 'hot products' concept (described below) identifying types of item at greatest risk of theft. However, strategic UK work on product design was halted soon after, as government funds were diverted to control a street crime panic. Ironically, although the crime wave was heightened by insecure product and system design of cellphones, the solution the government came up with was an expensive and unsustainable boost of police overtime.

Research on cell phone vulnerability and security nevertheless continued in the UK (Harrington and Mayhew 2001), USA (Clarke et al. 2001); and Australia on product design more generally (Lester 2001). And 'practice-led' design studies began to emerge in the UK under an initiative led by Lorraine Gamman at Central Saint Martins. The European Commission, which had introduced a directive requiring compulsory factory-fitted vehicle immobilizers from 1998, showed renewed interest in 'crime proofing' of domestic electronic products (e.g. music players), funding Project MARC (Armitage 2012) to pursue an approach to security rating suggested by Clarke and Newman (2005a). The UK Home Office incorporated DAC within its national crime reduction/safety strategy (Home Office 2007:33-37) and at the same time inaugurated a Design and Technology Alliance involving the UK Design Council, designers, industrialists and academics, to take this forward. Sadly, financial stringency meant this promising avenue was not fully followed through.

UK design against crime research is now supported by individual Research Council awards on a project-by-project basis and there is a fairly active commercial sector developing dedicated security products (e.g. www.itsminetechnology.com); but no sustained and coordinated effort. More happily, in 2007 in Australia, the Designing Out Crime Research Centre (www.designingoutcrime.com) was founded with funding from the New South Wales state government, which continues to this day.

Products and Crime – the Future

Various trends in product design and technology may well influence criminal opportunity (for the dimensions of opportunity, see the Conjunction of Criminal Opportunity discussed below; and Ekblom 2002 for its 'futures' application).

- Shifting of value from outright ownership of products to leasing of serviced products may cause further changes in the role of products in crime, whether an outright reduction or a link to identity and service theft.
- The 'Internet of Things' (microchips embedded in any product for purposes of control, tracking or identification plus wireless connection to the internet for access to services, upgrades etc.), offer enormous scope for 'piggybacking' security functions at little manufacturing cost, much as immobilizer functions have hitched a ride in vehicle engine management computers. But they also enable new perpetrator techniques –access to vehicles' computer systems is increasingly facilitated by vehicle-to-vehicle wireless communication for collision avoidance and convoy control (Brown (2013a).
- More generally a blurring of the distinction between products, places, people and systems is occurring with various combinations of wireless connection, even wearable connections and networks.
- Another trend with crime implications is 'mass-customising', where products are personalized via computer-controlled manufacture. Which thief would risk being caught with someone else's personalized products when frisked by police? Who would want to buy a stolen phone with someone else's partner's picture indelibly embedded in it?
- 3D printing enables criminals to construct their own weapons, e.g. (theoretically functional) guns; and tools, e.g. realistic and well-fitting card-skimming mouthpieces stuck onto ATMs to support fraud.
- Drones offer scope for anonymous hostile reconnaissance and drug or bomb delivery.
- Who knows where Artificial Intelligence may lead?

DESIGN FUNDAMENTALS

What is Design?

The scope of design is enormous, potentially embracing all human productive and artistic activity in every medium. Focusing on the applied side, design is a generic *process* of creating some new or improved product which:

- Is materially possible to make (e.g. it doesn't fall apart, obeys the laws of science and respects the properties of its constituent materials)
- Is fit, or fitter than predecessors, for some specified primary purpose

- Does not significantly interfere with other purposes or with wider requirements of social and economic life and the environment

This broad definition (adapted from Booch 1993) embraces enormous variety among processes or approaches to design. At one end of the scale, we could envisage someone jamming a nail into a window frame to hastily secure it; at the other, a complex and sophisticated vehicle immobilizer system developed over years by large and heavily-coordinated professional teams.

The *purpose* of the designed product can vary from utilitarian to aesthetic and the conveyance of image, lifestyle and value. Playful and subversive designs are also possible. For example, one entry to the Royal Society of Arts' Student Design Award, disguised the real openings in a rucksack with false, and deterrent, ones revealing apparent dirty underwear. The classic principle of 'form following function' can at times be supplanted by 'form following emotion'. In crime, of course, emotions are not always positive, hence (using Wortley's (this volume) two-stage 'precipitation' model of situational prevention) a poster may provoke vandalism, or a knife prompt aggression.

Broadening Horizons – Drawing on Design in the Crime Preventive Process

Previously designers have been urged to *'think thief'* about their products (Ekblom 1997). The emphasis here is more on encouraging crime prevention practitioners, and students of prevention, to *'draw on design'* both practically and conceptually. Mapping out the nature and diversity of design is important, too, because crime preventers often have quite limited assumptions about what design means. Many will be familiar with the built-environment interventions advocated by the CPTED (Crime Prevention Through Environmental Design) movement, and with the design of locks and other security fittings. Both of these demonstrate the obvious relationship between DAC and Situational Crime Prevention. However, DAC is far more than a set of products or buildings, important though they are. Understanding and applying the design *process*, the designer's way of capturing requirements and formulating and solving problems, can greatly benefit all crime prevention practitioners. The Design Council offers a useful process model, the 'Double Diamond' www.designcouncil.org.uk/sites/default/files/asset/document/ElevenLessons_Design_Council%20(2).pdf: Discover, Define, Develop and Deliver (a crime version www.designcouncil.org.uk/sites/default/files/asset/document/designersGuide_digital_0_0.pdf adds a third diamond namely Deploy and Digest.). There is affinity with the problem-oriented process models of crime prevention namely SARA and 5Is (in fact, the latter was itself deliberately specified and designed, to handle complexity as Ekblom 2011 describes).

Techniques to aid the design process range from developing 'criminal personas' – typical types of abuser (Hilton and Irons 2006), to visualisation (Gamman and Pascoe 2004), to role play and empathy (Gamman et al. 2012). The Counter-terrorist trash bin (Figure 5 and Lulham et al. 2012) illustrated another, strategic, design technique – reframing. What was presented to the designers by the rail company as a problem of limiting harm from terrorist bombs turned out, on further interrogation of the clients, that a much more routine and practically significant problem was false alarms and consequent delays. The designers then worked with the clients to reframe the problem and a substantially more beneficial outcome was delivered that handled the risks of both rare/severe events, and frequent/disruptive and costly ones. This suggests lessons for the problem-oriented approach to prevention. A useful account of the distinctiveness of design-based 'abductive' problem-solving is in Dorst (2015).

PRODUCTS AND CRIME

How Products Feature in Crime

Unsurprisingly, products can feature in crime in myriad ways. Practical approaches must be systematic. Two linked frameworks can aid this. The Conjunction of Criminal Opportunity, a more detailed equivalent of the Problem Analysis Triangle (Clarke and Eck 2003, see also Scott et al, this volume), can be used to define the broad types of role products play in causing criminal events. Products can be:

- Targets
- Target enclosures (e.g. houses, cars, containers, packaging (Segato 2012) or handbags)
- Environments (with products, e.g. the designed interior of trains, bus shelters or phone boxes)
- Resources for offending (e.g. tools, weapons – see Ekblom and Tilley 2000; Gill 2005), equivalent to 'facilitators' (Clarke and Eck 2003).

