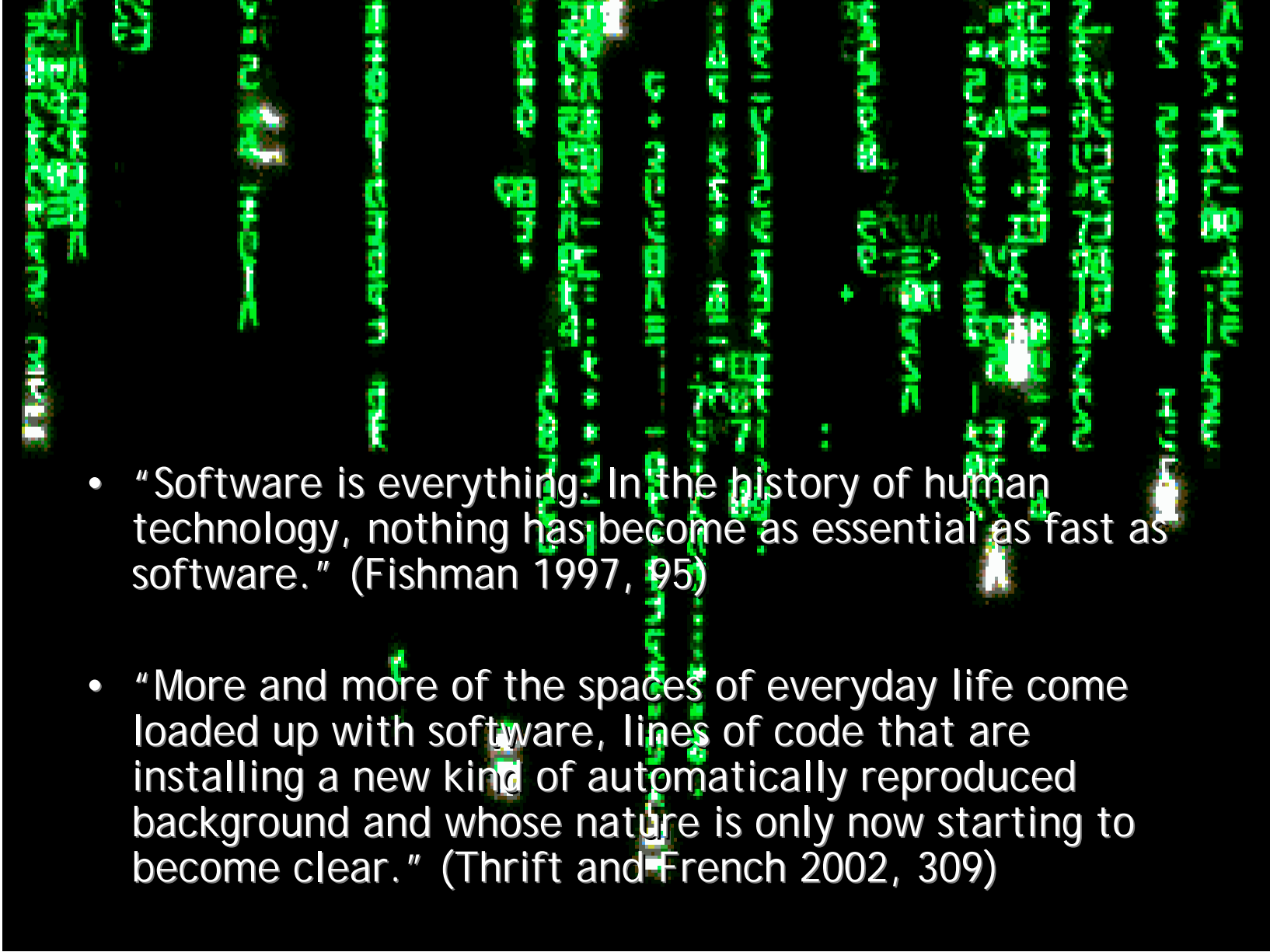


Coding in the city: spaces 'written' with software

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- 
- “Software is everything. In the history of human technology, nothing has become as essential as fast as software.” (Fishman 1997, 95)
 - “More and more of the spaces of everyday life come loaded up with software, lines of code that are installing a new kind of automatically reproduced background and whose nature is only now starting to become clear.” (Thrift and French 2002, 309)

Code/space research

- seek to document the socio-technical governance of cities that is becoming automatic in character using the calculative power of computer software - 'code'
- long history of software (written instructions) extending human action beyond the body
- account for software's growth and understand the productive & creative power it has in the world
- consider how human geography has begun to examine the landscapes of code and some of the implications

Main Entry: code

Pronunciation: 'kOd

Function: noun

Etymology: Middle English, from Middle French, from Latin caudex, codex trunk of a tree, document formed originally from wooden tablets

Date: 14th century

1 : a systematic statement of a body of law; especially : one given statutory force

2 : a system of principles or rules <moral code>

3 a : a system of signals or symbols for communication

b : a system of symbols (as letters or numbers) used to represent assigned and often secret meanings

4 : genetic code, Date: 1961, the biochemical basis of heredity consisting of codons in DNA and RNA that determine the specific amino acid sequence in proteins and appear to be uniform for all known forms of life

5 : a set of instructions for a computer

- code-less /-l&s/ adjective

Function: verb

Inflected Form(s): cod·ed; cod·ing,

Date: 1815,

transitive senses : to put in or into the form or symbols of a code

intransitive senses : to specify the genetic code

<a gene that codes for a protein>

- cod·able /'kO-d&-b&l/ adjective,

- cod·er noun

(Source: Merriam-Webster Dictionary,
www.Merriam-Webster.com)