The 'Misdeeds and Security' framework (Ekblom 2005) describes how products feature as object, subject, tool or setting for particular *kinds* of criminal behaviour:

- Misappropriated (products are stolen for themselves, their parts or materials)
- Mistreated (products are damaged, destroyed, or their security function disabled)
- Mishandled (products are sold after being stolen, or smuggled)
- Misbegotten (products are counterfeited or copied)
- Misused (products are malevolently employed as tools, weapons or facilitators for crime)

- Misbehaved with (products are used in the course of antisocial behaviour e.g. spray cans for graffiti, metal street furniture for making noise)

Criminal Misuse or Misbehaviour could implicate cordless drills as a tools for burglary, cellphones for drug-dealing or illicitly photographing young swimmers, laser pointers as weapons, aerosol paint cans spraying graffiti on walls, computer applications controlling re-chipping of stolen phones, fake jewellery as props in confidence tricks. Some products are heavily implicated in crime. Formally combining the frameworks enables us to organize what we know and (by providing boxes to fill) anticipate new risks. Table 1 shows combined analysis of the roles played by motor vehicles.

Table 1. The motor vehicle as criminogenic product

Nature of crime risk to motor vehicle and its human/material contents (from Misdeeds and Security framework)	**Motor vehicle as causal ingredient of crime (from Conjunction of Criminal Opportunity framework)**			
	Target of crime	Target enclosure	Environment of crime	Resource/facilitator for crime
Misappropriation	Theft of car for resale	Theft from car	Pickpocketing in bus	Theft of car for misuse/misbehaviour
Mistreatment	Vandalized car	Damage to achieve entry; assassination of passengers	Assault/sexual assault in bus	Damage during misuse
Misuse	See 'Resource' >	See 'Resource' >	See 'Resource' >	Getaway car, ram-raiding, drug dealing, car bomb
Mishandling	'Ringing' of car identity, smuggling,	Delivery scams, falsifying weight of load carried by truck	Car burnt out to destroy DNA evidence	Avoidance of paying speeding fines etc by cloned number plate
Misbegetting	Counterfeit spares	Forged packaging of spares	Fake number plates to confuse pursuers	Cloned car key
Misbehaviour	Obscene messages in dirt on vehicle paintwork	Illegal use of cellphone when driving	Rowdy behaviour/ consumption of drugs in taxi	Joyriding, speeding, drink driving

Risk Factors – Which Products Feature in Crime?

Not all classes of product are at equal risk of involvement in crime. Domestic consumer electronics items are at greater risk than 'white goods' (washing machines etc.). Likewise within a single class, not all makes and models are at equal risk, as Houghton

(1992) revealed. The 'classic' risk factor approach within situational prevention is Clarke's (1999) 'hot products'. According to this model, based on a mix of statistical and theoretical analysis, the risk of *theft* is raised if the product is CRAVED:

- Concealable (by the offender)
- Removable
- Available (many such targets in accessible places)
- Valuable
- Enjoyable and
- Disposable (via resale)

The best exemplar of a CRAVED product is the cell phone.

The value of CRAVED is in guiding the targeting of preventive effort: it is only reasonable to ask manufacturers to build additional security into a particular new product if it is likely, on sound research grounds, to be at high risk of theft. A recent study (Armitage 2012) sought to incorporate CRAVED into a practical system of crime proofing. The aim, following proposals by Clarke and Newman (2005a), was to encourage manufacturers of domestic electronic products judged at high risk of theft, to design them with commensurately high security. Various difficulties were encountered however, especially in development of a security rating system. Ekblom and Sidebottom (2008) attempted to learn from these experiences by evolving a wider suite of definitions of risk and security, and a range of different discourses (e.g. technical, mechanistic, functional). They also drew on Cornish's concept of *crime scripts* (Cornish and Leclerc, this volume) to argue that designers need to consider the different risks to the product at different stages of the theft process (seek, see, take, escape, realise value). As Ekblom and Gill (2015) also note, while concealability of a cell phone at the escape stage aids the thief, the same property at the seek/see stages helps the legitimate owner, who doesn't want the thief to spot it. Product design must envisage, and address, the whole sequence and any such design conflicts within it (indeed, the cells of Table 1 above could be further cross-cut with the stages of appropriate scripts). Also with cell phones, Whitehead et al. (2008) have gone further to identify *protective* factors in their design under the acronym IN SAFE HANDS.

How Does it Work? How Product Design Can Prevent Crime

Product security uses design and technology to reduce the risk of criminal events. Risk divides into *possibility* (the class of malign event to be avoided), *probability* of such events, and various kinds of *harm* from those events to the product, the owner or others (see *crime frameworks*). The focus here is on probability, although knock-on

consequences can also be considered (for example, phones which can be remotely wiped after being stolen, to reduce possible identity theft, or automatic cloud-based backups to mitigate data loss from laptop theft).

Reducing the probability of crime by product design may work either by making the products objectively harder, riskier or less rewarding for the offender to exploit, or making them *perceived* as such by the offender – this is standard situational prevention (for a more comprehensive and subtle alternative account of crime preventive mechanisms acting on the offender – the 'Ds' framework – see Ekblom and Hirschfield 2014). Obviously real resistance is the more durable alternative: offenders eventually detect any pretence. However, the 'semiotics' of design makes a significant additional contribution. Giving an objectively-resistant product a robust appearance can confer the additional advantage of deterring or discouraging criminal *attempts*, and any damage they may cause (Whitehead et al. 2008). Think also of the winking red light indicating, faintly menacingly, an armed vehicle alarm. This strategy is used in nature by wasps which supplement stings with warning coloration (Ekblom 1999; Felson 2006). Evolutionary psychology suggests images of *eyes* have a potent effect on would-be offenders (Nettle et al. 2012), though precisely what the mechanism/s are is so far unknown.

There are four broad ways of objectively securing products against crime: designing them to be inherently secure, adding on security products, securing the immediate situation in which other products/people are at risk, and making remote interventions.

Designing Inherently Secure Products

Products designed as inherently secure will incorporate specific 'security adaptations' – components, structural features or materials whose explicit purpose is to confer the security. Using the labels which are the 'Security' counterpart of 'Misdeeds', they may be:

- Secured against Misappropriation
    - Spatially fragmented – e.g. computers whose terminals are cheap with the main processing done in a secure or remote location; or in-car entertainment systems whose components are distributed throughout the vehicle requiring more time, effort and knowledge to extract as a saleable set.
    - Less distinctive, or 'prompting', targets at the 'seeking and seeing' stages of crime scripts, e.g. in-car entertainment systems that are camouflaged by a flap that descends when the vehicle is locked.
    - More distinctive to law enforcers at the 'using and selling' stages of crime scripts, countering the anonymity of mass production and increasing risk to

offender and secondary purchaser. Perhaps incorporating deliberately traceable features such as 'property marking' (Sutton et al. 2001). Advanced equivalents exist including incorporating multi-layered paint spots with unique, registered 'barcode' sequences into the material of the product.

    - Discriminating in allowing access to their value. This can include mechanical lockability, password operation, or intelligent systems that recognize they are not in the location they are meant to be, and shut down.
    - Building on the last example, actively enhancing risk to offenders, and aiding recovery of loot, by sending tracking signals or Internet messages to the owner.

- Safeguarded against Mistreatment
    - Non-provocative, e.g. street signs that avoid couching regulations in confrontational terms.
    - Physically resistant or resilient, such as laminated glass, street furniture that pops back into shape after being kicked in, or graffiti-resistant surfaces. Note that targets can be *softened* as well as hardened – many vehicle fuel caps, when locked, spin free of the screw-thread so no force can be applied.
- Scam-proofed against Mishandling
    - Indicative of loss or tampering. Examples include paint cans whose lids reveal they have been opened, by rupturing a thin membrane: this prevents them being returned, refilled with water, for refund (Design Council Case Studies).
    - Resistant to interception of information – e.g. fold-over airline baggage labels that conceal holidaymakers' addresses from professional burglars' touts lurking near airport queues.
    - Resistant to fraud. London Underground ticket machines used to let offenders insert a low-value 'slug' into the slot and eject a high-value coin in exchange. These were modified (Clarke 1997) to frustrate offenders so the last coin in became the first to be ejected. And official documents such as certificates of importation are made difficult to copy (Burrows and Ekblom 1986).
- Shielded against Misuse or Misbehaviour
    - Resistant: once-only syringes; beer glasses made from plastic that cannot be 'weaponized' (Design Council case studies); guns that fire only for the registered owner through a fingerprint scanner in the grip; colour photocopiers that refuse attempts to copy banknotes.
    - Indicative: food or medicine containers with sealed or pop-up lids, a design response to the infamous Tylenol painkiller case where poison was substituted for medicine (Clarke and Newman 2005b); emergency alarms on

trains which activate an appropriate CCTV camera, perhaps with video analytics that discriminate between suspicious and harmless actions.

- Non-provocative: sound insulation which prevents earphones annoying fellow travellers, thereby avoiding the occasionally serious conflict.
- Rewarding good behaviour, 'nudge- fashion: e.g. bins that play a famous cricketer's 'Howzat!' when someone throws some trash in (contextual note: this design will probably need modification in America); or the image of an insect under the glaze on a urinal (inherently rewarding target-practice for males, intended to reduce spillage). The famous Schiphol Airport fly was actually beaten to the mark by Victorian 'bee' versions (for the classically-minded: Latin for bee is Apis).

Inherent security, at one extreme, is an intrinsic property of a product: the bulk of some home-cinema televisions makes them unlikely loot for opportunist burglars (see Cohen and Felson 1979). This could hardly be accredited to deliberate design as the weight is simply a by-product of other technical considerations. However, future displays could perhaps be rolled up and carried off under the arm. Reliance on intrinsic security features should then be supplanted by designed-in security adaptations.

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 used a different voltage from domestic supply. This makes them unattractive to (moderately intelligent) thieves. At the other extreme are specialized security components, like holographic labels for brand protection of vodka (Design Council 2000); or the integration of the immobilizer function into, say, a vehicle engine management computer.

Adding on Security Products

Products which themselves are insecure can be protected by dedicated add-on security products, often fitted after a crime problem has become apparent.

- Laptops can be secured against theft by low-tech anchor-cables, or high-tech wireless sensors (transmitter incorporated in laptop; sensor, in owner's pocket, protests if the computer is moved).
- Add-on car alarms or steering-wheel locks can protect vehicles.
- Grilles and screens can safeguard street furniture against vandal damage.
- Expensive consumer items liable to counterfeiting and can be scam-proofed by hard- or expensive-to-copy packaging e.g. using codes that only appear when body warmth is applied (Design Council 2000). However, the international nature of

product piracy means factories in far-off places are well-appointed to copy even these.

Security add-ons may not provide the best solution to security, as discussed below.

Securing the Immediate Situation in which Products are at Risk

Otherwise insecure products can be kept in situations which have been made secure. This may involve the use of additional products, or environmental design, with little recourse to human intervention:

- Security products like safes provide enclosures for storage; cages, e.g. for computer projectors in school classrooms, enable secure use.
- Physical or electronic access control methods can prevent unauthorized people from reaching the target products.
- Items readily to hand, which can be misused as an impromptu resource for crime, can be restricted. For example, designing lockable rubbish hoppers so they cannot be used as a stash for shoplifted goods; securing 'emergency escape hammers' misused to break car windows, behind a screen sufficiently monitored to deter offenders; designing litterbins so empty bottles cannot be extracted for fighting with.

Often, however, designs are intended to work *with* human crime preventers and *against* crime promoters. The requirement to mobilize preventers may either be an on-cost of bad design, as with cars so vulnerable to theft they need guarding; realistic admission of product design's limitations in particular circumstances; or positive exploitation of the human element:

- Some products, whose main function does not concern prevention, can be modified to alert and empower people in various kinds of crime preventer role. Guardians of targets can be aided in protecting their own bags in bars by the 'Stop Thief' chairs and table clips illustrated above. These can be called 'securing products'.
- Other products can constrain or influence people from unintentionally acting as crime promoters (those who do not commit the central offence being considered but who, perhaps through inaction, make it more likely). The CaMden bike stand illustrated above forces cyclists to lock their bike securely as described. User-friendly central/remote locking on car doors removes the effort from securing the vehicle when parking (only older readers will recall the requirement to press the locking button on every single door).
- Inherently insecure products can be designed to compensate by prompting securing behaviour by their guardians. Vehicles nowadays give various (often annoying) audio

reminders e.g. to remove the key on leaving the car. As inbuilt intelligence increases in hot products such as music players, one can anticipate the incorporation of the same nag-functions. This is because they may be a cheaper solution to getting manufacturers off the moral/legal hook for theft prevention and deflecting responsibility onto the owner, than is incorporating inherent security.

- Preventers' presence, alertness, motivation, empowerment and direction could all fit within the design of some *integrated security system* (Tilley 2005). A familiar example is a retail security environment with an interior designed for surveillance, and where products or their packaging are fitted with tags which, if not neutralized by sales staff, activate detectors at the exit, bring security guards running, and provide legal evidence of ownership for the court.

Human preventers are unreliable: this raises issues whether preventers are included or excluded in the installation or operation of a product. Ekblom (2012d) describes an instance of 'involvement failure', where the Grippa clips illustrated above necessarily required people to fit, maintain and use them. Although well-designed and approved in critique sessions by both the management and customers of bars, in some contexts they simply did not get used to protect bags. Some security functions have therefore been designed to remove unreliable users from the loop: the car radio aerial built into the window glass, does not require the driver to telescope it shut on leaving the vehicle. But removing human intermediaries is not always beneficial. As Pease (2001) notes, the arrival of digital photography removed the employee-based surveillance from photographic development services which once kept paedophilic activities in check. And more generally, if circumstances change, a stand-alone security function may cease to be effective since it lacks the adaptability of human guardianship.