Defining code

- code - set of instructions and rules that when combined together produce programs capable of complex digital functions that operate on computer hardware
- runs on a variety of hardware
- can distribute, generate, monitor, control data exchange across a range of media (e.g. fibre, wireless, satellite)
- code is written various forms: abstract machine code and assembly language to programming languages, applications, macros and scripts

Defining code

- code can be “couched as the guts of a set of commodities: websites, software packages, games, animated movies and so on, which are dispensed via the medium of the screen and have become part of a more general cultural ambience.” (Thrift and French 2002, 310)
- relationship between code and hardware; media of activity - not merely written text
- unit of analysis (is MS Windows one code unit?)
- much (all) is hidden from view. even when can see the computer carapace, cannot observe the code working
- emergent. code “somewhere between the artificial and a new kind of natural, the dead and a new kind of living”; has a “presence as ‘local intelligence’” (Thrift and French 2002, 310)

Embedded software systems

- “The simple fact of the matter is that software, in the shape of embedded systems is now so widespread that we are not longer able to be sure of its extent” (Thrift and French 2002, 320)
- cannot necessarily tell from external visual appearance (material form of object) or its observable functions that it contains code making essential decisions
- “software becoming so pervasive and complex that it is beginning to take on many of the features of an organism” (Thrift and French 2002, 311)
- not a planned (hegemonic), but many small and large, overlapping and conflicting projects, deployments and adoptions of software systems and coded objects



Millennium bug
act now!

Y2K 'wake up call'



Millennium bug
act now!

- thorough audits of software prior to 2000 because of fears of 'millennium bug' highlighted how far code had seeped into the interstices of everyday life, embedded in all manner of machines and places
- the last five years have seen pervasive digitising of many more activities -> photography, music listening, television, payment, access control
- software is slipping into background

Typology of code 'work'

- many technologies increasingly rely on code (but often don't look like computers)
- code is becoming increasingly embedded into daily life in at least four main ways, producing what we term
 - coded objects,
 - coded infrastructure,
 - coded processes,
 - coded assemblages.

1. Coded Objects

- *coded objects* refer to non-networked objects that use code to function or permanently store digital data which cannot be accessed without software
- the former range from simple household items such as alarm clocks, 'smart' irons, washing machines that use basic code to augment their use, to complex, but isolated machines, such as DVD players
- the latter include cash cards, floppy disks and CD-ROMs
- though they vary in their scope, sophistication and programmability, the importance of code to their function is such that if the code (or hardware that supports it) fails, the object ceases to function as intended (e.g. a cashcard ceases to be a cashcard)
- In all cases, unless networked, the remit of the code is limited purely to that object

2. Coded Infrastructures

- *coded infrastructure* refers both to networks that link together coded objects and infrastructure that is monitored and regulated, either fully or in part, by code
- such coded infrastructure (or ensembles) includes distributed infrastructures such as
 - computing networks (e.g. Internet, intranets)
 - communication and entertainment networks (e.g. mail, telephone, mobile phones, broadcast television & radio)
 - utility networks (e.g. water, electricity, gas, sewerage)
 - transport and logistics networks (e.g. air, train, road, shipping)
 - financial networks (e.g. bank intranets, stock markets)
 - security and policing networks (e.g. surveillance cameras)
- and relatively localised and closed systems such as localised surveillance (say within one building complex) and small but complex systems such as a car

3. Coded Processes

- *coded processes* refer to the transaction and flow of digital data across coded infrastructure
- particularly important when they access, update, and monitor relational databases that hold individual and institutional data
- such databases can be accessed at a distance and used to verify, monitor (say for billing purposes) and regulate user access to a network, update personal files, and so on
- many such coded processes related to bank accounts, taxation, insurance, health, crime, utility, shopping
- coded processes are largely invisible and distant, but are revealed to individuals through letters, statements, bills, receipts, print-outs, licenses and so on, and through unique personal identification numbers on the coded objects used to access them (e.g. bank cards, library cards, donor cards, and so on)

4. Coded Assemblages

- *coded assemblages* are where *several* different coded infrastructures converge, becoming integral to each other in producing particular environments, such as office complexes, transport systems, shopping centres
- for example, the combined systems of billing, ticketing, check-in, baggage routing, security, safety, customs, immigration, air traffic control, airplane instruments, work together to create a coded assemblage that defines and produces airports and passenger air travel
- Similarly, the coded infrastructures of water, electricity, gas, banks, commodities, telephone, mail, television, government database systems, and so on, work together to create an domestic assemblage (the household)
- the power of these assemblages is their interconnection and interdependence creating systems whose complexity and power are much greater than the sum of their parts

Power of code

consider power in four way:

1. productive capacity
 - makes things happen in ways not possible without it
2. governmentality capability
 - used to discipline people
3. creativity / empower people
4. automatic production of space

1. Productive capacity of code:

'Software - the right stuff'

Charles Fishman's (1996, 95) eloquent description of the power of code:

As the 120-ton space shuttle sits surrounded by almost 4 million pounds of rocket fuel, exhaling noxious fumes, visibly impatient to defy gravity, its on-board computers take command. Four identical machines, running identical software, pull information from thousands of sensors, make hundreds of milli-second decisions, vote on every decision, check with each other 250 times a second. A fifth computer, with different software, stands by to take control should the other four malfunction.

At T-minus 6.6 seconds, if the pressures, pumps, and temperatures are nominal, the computers give the order to light the shuttle main engines -- each of the three engines firing off precisely 160 milliseconds apart, tons of super-cooled liquid fuel pouring into combustion chambers, the ship rocking on its launch pad, held to the ground only by bolts. As the main engines come to one million pounds of thrust, their exhausts tighten into blue diamonds of flame.

Then and only then at T-minus zero seconds, if the computers are satisfied that the engines are running true, they give the order to light the solid rocket boosters. In less than one second, they achieve 6.6 million pounds of thrust. And at that exact same moment, the computers give the order for the explosive bolts to blow, and 4.5 million pounds of spacecraft lifts majestically off its launch pad.

It's an awesome display of hardware prowess. But no human pushes a button to make it happen, no astronaut jockeys a joy stick to settle the shuttle into orbit.

The right stuff is the software.

(Source: www.spectrum.ieee.org/sep05/1685)

2. Code as unseen governmentality



Chip and PIN

I ♥ PIN
14 February 2006

You have 3 goes before
the card is 'locked'

- Referring to Foucauldian modes of governmentality, it is clear that code is key means for governments and corporations to discipline people
- software provide new forms of visibility, new means of classification, sophisticated modes of calculation and ways to deliver decisions
- “By code, we refer to a system of regulation, a regime, which is both structured and structuring, ... the primary function of code is normative.” (Thomas 2005, 649)
- ‘code is law’ according to Lawrence Lessig (1999)
- new potential for *adaptive* classification, calculation and decision-making that happens without human intervention
- “what software is able to achieve is a standardization and classification of urban situations in ways that were formerly impossible.” (Thrift and French 2002, 326)

3. Creativity of / through code

- code open many exciting opportunities for artists and craft practices
- imperfections in software become points of unexpected innovations
- manipulation of digital media and easy to sharing of results - mod'ing, mash-ups, remixing
- many most innovative software has come from 'experimentalists' and hackers
- software for play and for fun. Interactive games and virtualised experiences
- next generation of locative games where city becomes the game board

4. Code and the 'automatic production of space'

- defined Thrift and French (2002, 309) paper, argue that Euro-American societies are increasingly "interwoven with computer software"
- we posit that coded objects, infrastructures, processes and assemblages, the technicity they engender, transduces space - beckons new spatial formations into existence - in three related ways
 - (i) code/space
 - (ii) coded space
 - (iii) background coded space

(i) Code/Space

- *Code/space* refers to a transduction wherein 'the problem' *cannot* be solved without code
- here, code dominates the transduction of space to the extent that the transduction is dependent on code; they are mutually constituted and hence dyadic
- this domination is so pervasive that if one half of the dyad is put 'out of action' then the entire transduction fails
- for example, the experience of drawing money from an ATM is one of transducing code/space through coded infrastructure and processes
 - if the network is 'down' or the bank's software not working (or working incorrectly) the space - in this case the bank or the location of the ATM - fails to be a cash machine and the individual is forced to seek another means of obtaining money
- In other words the space cannot function as intended; the transduction fails

(ii) Coded Space

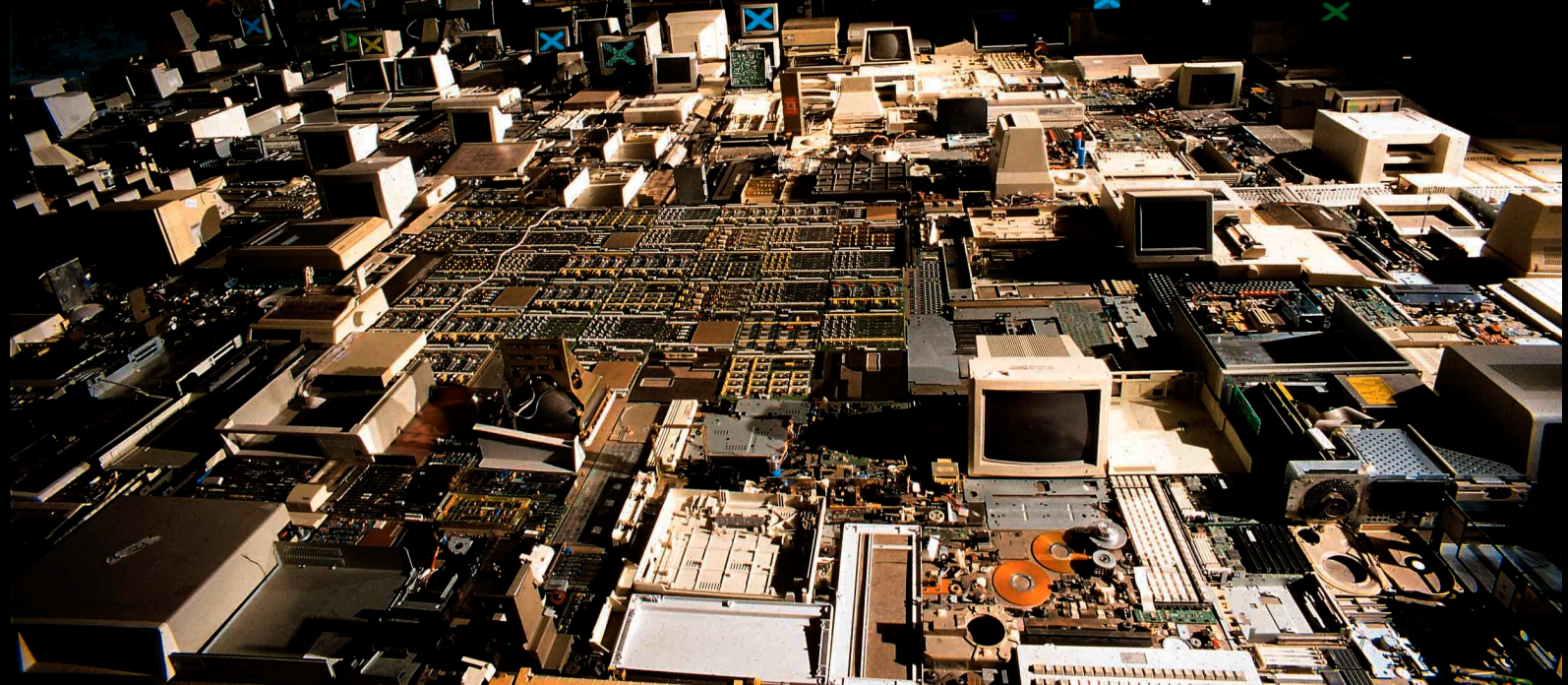
- *coded space* is a transduction that is mediated by code, but whose relationship is not dyadic
- here, code matters to the production and functioning of a space but if the code fails the space continues to function as intended, but not necessarily as efficiently or least costly or safely
- code mediates the solution to a problem, but it is not the only solution
- in other words, the code's role is one of augmentation, facilitation, monitoring, and so on, rather than control and regulation
- for example, a networked surveillance camera affects the transduction of space, but if the camera is non-operational the shop still functions as a shop
- however, if the networked tills (code/space) fail to work then the store cannot sell any goods as it has no way of processing payments