Securing Products by Remoter Interventions

Vulnerable and valuable products can also be protected by actions beyond the immediate crime situation:

- Making it hard to obtain specialist tools used to remove or destroy a target product. Unfortunately, this goes against modern trends to hire out virtually anything, no questions asked. However, concerns about terrorist misuse of everyday items (like fertilizer or other precursor chemicals) have prompted a counter-trend of registration and identification.
- Limiting knowledge of where the target products can be found and what their vulnerabilities are. Again this is counter to contemporary trends except for very high value, dangerous or 'critical infrastructure' products.
- Restricting the activities of deliberate crime promoters such as fences via a range of interventions including property marking and registration, tracking devices etc. Specific laws have been enacted (e.g. in UK) forbidding re-coding of stolen cell

phones, or even possession of requisite equipment; likewise with the recycling of frequently-stolen commodities such as copper – UK scrap metal dealers must now comply with regulations requiring strict recording of purchases and avoidance of cash sales.

- Action against crime promoters can be part of a wider market-reduction approach 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) and registration systems.

Together, the approaches described in this 'how does it work?' section exemplify most of the 25 techniques of situational crime prevention (Clarke and Eck 2003, and see Clarke, this volume). Underlying these techniques they engage the familiar 'rational choice' mechanisms of increasing effort, cost, time and risk of harm to offender, and reducing reward. In some cases however the situational influences are directed towards changing, not the offender's behaviour but that of preventers/promoters. But besides treating humans as 'active agents' in all these ways (Ekblom 2012b), design may also act through methods that are more 'causal', such as those which *provoke* criminal motivation (Wortley, this volume).

One means of capturing and condensing many of the above issues is the *Security Function Framework* (Ekblom 2012e). This tries to systematically articulate design considerations in terms of *Purpose* (what and who is the design for, in both crime prevention and other terms?); *Niche* (how does it relate to the rest of the security ecosystem – e.g. is it a potentially insecure product requiring inherent or add-on protection; a security product dedicated to conferring protection e.g. a Grippa clip; or a securing product with some other main function, e.g. the Stop Thief chair); *Mechanism (how does it work?*); and *Technicality* (How is it made, and how does it operate?).

THE CHALLENGES OF DESIGN AGAINST CRIME

Someone designing coffee machines must address manufacturing and shipping considerations, changing fashion, changing values (e.g. sustainability), evolving technology, and the products of competitors. Those designing products additionally to be crime resistant must squeeze in yet another, distinctive, set of requirements. Worse, they must cope with, or preferably anticipate, adaptive adversaries who may develop countermoves against the resistance.

Designs fit-for-purpose: Troublesome Trade-offs

Despite public concern about crime, when it comes to consumers' priorities, crime prevention is often way down the list. People want a car that is stylish, high performance, economical, safe, cheap – and by the way, that does not get stolen or broken into. A major challenge, therefore, is how to design products that are secure without jeopardising their main purpose or interfering with many other criteria. Designers must consider how incorporation of security interacts with a product's manufacture, safe and economic delivery through the supply chain, marketing, installation and ultimate disposal. Recognising, and reconciling, the range of potentially competing and conflicting requirements at (and between) all these stages is the heart of the industrial designer's skill. Several such 'troublesome trade-offs' are particularly significant. While presented in a product design context here, they can apply to all kinds of crime prevention intervention or problem-oriented policing solution.

- **Aesthetics** A familiar negative image of DAC is the 'fortress society'. Originally applied to built environments (blockhouses, heavy shutters), this could equally cover movable products: hideous armoured computer cases, ugly money belts, or chains on music players signalling 'uncool' risk-aversion. Crude fortification can happen, of course, through thoughtless commissioning and bad design. But as seen, for example, perfectly aesthetic handbags can be designed which are secure in diverse ways against dipping and slashing (Gamman and Hughes 2003), and window-embedded car radio aerials can be designed without obvious protective engineering features.
- **Legal and ethical issues** Designers against crime must also consider whether their proposal violates privacy or unacceptably constrains freedom. One example is a mobile phone which reports on someone's movements without their awareness or consent. Communicating lack of trust may also be an issue, as in over-intrusive anti-shoplifting devices.
- **Sustainability** Crime prevention requirements sit alongside environmental/energy considerations (Pease 2009; Armitage and Gamman 2009). One approach to preventing shoplifting of small, pocketable goods is to put them in a big package; this consumes materials and energy. One item thus protected (Design Council 2000) was a small torch, but cleverly, the packaging material came from surplus plastic from manufacturing the product itself.
- **Nuisance** is another trade-off in the quality of the social environment. Whereas designing insecure cars may export costs of *crime* onto victims and the rest of society (Roman and Farrell 2002; Hardie and Hobbs 2005), poorly-designed car alarms export the costs of crime *prevention*.
- **Safety** With efforts to stop drink-driving or restrict weapon use, safety and crime prevention are on the same side (intelligent cars can recognize and act on drink-diminished skills and intelligent weapons fire only for their registered owner). However, safety (and failsafe) considerations can collide with security. Nobody

wants a crime-proof car that occupants cannot be rescued from. But creative leaps can serve both safety *and* crime prevention. The bottom run of some fire escape stairs are drawn up from street level, sliding down under the weight of fleeing occupants, but otherwise keeping burglars out.

- **Convenience** Design against crime must be simultaneously *user-friendly whilst abuser-unfriendly* (Ekblom 2014). Elaborate security procedures, forgettable passwords and awkward locks rapidly destroy a product's allure. They will also conflict with *inclusive design* (see www.designcouncil.org.uk/resources/guide/principles-inclusive-design) which aims to make products and places readily and unobtrusively usable by the elderly or disabled. Indeed, difficult security features may well be bypassed. Who has not seen a seedy advertisement on a street stall for unblocking of cell phones?
- **Cost** Every additional feature in a product imposes extra cost on the design process and manufacture. In fiercely competitive sectors like automotive design or consumer electronics even additional pence may be unacceptable. But some security features only require thought at the design stage. An example is the road sign for the River Uck, which (as can be imagined) is quite provocative of graffiti. Presumably after wearying experience, the local council devised the sign shown in Figure 6 to deny writing-space for the offending extra letter.

Figure 6

Ingenuity apart, the earlier crime considerations are raised in the design process, the easier to optimize troublesome trade-offs. Security features will be less obtrusive, hence

more aesthetic and less vulnerable to counterattack; operation may be more user-friendly; constraints on design freedom less, and costs reduced.

Sometimes, new technology can relax these trade-offs. In cars, the arrival of cheap, reliable miniature electric motors allowed the *discriminant* function of locks to be physically detached from the *actuator* devices that latch the doors, thus removing size, space and reliability constraints on the design of door security. But technology and engineering must yield to wider design requirements. Superficial, 'bolt-on-drop-off' techno-fixes or clunky, awkward engineering solutions like heavy grilles are unfortunately encountered and spoil the reputation of DAC (Ekblom 2014).

Anticipating risk

Continual arrival on the market of new, naively insecure products generates what Pease (2001) calls *crime harvests,* followed by hasty retrospective efforts to cope with the crime and clumsily patch the damage by remedial design. The classic example has been with cell phones (Clarke et al. 2001). Although older leaks are now plugged, arguably the early vulnerabilities enabled the establishment of a self-sustaining crime market, with criminal expertise, criminal service providers, and criminal networks. Advances in technology also produce a stream of new resources for crime, like cordless drills, or pocketable 12V batteries (which can be misused to energise car door locks). Previously secure items become vulnerable overnight.

Anticipation could avoid many of these problems. Clarke's (1999) 'hot products' concept was conceived to predict which new products could be prone to theft. And to match the largely empirical identification of risk factors underlying CRAVED, the more theoretical approach of Routine Activities Theory (Cohen and Felson 1979; Felson 1997; Pease 1997) and the Conjunction of Criminal Opportunity (Ekblom 2010, 2011 and http://5isframework.wordpress.com) can be applied.

Offenders fight back

As every discussion of displacement acknowledges, offenders are adaptable: potentially able to circumvent crime prevention methods 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 (Guerette and Bowers 2009) show it is rare or only partial. In DAC however, the wider picture of offender adaptation is not so clear, although quantitative evidence is lacking. Offenders can respond to crime-resistant design at several levels:

- Making tactical countermoves in situ – spraying quick-setting foam in car alarms to deaden the sound.

- Turning crime prevention devices to their own advantage – anti shoplifting mirrors work both ways; communal CCTV in blocks of flats has been misused by residents to spot which neighbours are going out, prior to burgling their flat.
- Turning designer themselves and developing tools; perhaps doing sophisticated reverse engineering of locks to understand and defeat the mechanism.

Crime prevention is a kind of arms race (Ekblom 1999) between crime preventers and adaptive offenders who innovate, exploit change and enjoy the obsolescence of familiar crime prevention methods. A good illustration (Shover 1996) is the unfolding history of safes and safe-crackers. A more recent one concerns 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 Internet purchases) as each successive loophole is closed. And recent incidents suggest a resurgence of vehicle theft as vulnerabilities in immobilizers emerge (e.g. www.bbc.co.uk/news/technology-29786320).

In the longer term, crime levels depend on which side is innovating, and mainstreaming their innovations, faster than the other. And offender innovation is accelerating. Previously techniques were often learned in prison, but guides on making bombs or picking locks now regularly appear on the Internet. Preventers can however catch up by learning from other 'evolutionary struggles' including military, predator versus prey, antibiotic versus bacteria and pest versus pest control. Ekblom (1997, 1999, 2015) explores these issues in depth (and see also Felson 2006; Sagarin and Taylor 2008).

Involving designers in DAC

Few crime prevention interventions in the 'civil' world of work, leisure, travel and shopping are directly implemented by police and other professional preventers. Usually, the professionals aim to get other people or institutions to take responsibility for implementing and sometimes designing the intervention. This is the sphere of *involvement*. Involvement in turn has three main aspects – *climate-setting, partnership* (as between government and insurance companies, well-developed in the Netherlands (see www.hetccv.nl/english) and *mobilisation*. The first two are touched on below, but mobilisation is the key. One generic framework for mobilising crime preventers, CLAIMED (Ekblom 2011), sets out the following steps:

- **C**larify the crime prevention tasks or roles that need doing, e.g. implementing the intervention itself; alleviating constraints; and supplying enablers.
- **L**ocate the individuals or organisations best-placed to undertake them, including designers, manufacturers, marketers and consumers. Then

- **A**lert them that their product could be causing crime, or that they could help stop unrelated crimes;
- **I**nform them in detail of the risks;
- **M**otivate them;
- **E**mpower them; and where appropriate,
- **D**irect them.

This process can be done locally or nationally; by government, police or other institutions with an interest in crime prevention. Let's assume by this point that we have clarified the crime prevention tasks and roles, and located the designers and design decision-makers we wish to mobilize. What exactly do we do next?

Alerting designers, clients and customers to the role of design in crime

The cultural and political focus on the offender as problem, and 'cops, courts and corrections' as solution, has allowed designers and the manufacturers that commission them to get away with statements like 'don't blame my design, but the people who use it'; and the media, politicians and the public to go along with this complicity with crime. The first stage in getting designers and design decision-makers to 'think thief', is to give them the right mind-set. This is best done with a range of 'why didn't I think of that?' illustrations like those that opened this chapter.

Individual examples may have localized effects. Strategically it is important to establish a pervasive public climate of expectation that designers and manufacturers will have responsibility for addressing crime through effective product design, as has happened with vehicle security (Webb 2005).

Informing designers through intelligence on risk and design

For governments and insurers to act directly against insecure designs, or to get manufacturers, retailers and service providers to do likewise in a way that is efficient and proportionate to risk, it is necessary to know which products are insecure, to what degree, and why. Such evidence is also needed to inform the detail of design itself. There are three main approaches to obtaining it.

- *Deriving comparative risk rates* requires combining two kinds of information: the numbers of different makes and models (preferably by year, as production details change quite rapidly) *exposed to crime*, say, theft; and the numbers *actually stolen*. This is to index out a simple effect of numbers at risk – the more music players on the streets, the more would likely get stolen irrespective of design.

This approach was successfully used to generate the UK Car Theft Index (Houghton 1992 and https://data.gov.uk/dataset/car-theft-index-2004-2006), intended to mobilize consumer pressure to encourage manufacturers to increase security levels. A similar index has more recently been developed for cell phones (Home Office 2014). However these products may be special cases – e.g. with vehicles it was relatively straightforward to get the datasets on exposure (number of cars of each make and model on the road) and crime (from police records of this highly-reported offence). It is hard to envisage any equivalent index for say, laptops, being easy to produce and reliable. However, the situation may improve as products increasingly incorporate web-enabled electronics, and automated registration of ownership.

- *Attack testing* of products uses the tools and perpetrator techniques that offenders employ currently or are likely to adopt in the near future. The Association of British Insurers does just this for automobiles. Models rated insecure are assigned to a higher insurance premium band – as can be imagined, this concentrates the minds of the manufacturers because of its influence on consumer purchasing choice. Apart from on vehicles and financial systems, attack testing remains rare.
- *Systematic scrutiny of design and construction* of the products themselves seeks to identify vulnerabilities and assess whether security is commensurate with risk; and thence to assign a security rating. Such certification has been done with houses and other buildings (as with the UK Secured By Design scheme, and the equivalent Dutch Police Safe Housing). But attempts to develop ways for rating the security of movable products have yet to reach a practicable state, as experience with consumer electronics recently showed (Armitage 2012).

Both attack testing and systematic scrutiny draw on various kinds of background research. This can include literally picking up the pieces of some stolen product and looking at them forensically to see how the offender overcame any resistance; obtaining descriptions of perpetrator techniques from crime reports (sadly, rarely well-documented); interviewing product-servicing people; and interviewing offenders to explicitly obtain this 'preventive intelligence'.

Motivating designers and others to take on crime

Much has been written on the problem of 'incentivising' crime prevention in general (e.g. Home Office 2006). Motivation of designers has been attempted through various awards (e.g. the Royal Society of Arts Student Design Awards) and simply by stimulating them with the challenges of the task outlined above. But converting student enthusiasm into sustained interest and career commitment requires that for designers, crime pays; and that they see their crime resistant designs consistently welcomed and put into production. The attention thus turns to design decision-makers.