(iii) Background Coded Space

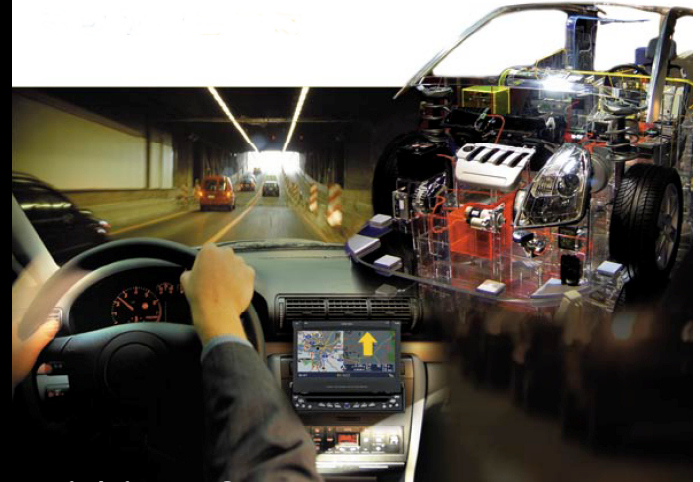
- *background coded space* is where code has the potential to mediate a solution if activated
- potential codings include local, but turned off, sources of code such as coded objects and infrastructures (e.g. water, electricity), and GPS, radio and mobile phone signals which are always ever present, but mute until activated
- once the code is activated the transduction of space is alternatively modulated to one of coded space or code/space.
- In the case of water or electricity, code does not obviously or explicitly mediate the solution of accessing supply (e.g. turning the tap), but it is an important component that is several steps removed

Code in cities

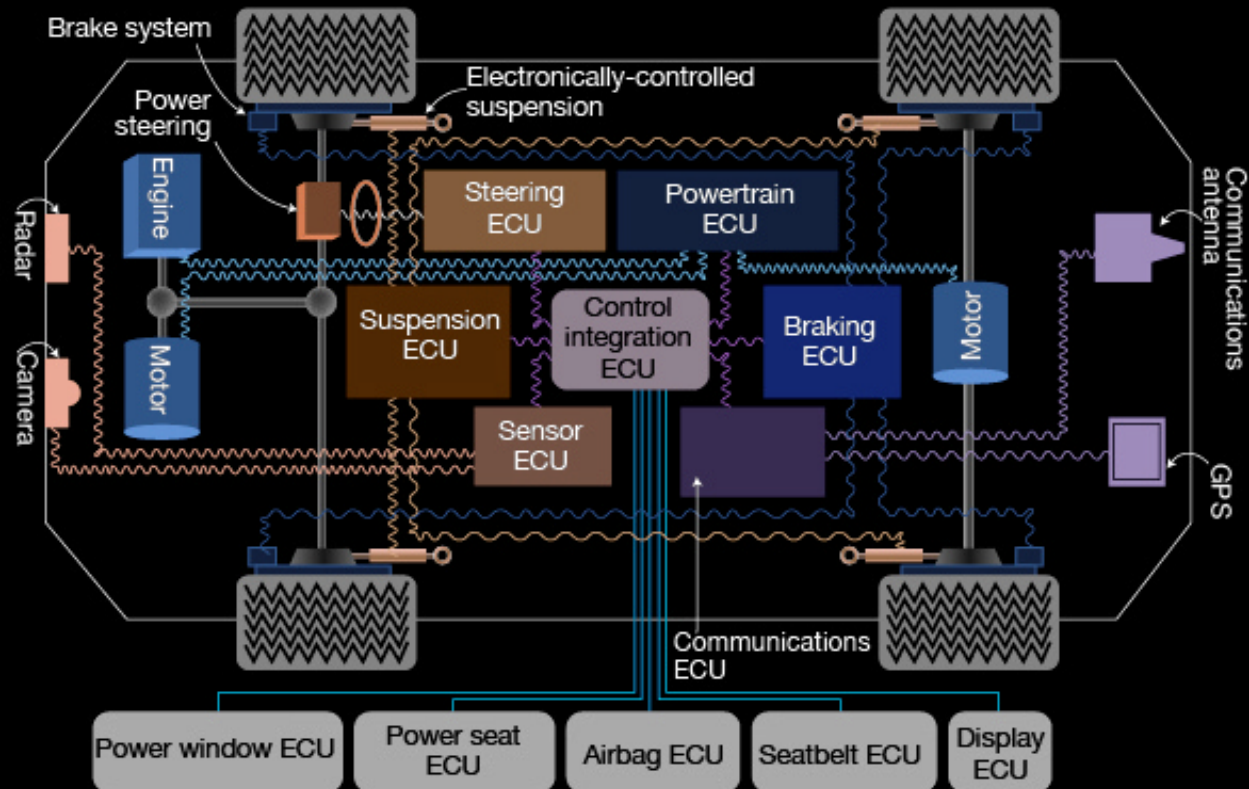
- mobility & driving
- surveillance & access control
- domestic reproduction & consumption



1. Mobility - 'driving spaces'



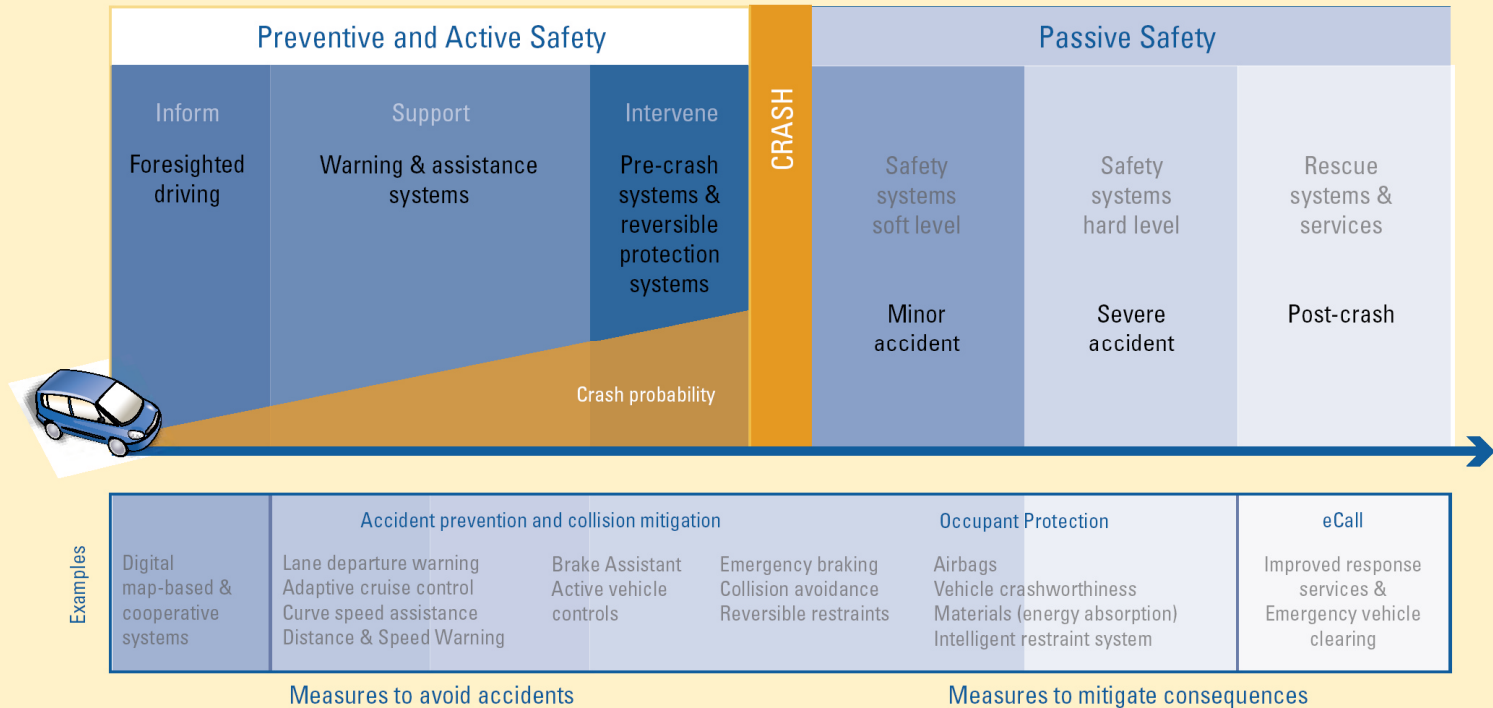
- Vehicles as code/spaces
 - new vehicles are conceived primarily within software
 - design and engineering testing undertaken within CAD systems
 - manufactured in plants of computerised robotic production lines, and global supply chains enabled by networked information systems
 - Increasingly, code is becoming bound into the very materiality of the vehicles themselves
 - the calculative power of code supplanting the cognitive ability of the human
 - As Thrift (2004, 50) notes, “[a]lmost every element of the modern automobile is either shadowed by software or software has become ... the pivotal component.”