Motivation of manufacturers to make their products secure can be achieved by hard or soft incentives including an image of corporate social responsibility, naming and shaming, 'polluter-pays' taxes (Roman and Farrell 2002; and see Newman 2012 for a 'carbon cap-and-trade' approach), awakening consumer expectations and pressures and imposing insurance costs, and legislation (Design Council 2000; Clarke and Newman 2005). Webb (2005 and see POP Chapter in this volume) gives a good description of how a combination of many of these pressures led to radical improvements in car security.

But none of the supply-side motivators are 'intrinsic' to the core profit motive of manufacturers, so will always remain precarious. The closer the desire to incorporate crime resistance can be aligned to this 'natural' motivation, the more consistently, sustainably and creatively the task will be done. The general answer is to look towards demand-side motivation. However, while encouraging consumers to preferentially buy secure products is theoretically plausible (Design Council 2000) it has yet to convincingly demonstrate effective influence on choice, let alone showing that those choices go on to induce manufacturers to reduce crime. This is an area where economists might usefully contribute ideas on, for example, how the market context (e.g. multiple producers v monopoly; frequency or longevity of purchase of the product) might encourage or discourage suppliers' tendency to address security.

Government intervention remains a vital corrective to such 'market failures' (e.g. Newman 2012). Clarke and Newman (2005) assess various roles governments could undertake to support modification of criminogenic products, including acting as socially-responsible large-scale procurers for their own needs, managing incentives and ensuring a level playing-field so socially-responsible manufacturers do not lose out. Brown (2013b) draws a range of lessons for governments seeking to get crime prevention design into consumer products, based on his experience with vehicle crime.

Empowering designers to make products crime resistant

Compared with the CPTED field, guidance for product designers has been sparse – but that is changing. The UK Design Council issued updated guidance by Salford University at www.designcouncil.org.uk/resources/guide/designing-out-crime-designers-guide. The DAC Research Centre at Central Saint Martins produces a range of design resource materials in various media including many examples of cartoon graphics of, say, bag, bike theft and ATM crime methods (www.designagainstcrime.com/methodology-resources/perpetrator-techniques/, www.inthebag.org.uk and www.bikeoff.org/design_resource/). Other British institutions in the field include Loughborough University which as described developed ways of assessing security features of cell phones (Whitehead et al. 2008); and the UK-Italian team of Project MARC (Armitage 2012) as already mentioned took forward the security rating process.

Directing designers – standards

Standards are an important implementation tool for government policy; but rigid requirements may make designs difficult to adapt to individual contexts and slow to adapt to change. And variety of preventive methods is important in running arms races. Enhancing design freedom is therefore vital in tackling crime. The paradox can be resolved if performance standards are used rather than technical or construction standards… and if those performance standards are future-proofed. For example, a vehicle security specification would not be for 'hardened steel lock surrounds', but for 'locks which resist offenders, armed with the latest tools, for at least five minutes'. Such criteria are preferred by the UK Loss Prevention Certification Board, and the European CEN standards organisation.

DAC – evidence of Impact

Assessment and feedback from studio tests, field trials, user and service engineer experience and ultimately sales, profitability and market leadership are inherent to the evolutionary process that is product design. In evaluation and cost-effectiveness terms normally applied to crime prevention, however, there remains little hard evidence relating to product design as opposed to 'target-hardening', or situational approaches in general. Such evidence as exists is often characterized by weak research designs; formally evaluated products are summarized in Clarke and Newman (2005b, Table 4). With vehicles in particular, evidence of varying quality in 16 studies reviewed by Brown (2013) points to the contribution of immobilizers towards the substantial and sustained reduction of theft of cars in recent years. The timescale and expense of conducting full impact evaluations (including the cost of producing and installing prototype designs of, say, security products such as the Grippa clip) is considerable – Bowers et al. (2009) sought to develop a spreadsheet approach to handle trade-offs in production costs versus statistical power. (Problems in influencing the stakeholders in a planned rigorous impact evaluation of the clips are reported in Ekblom 2012d.) An alternative approach has been to focus on *intermediate*, behavioural, outcomes of secure designs. For example, the CaMden stand showed a significant increase, relative to conventional designs, in more secure locking behaviour, which can be considered a necessary precursor for reduced theft risk. Other impact evidence is anecdotal but (as Clarke and Newman 2005b, note) almost entirely self-evident. For example, remedial plastic housing was put on the end beams of London train carriages, to stop boys riding there. The most superficial glance reveals there is now simply nowhere for them to stand.

The more such hard evidence can be obtained, the better DAC will fare in securing sustained funding and attention from government. The evidence may also help convince

consumers to prefer products so designed and manufacturers to include security in their requirements capture.

CONCLUSION

The study and practice of designing products against crime lets us view the familiar with fresh eyes. It also leads to unfamiliar territory. DAC as a whole is simultaneously a relatively narrow domain of intervention within Situational Prevention, and a broad approach that can contribute to every kind of intervention and indeed to every stage of the preventive process. Further thoughts on this relationship are in Ekblom (2012b).

DAC interventions can never be the complete answer to crime (although hard evidence either way is sorely-needed). Implementation and involvement, too, are major issues – how to mobilize producers and users to make the crime-resistant choice, and to realize it well. However, designing products will continue to help reduce all kinds of crime in ways which complement place management, built-environment or offender-oriented interventions. The boundaries of its competence will surely undergo some drastic shifts as new technology and, especially, inbuilt intelligence and connectivity make their presence felt in everyday products and the systems and places they are embedded in.

Questions

1. Repeat Table 1, substituting smartphones or tablets for motor vehicles.
2. Suggest design solutions for the criminal activities listed in each of the cells of Table 1, for motor vehicles or for cell phones.
3. Can governments forecast specific risks to specific products reliably enough to insist manufacturers address them?
4. Think up some potential new crime risks associated with products that derive from technological innovation or social change. Use the Misdeeds and Security framework to help structure your list.
5. Are there any of the 25 techniques of situational crime prevention to which design of products or places cannot contribute? Are there any DAC approaches which fall outside the 25 techniques?

REFERENCES

All web pages accessed February 17, 2016

Armitage, R. (2012) 'Making a Brave Transition from Research to Reality', in P. Ekblom (ed.) *Design Against Crime: Crime Proofing Everyday Objects,* Boulder, CO: Rienner.

Armitage, R. and Gamman, L. (2009) 'Sustainability via Security: A New Look', *Built Environment*, 35: 297-301.

Booch, G. (1993) *Object-Oriented Analysis and Design with Applications* (2nd edn), Boston, MA: Addison-Wesley Professional.

Bowers, K. Sidebottom, A. and Ekblom, P. (2009) 'CRITIC: A Prospective Planning Tool for Crime Prevention Evaluation Designs', *Crime Prevention and Community Safety,* 11: 48-70.

Brown, R. (2013a) 'Reviewing the Effectiveness of Electronic Vehicle Immobilisation: Evidence from four countries'. *Security Journal* (online first), doi:10.1057/sj.2012.55.

Brown, R. (2013b) 'Regulating Crime Prevention Design into Consumer Products: Learning the lessons from electronic vehicle immobilisation', *Trends and Issues* 453. Canberra: Australian Institute of Criminology.