- contemporary cars (especially luxury models, but filtering down as the costs falls) are a collection of computers on wheels
- cars represent one of the densest concentrations of digital computing and embedded software that most people encounter in the everyday environment

Coding up the driver

- drivers are subject to software-enabled regulation through 'driver assistance systems'
- aimed at increasing driver safety and those aimed at enhancing convenience
- use code to
 - reduce the cognitive burden on drivers (e.g., sat-nav provides turn-by-turn voice instructions),
 - reduce the level of kinaesthetic and spatio-perceptive skills required (e.g., distance detection within parking aids),
 - reduce the physical strength/endurance needed to drive (e.g., active steering, active cruise control),
 - sense environmental conditions beyond normal human senses (e.g., black ice detector)



(Source: eSafety project flier, 2005, page 10, <www.escope.info/index.html?file=312>.)

- 'safety through software', the assumption is that drivers are often the 'problem' and need to be protected from themselves
- a radical change in the way a vehicle's controls work, with a shift away from direct physical connection between the driver's embodied actions and mechanical response to software-mediated 'drive-by-wire' operations

'Smart streets' - roads as code spaces



(source: http://www.clui.org/clui_4_1/ondisplay/loop/exhibit/loop.html)

Smart streets



(source: http://www.clui.org/clui_4_1/ondisplay/loop/exhibit/loop.html)

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Smart streets



(source: http://www.clui.org/clui_4_1/ondisplay/loop/exhibit/loop.html)

'Smart' parking



FORT LAUDERDALE, FLA.

In-car meters

Drivers can load up to \$100 onto a prepaid meter that dangles from the rearview mirror, above; the meter counts down remaining parking minutes.



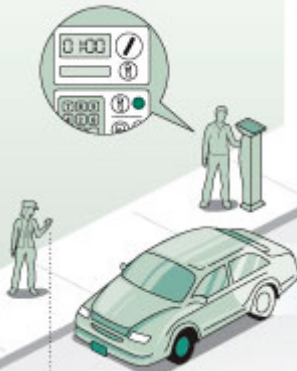
Sources: InnovaPark; Cole Parking Systems USA; T2 Systems; Lexis Systems; Mint Technology; AutoVu Technologies

Rich Franconeri/The Wall Street Journal

MONTREAL

Multispace meters, Handheld alerts

Each meter governs 10 to 15 spaces. After parking, drivers type in space number and pay with credit card or cash. Meters send real-time, block-by-block information to enforcement officers' handheld devices.



Handheld Device

Cars parked legally are displayed as green squares, while those that have exceeded their time limit turn red.

CORAL GABLES, FLA.

Pay with cellphone

Drivers register their cellphone, credit card and license plate numbers online. After they park, they dial a number and enter a lot and space number to begin their parking session.



SACRAMENTO, CALIF.

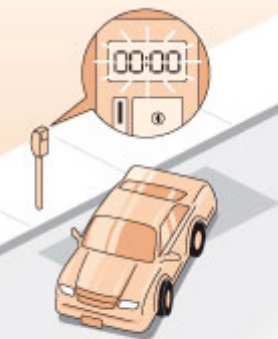
Infrared license plate scanners

Enforcement vehicles traveling as fast as 30 mph use cameras to scan license plates. Using a global positioning system, the system lets officers check whether a car has outlasted its time on the meter. The system also can match license plates against databases of unpaid parking tickets and stolen vehicles.

PACIFIC GROVE, CALIF.

Smart meters

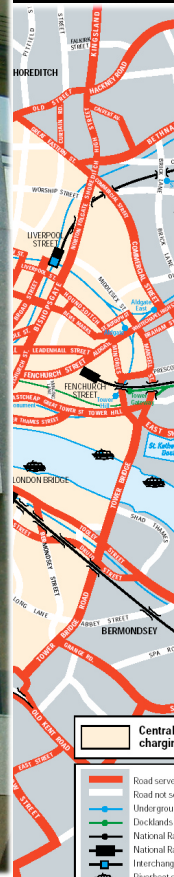
Sensors embedded in the concrete under a parking space can tell when a car pulls out, resetting the meter to zero.



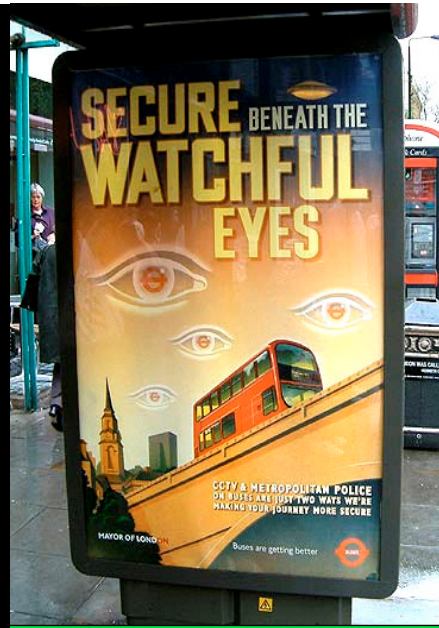
Tracking cars

- insurance will shift from a fixed annual premium based largely on personal circumstances and vehicle type
- to variable premiums dynamically calculated by driving patterns (kilometres driven, driving route, location of parking, time of day of journeys, and so on) and perhaps even driving behaviour (speeding, jumping lights, etc)
- such journey-by-journey risk calculation facilitated by telematics networks working as a potent socio-technical fix capable of continuously tracking vehicles
- parallel is shift in government taxation systems from fixed to dynamic ones based on road pricing
- implications - anonymity of driving and privacy; equity and discriminatory pricing models

Congestion Charge



- all vehicle movement into and out of 21 square kilometre zone
- networked video system, 500 cameras at some 250 sites with ANPR
- watching at all times, including 49.4% of non-charging time



Urban geo-surveillance and securitisation

- tracking through space-time
- interlocking techno-social assemblages (e.g. mobiles, ANPR, CCTV, id cards)
- casual regimes of positional knowledge of people
- social implications, political discourses, resistance

From 'dumb' keys to cards-n-code



digitally controlled physical access (cards, pin numbers)



```
Cardholder Activity Report
** 22/04/03 *****
10:45 01 Torr Pl 1-19, Rear Torr Pl 1-19 Ents Door Access Granted
18:00 01 Torr Pl 1-19,Ent,Out Torr Pl 1-19 Ents Door Access Granted

** 23/04/03 *****
19:38 01 Torr Pl 1-19, Rear Torr Pl 1-19 Ents Valid Card Exit

** 24/04/03 *****
No Activity

** 25/04/03 *****
16:51 01 Torr Pl 1-19, Rear Torr Pl 1-19 Ents Valid Card Exit
19:43 01 Torr Pl 1-19, Rear Torr Pl 1-19 Ents Valid Card Exit

** 26/04/03 *****
No Activity

** 27/04/03 *****
12:54 01 Torr Pl 1-19,Ent,In Torr Pl 1-19 Ents Door Access Granted
17:38 01 Torr Pl 1-19,Ent,Out Torr Pl 1-19 Ents Door Access Granted

** 28/04/03 *****
19:22 01 Torr Pl 1-19, Rear Torr Pl 1-19 Ents Valid Card Exit

** 29/04/03 *****
19:17 01 Torr Pl 1-19, Rear Torr Pl 1-19 Ents Valid Card Exit

** 30/04/03 *****
No Activity

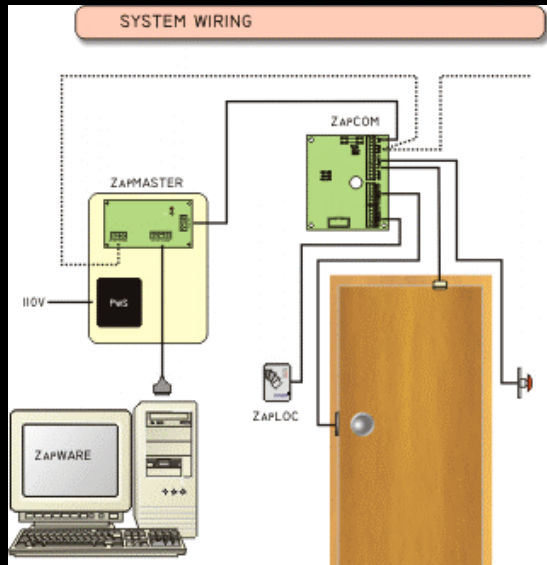
** 01/05/03 *****
18:32 01 Torr Pl 1-19, Rear Torr Pl 1-19 Ents Valid Card Exit
18:45 01 Torr Pl 1-19, Rear Torr Pl 1-19 Ents Door Access Granted
20:18 01 Torr Pl 1-19, Rear Torr Pl 1-19 Ents Valid Card Exit

** 02/05/03 *****
No Activity

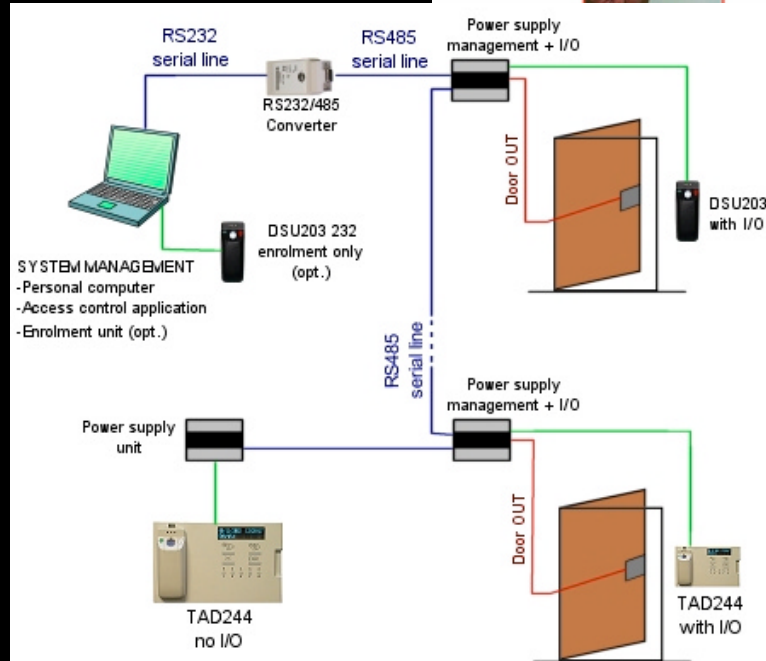
** 03/05/03 *****
No Activity

** 04/05/03 *****
No Activity
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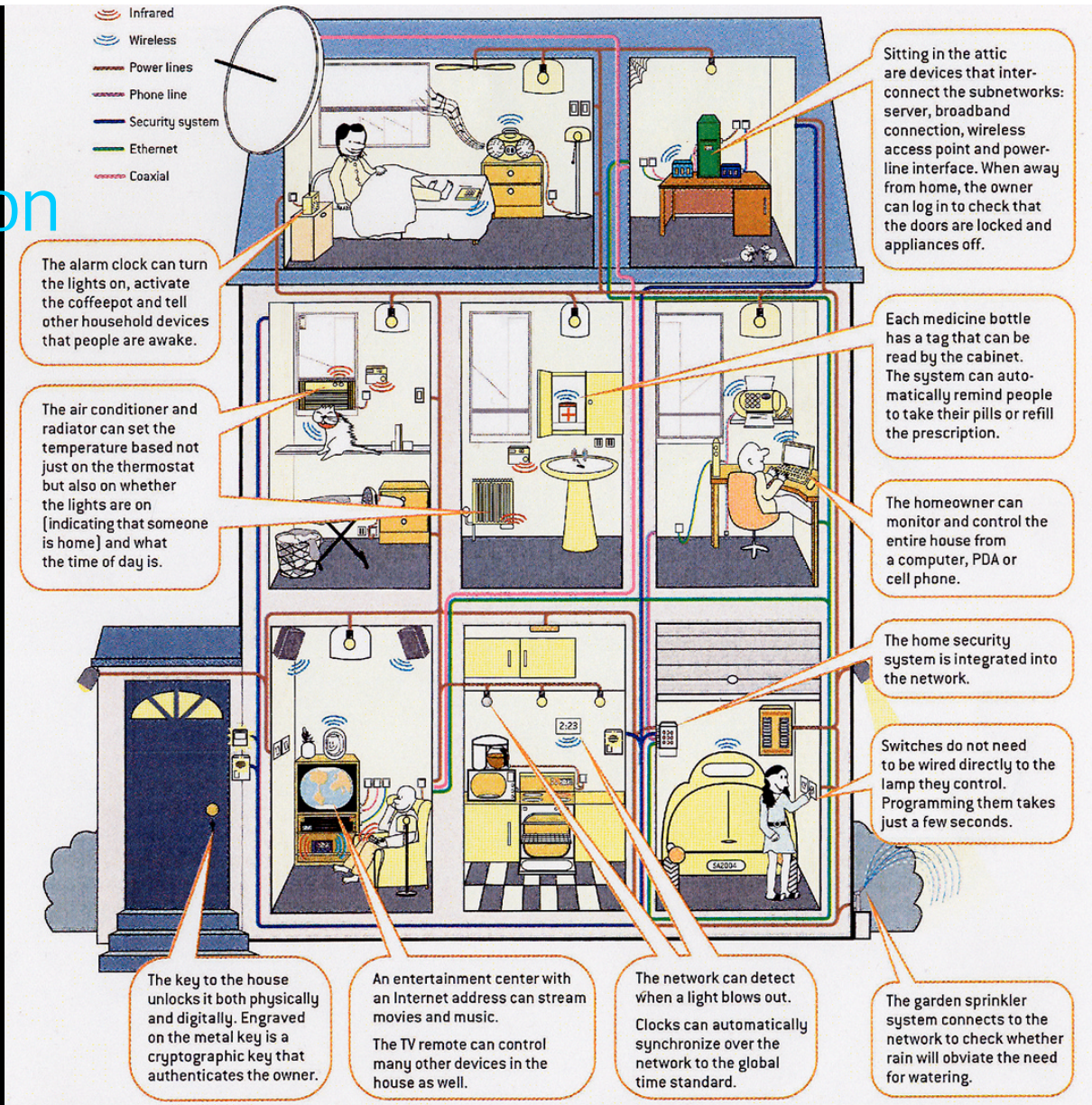
Security - access control systems