Burrows, J. and Ekblom, P. (1986) 'Preventing Car Crime: an initiative affecting vehicle import procedures', *Home Office Research Bulletin* 21, London: Home Office.

Clarke, R. (1997) *Situational Crime Prevention: Successful Case Studies* (2nd edn), New York: Harrow and Heston.

Clarke, R. (1999) *Hot Products: Understanding, Anticipating and Reducing Demand for Stolen Goods,* Police Research Series Papers 112, London: Home Office.

Clarke, R. and Eck, J. (2003) *Become a Problem Solving Crime Analyst in 55 Small Steps,* London: Jill Dando Institute, University College London. Available from www.popcenter.org/library/reading/PDFs/55stepsUK.pdf.

Clarke, R., Kemper, R. and Wyckoff, L. (2001) 'Controlling Cell Phone Fraud in the US: Lessons for the UK 'Foresight' prevention initiative', *Security Journal*, 14: 7-22.

Clarke, R. and Newman, G. (2005a) 'Secured by Design. A Plan for Security Coding of Electronic Products', in R. Clarke and G. Newman (eds) *Designing out Crime from Products and Systems*. *Crime Prevention Studies* 18, Monsey, NY: Criminal Justice Press and Cullompton: Willan Publishing.

Clarke, R. and Newman, G. (2005b) 'Modifying Criminogenic Products – What Role for Government?' in R. Clarke and G. Newman (eds) *Designing out Crime from Products and Systems*. *Crime Prevention Studies* 18, Monsey, NY: Criminal Justice Press and Cullompton: Willan Publishing.

Cohen, L. and Felson, M. (1979) 'Social Change and Crime Rate Changes: A Routine Activities Approach', *American Sociological Review,* 44:588-608.

Cornish, D. (1994) 'The Procedural Analysis of Offending and its Relevance for Situational Prevention', in R.Clarke (ed.), *Crime Prevention Studies*, 3: 151-196. Monsey, NY: Criminal Justice Press.

Department of Trade and Industry (2000) *Turning the Corner*. Report of Foresight Programme's Crime Prevention Panel. London: Department of Trade and Industry.

Design Council (2000) Design Against Crime. A Report to the Design Council, the Home Office and the Department of Trade and Industry. Cambridge, Salford and Sheffield Hallam Universities.
www.shu.ac.uk/schools/cs/cri/adrc/dac/designagainstcrimereport.pdf

Design Council (2011) *Designing Out Crime: A Designers' Guide,* London: Design Council.

Dorst, K. (2015) *Frame Innovation: Create New Thinking by Design*, Cambridge, MA: MIT Press.

Ekblom, P. (1979) 'A Crime Free Car?' *Home Office Research Bulletin* 7, London: Home Office.

Ekblom, P. (1995) 'Less Crime, by Design'. *Annals of the American Academy of Political and Social Science*, 539: 114-129 (Special review edition edited by Prof. Wesley Skogan, Northwestern University).

Ekblom, P. (1997) 'Gearing up against Crime: A dynamic framework to help designers keep up with the adaptive criminal in a changing world', *International Journal of Risk, Security and Crime Prevention*, 2: 249-265.

Ekblom, P. (1998) 'Situational Crime Prevention', in Goldblatt, P. and Lewis, C. (eds.) *Reducing Offending: An Assessment of Research Evidence on Ways of Dealing with Offending Behaviour*, Home Office Research Study 187, London: Home Office.

Ekblom, P. (1999) 'Can we Make Crime Prevention Adaptive by Learning from other Evolutionary Struggles?', *Studies on Crime and Crime Prevention,* 8/1: 27-51.

Ekblom, P. (2002) 'Future Imperfect: Preparing for the crimes to come', *Criminal Justice Matters,* 46 Winter 2001/02: 38-40, London: Centre for Crime and Justice Studies, Kings College.

Ekblom, P. (2005) 'How to Police the Future: Scanning for scientific and technological innovations which generate potential threats and opportunities in crime, policing and crime reduction', in M. Smith and N. Tilley (eds), *Crime Science: New Approaches to Preventing and Detecting Crime*, Cullompton: Willan.

Ekblom, P. (2010) 'The Conjunction of Criminal Opportunity Theory', *Sage Encyclopedia of Victimology and Crime Prevention,* 1:139-146.

Ekblom, P. (2011) *Crime Prevention, Security and Community Safety Using the 5Is Framework,* Basingstoke: Palgrave Macmillan.

Ekblom, P. (2012a). 'The Private Sector and Designing Products against Crime' in B. Welsh and D. Farrington (eds) *The Oxford Handbook on Crime Prevention,* 384-403. Oxford: OUP.

Ekblom, P. (2012b). 'Happy Returns: Ideas brought back from situational crime prevention's exploration of design against crime', in G. Farrell and N. Tilley (eds) *The*

Reasoning Criminologist: Essays in Honour of Ronald V. Clarke, 163-198, Crime Science series, Cullompton: Willan.

Ekblom, P. (ed.) (2012c) *Design Against Crime: Crime Proofing Everyday Objects,* Crime Prevention Studies 27, Boulder, CO: Rienner.

Ekblom, P. (2012d) 'Citizen Participation in Crime Prevention – capturing practice knowledge through the 5Is framework', in M. Coester and E. Marks (eds) *International Perspectives of Crime Prevention 4. Contributions from the 4th and the 5th Annual International Forum 2010 and 2011 within the German Congress on Crime Prevention*, Mönchengladbach: Forum Verlag Godesberg GmbH. www.erich-marks.de/Biografie/InternationalPerspectivesofCrimePrevention42012.pdf.

Ekblom, P. (2012e) 'The Security Function Framework', in P. Ekblom (ed.), *Design Against Crime: Crime Proofing Everyday Objects,* Crime Prevention Studies 27, Boulder, CO: Rienner.

Ekblom, P. (2014) 'Design and security', in M. Gill (ed.) *The Handbook of Security* (2nd edn), 133-156*,* Basingstoke: Palgrave MacMillan.

Ekblom, P. (in press) 'Technology, Opportunity, Crime and Crime Prevention – current and evolutionary perspectives', in B. Leclerc and E. Savona (eds.) *Crime Prevention in the 21st Century*, New York: Springer.

Ekblom, P. and Gill, M. (2015) 'Rewriting the Script: Cross-disciplinary exploration and conceptual consolidation of the procedural analysis of crime', *European Journal of Criminal Policy and Research* (online first). DOI 10.1007/s10610-015-9291-9.

Ekblom, P. and Hirschfield, A. (2014) 'Developing an Alternative Formulation of SCP Principles – the Ds (11 and counting).' *Crime Science*, 3:2.

Ekblom, P and Sidebottom, A. (2008) 'What do you mean, 'Is it secure?' Redesigning language to be fit for the task of assessing the security of domestic and personal electronic goods.' European Journal on Criminal Policy and Research.

Ekblom, P. and Tilley, N. (2000) 'Going Equipped: Criminology, Situational Crime Prevention and the Resourceful Offender' *British Journal of Criminology* 40:376-398.

Felson, M. (1997) 'Technology, Business, and Crime', in M. Felson and R. Clarke (eds) *Business and Crime Prevention*, Monsey, NY: Criminal Justice Press.

Felson, M. (2006). *Crime and Nature*, Sage: CA: Thousand Oaks.

Gamman, L. and Hughes, B. (2003) ''Thinking thief' – Designing out Misuse, Abuse and "Criminal' Aesthetics"', *Ingenia,* 15: 36-43. London: Royal Academy of Engineering.

Gamman, L. and Pascoe, T. (eds) (2004) *Seeing is Believing*, special issue of *Crime Prevention and Community Safety Journal,* 6/4.

Gamman, L., Thorpe, A., Malpass, M. and Liparova, E. (2012) 'Hey Babe – Take a Walk on the Wild Side!: Why role-playing and visualization of user and abuser "scripts" offer

useful tools to effectively “think thief” and build empathy to design against crime’, *Design and Culture*, 4/2: 171-193.

Gill, M. (2005) ‘Reducing the Capacity to Offend: Restricting resources for offending’, in N. Tilley (ed.), *Handbook of Crime Prevention and Community Safety,* Cullompton: Willan.

Guerette, R. and Bowers, K. (2009). ‘Assessing the Extent of Crime Displacement and Diffusion of Benefit: A systematic review of situational crime prevention evaluations’, *Criminology*, 47/4: 1331-1368.

Hardie, J. and Hobbs, B. (2005) ‘Partners against Crime – the Role of the Corporate Sector in Tackling Crime’, in R. Clarke and G. Newman (eds) *Designing out Crime from Products and Systems*. *Crime Prevention Studies* 18, Monsey, NY: Criminal Justice Press.

Harrington, V. and Mayhew, P. (2001) *Mobile Phone Theft*, Home Office Research Study 235, London: Home Office.

Hilton, K. and Irons, A. (2006) ‘A “Criminal Personas” Approach to Countering Criminal Creativity.’ *Crime Prevention and Community Safety*, 8: 248-259.

Home Office (2004) *The Car Theft Index 2004*, London: Home Office.

Home Office (2006) *Changing Behaviour to Prevent Crime: an Incentives-Based Approach*, Online report 05/06. http://webarchive.nationalarchives.gov.uk/20110218135832/http://uk.sitestat.com/homeoffice/rds/s?rds.rdsolr0506pdf&ns_type=pdf&ns_url=%5Bhttp://www.homeoffice.gov.uk/rds/pdfs06/rdsolr0506.pdf%5D

Home Office (2007a) *Cutting Crime. A new Partnership 2008-2011*, London: Home Office.

Home Office (2007b) *Crime in England & Wales 2006/7*. Statistical Bulletin 11/07, London: Home Office.

Home Office (2014) *Reducing Mobile Phone Theft and Improving Security*, London: Home Office.

Houghton, G. (1992) *Car Theft in England & Wales. The Home Office Car Theft Index*, CPU Paper 33, London: Home Office.

James, P. and Thorpe, N. (1994) *Ancient Inventions*, London: Michael O’Mara Books.

Lester, A. (2001) *Crime reduction through product design,* Trends & Issues in Crime and Criminal Justice No. 206, Canberra: Australian Institute of Criminology. www.aic.gov.au/publications/current%20series/tandi/201-220/tandi206.html.

Learmont, S. (2005) ‘Design Against Crime’, in R. Clarke and G. Newman (eds) *Designing out Crime from Products and Systems*, *Crime Prevention Studies* 18, Monsey, NY: Criminal Justice Press.

Levi, M. and Handley, J. (1998) *The Prevention of Plastic and Cheque Fraud Revisited,* Home Office Research Study 182, London: Home Office.

Lulham, R., Camacho Duarte, O., Dorst, K. and Kaldor, L. (2012) 'Designing a Counterterrorism Trash Bin', in P. Ekblom (ed.) *Design Against Crime: Crime Proofing Everyday Objects,* Boulder, CO: Rienner.

Mayhew, P., Clarke, R., Sturman, A. and Hough, J (1976) *Crime as Opportunity,* Home Office Research Study 34, London: Home Office.

Newman, G. (2012) 'A Market Approach to Crime Prevention', in P. Ekblom (ed.) *Design Against Crime: Crime Proofing Everyday Objects,* Boulder, CO: Rienner.

Nettle, D., Nott, K. and Bateson, M. (2012) 'Cycle Thieves, we are Watching you: Impact of a simple signage intervention against bicycle theft', *PLoS ONE*, 7/12, e51738.

Newman, G. (2012) 'A Market Approach to Crime Prevention', in P. Ekblom (ed.) *Design Against Crime: Crime Proofing Everyday Objects,* Boulder, CO: Rienner.

Pease, K. (1997) 'Predicting the Future: The roles of routine activity and rational choice theory', in G. Newman, R. Clarke and S. Shoham (eds), *Rational Choice and Situational Crime Prevention: Theoretical Foundations*, Dartmouth UK: Ashgate.

Pease, K. (2001) *Cracking Crime through Design*, London: Design Council.

Pease, K. (2009). *The Carbon Cost of Crime and Its Implications*, available at: www.securedbydesign.com/about-secured-by-design/casestudies-research-and-publications/.

Roman, J. and Farrell, G. (2002) 'Cost-Benefit Analysis for Crime Prevention: Opportunity costs, routine savings and crime externalities', *Crime Prevention Studies,* 14: 53-92.

Sagarin, R. and Taylor, T. (eds) (2008) *Natural Security. A Darwinian Approach to a Dangerous World,* Berkeley: University of California Press.

Segato, L. (2012) 'Packaging against Counterfeiting', in P. Ekblom (ed.) *Design Against Crime: Crime Proofing Everyday Objects,* Boulder, CO: Rienner.

Shover, N. (1996) *Great Pretenders: Pursuits and Careers of Persistent Thieves*, London: Westview Press/Harper Collins.

Sidebottom, A., Ashby, M. and Johnson, S. (2014) 'Copper Cable Theft: Revisiting the Price–Theft Hypothesis', *Journal of Research in Crime and Delinquency,* 51/5: 684-700.

Southall, D. and Ekblom, P. (1985) *Designing for Vehicle Security: Towards a Crime Free Car*. Home Office Crime Prevention Unit Paper 4. London: Home Office.

Sutton, M., Schneider, J. and Hetherington, S. (2001) *Tackling Theft with the Market Reduction Approach,* Crime Reduction Research Series Paper 8, London: Home Office.

Tilley (2005). 'Crime Prevention and System Design' in N. Tilley (ed.), *Handbook of Crime Prevention and Community Safety',* Cullompton: Willan.

Webb, B. (2005) 'Preventing vehicle crime' in N. Tilley (ed.), *Handbook of Crime Prevention and Community Safety'.* Cullompton: Willan

Welsh, B. and Farrington, D. (2000) ‘Monetary Costs and Benefits of Crime Prevention Programs’, in M. Tonry (ed.), *Crime and Justice: A Review of Research* 27, Chicago: University of Chicago Press.

Whitehead, S., Mailley, J., Storer, I., McCardle, J., Torrens, G. and Farrell, G. (2008) 'Mobile Phone Anti-Theft Designs: A review', *European Journal on Criminal Policy and Research*, 14(1): 39-60.