Integrated time attendance systems



Domestic reproduction



Coding bodies

> paranoid consumption



Implications

- complexity of urban management increasingly dependent on code
- what are the risks when code fails? can they be mitigated?
- software production and implementation is hard and often fails, costing millions
- Steve Graham (2005, 562) highlights the “central role of computerised code in shaping the social and geographical politics of inequality in advanced societies.”
- process of ‘software-sorting’, for reasons of profit, risk-reduction, security, convenience, etc, work to separate groups, their access to spaces and ability to undertake activities in particular places according to automated sets of criteria
- dominant criteria set arise from neoliberal service restructuring
- hidden and automatic discriminatory action. “because most processes of software-sorting are actually invisible from the point of the users, these prioritizations are often not evident either to the favoured groups or places or to the marginalized ones.”
(Graham 2005, 566)

The End

- Slides online at www.casa.ucl.ac.uk/martin/bratislava.pdf
- Contact
 - m.dodge@manchester.ac.uk
 - www.cybergeography.org/martin/
- Related papers
 - Dodge M, Kitchin R, 2006, "Code, vehicles and governmentality: The automatic production of driving spaces" under review. (email me for a draft)
 - Dodge M, Kitchin R, 2005, "Codes of life: Identification codes and the machine-readable world" *Environment and Planning D: Society and Space* 23(6) 851-881
 - Dodge M, Kitchin R, 2005, "Code and the transduction of space" *Annals of the Association of American Geographers* 95(1) 162-180
 - Dodge M, Kitchin R, 2004, "Flying through code/space: The real virtuality of air travel" *Environment and Planning A* 36(2) 195-211
 - (available via www.cybergeography.org/martin/)

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