The Bronze Key:
Performing Data Encryption

Susan Kozel
Malmö University
205 06 Malmö, Sweden
susan.kozel@mah.se

Ruth Gibson
Gibson/Martelli, and
Coventry University
Coventry, UK
ruth@gibsonmartelli.com

Bruno Martelli
Gibson/Martelli
London, UK
www.gibsonmartelli.com
bruno@gibsonmartelli.com

Abstract
The Bronze Key art installation is the result of
performative re-materializations of bodily data. This
collaborative experiment in data encryption expands
research into practices of archiving and critical
discourses around open data. It integrates bodily
movement, motion capture and Virtual Reality (VR)
with a critical awareness of data trails and data
protection. A symmetric cryptosystem was enacted
producing a post-digital cipher system, along with
archival artefacts of the encryption process. Material
components for inclusion in the TEI Arts Track include:
an audio file of text to speech of the raw motion
capture data from the original movement sequence on
cassette tape (*The Plaintext*), a 3D printed bronze
shape produced from a motion captured gesture (*The
Encryption Key*), and a printed book containing the
scrambled motion capture data (*The Ciphertext*).

Author Keywords
Materiality, performativity, embodied interaction,
encryption, motion capture, data

ACM Classification
Human Centered Computing - Interaction design
theory, concepts and paradigms, - Virtual Reality;
Security & Privacy - Cryptography

Introduction
The Bronze Key is the result of a collaboration between
designers and artists within the rubric of a major

research project at Malmö University (Sweden) called Living Archives.[1] It points to one of the most urgent issues around archiving in the contemporary climate: we archive but we are archived. If we realize that our data – in particular our bodily data – are archived often without our awareness or consent, then encryption becomes a necessity that filters down to everyday usage. Jacob Appelbaum provides a succinct description of the cultural context. (See sidebar quote).

General attitudes towards encryption are that it is complex, mathematical or only used to mask illegal activities. An aesthetic approach to encryption explores the potential for new performances of encryption, removing it from the domain of the paranoid, criminal or hacker elite [13]. Obfuscation practices can be performative, playful and daily, as simple as switching off a device [4]. The design materials for *The Bronze Key* experiment are: movement sequences revealing an affective bodily state; the digital data they produce; motion capture (Perception Neuron system); VR (Oculus Rift's Quill); animation software for visualisation (Motion Builder) and various material extractions from the encryption process. The installation for TEI's Art Track will focus on three non-digital artifacts (audio, bronze, print) embodying the combination of digital and physical practices that produced them. As this is an on-going research process the objects will be produced in early 2018.[2]

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[1] http://livingarchives.mah.se/

[2] http://gibsonmartelli.com/SpacePlace/2017/10/12/performing-
[2] http://gibsonmartelli.com/SpacePlace/2017/10/12/performing-encryption/

The goal is for performative material translations to foster an awareness of the need for encryption and to spark a range of ideas around what shape encryption might take: whether or not these processes are functional is less pressing than generate ideas for how control over bodily data traces.

The Design Context: Embodied, Somatic and Political

The Bronze Key is located at the junction where Embodied Interaction opens onto an interdisciplinary domain, taking in politics, performance, data security and legal issues around media privacy [2], [4], [6], [8]. The work is post-digital by playing across the ways human physical interactions are digitally captured and then re-materialized once again in the physical world. This process of material translations reveal how digital materials and digital culture are not peeled away, like the unwanted skin of an orange, but remain within the newly designed object.

A somatic dimension is implied, because gestures and bodily motion cannot be disconnected from deeper affective and somatic states. Practices of somatic attention (in other words inner-sensing) that subsequently radiate into designed prototypes and design thinking are increasingly influential in the interaction design community [9], [16], as are performative approaches to engagement with designed systems [5], [11]. However, this project adopts an approach to somatics (and by extension somaesthetics) that expands outwards from these respected perspectives in the design community, in an attempt both to capture a frightening aspect of the human condition in digital culture and to operate with a definition of performativity that is based on

transformation [7] and emergence [12]. The feeling of surveillance, and powerlessness in the face of it, produces strong affective and emotional states. Laura Poitras is the film maker who worked with Edward Snowden in 2013 to release the NSA documents revealing the extent to which the personal daily communications of citizens of the US and UK are intercepted, analyzed, recorded, and archived without consent. She kept a journal from that time. In it she combines strategies for data and personal security with poignant phenomenological descriptions of her somatic state. (See sidebar quote.)

Two design takeaways emerge: 1) that the embodied/somatic/affective is rarely far removed from the digital in our culture of pervasive computing, and 2) given that our data is manipulated constantly, all of us very soon will have to decide what data we carry with us and whether to find our own ways to encrypt. Or as danah boyd says: "we need to reconsider what security looks like in a data driven world." [3]

Developing new encryption practices can begin with aesthetic, metaphoric and digital experimentation.

Cryptography

Cryptography refers quite broadly to the history and science of keeping information or communication secret. Encryption is a stage within this process, made up of a set of practices that render confidential communication unintelligible, or intelligible only to those with whom we desire to communicate [14]. This standard definition of encryption can be refined for performance and affective exchanges. The performance of encryption is not based on creating impermeable barriers or permanent containment, rather it

emphasizes a re-patterning or a distortion of a flow of communication. Ambiguity and translation of bodily movement into other material forms are foregrounded, making translation and interpretation essential to the process [12], [13].
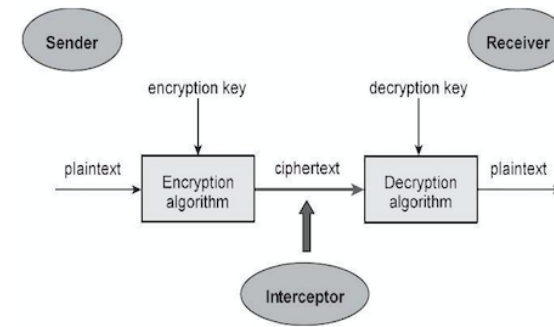

Figure 1: Basic cipher system (Piper & Murphy 2002, 8)

A basic symmetrical cipher system (Figure 1) has the following stages: A *plaintext* (readable message) is encrypted by means of an encryption algorithm embedded in a *key*. This is used to translate the plaintext into an incomprehensible *ciphertext (*or *cryptogram)*. The ciphertext is decrypted by a recipient who already possesses, or is able to guess, the key. After decryption, the plaintext is revealed once more. Classic encryption systems are symmetrical, meaning the sender and the receiver know each other and use the same key. They are also dynamic, meaning the passage of material information through time and space is usually implied. In a symmetric system the encryption and decryption algorithms are the same. It is worth noting that the contemporary encryption system securing all confidential internet transactions – such as banking -- is asymmetrical [14].

Figure 4: Key capture using Oculus Rift

Figure 5: Key capture using Oculus Rift

The Bronze Key

For *The Bronze Key* experiment we performed the basic cipher system and produced various materializations of each stage. The proposal for the Arts Track exhibition will consist in materializations of the first 3 steps: *The Plaintext*, *The Key*, and *The Ciphertext*.

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[Hips]
1      -4034.899902    951.2000122    6003     -1.341766
2      -4034.582275    951.2000122    6002.58252      -
3      -4034.399902    951.2333984    6002.263184     -
4      -4034.399902    951.3062134    6001.943848     -
5      -4034.399902    951.2999878    6001.729004     -
6      -4034.405762    951.1943359    6001.599609     -
7      -4034.299805    951.2999878    6001.599609     -
8      -4034.187988    951.2062988    6001.5  -1.257140
9      -4034.070313    951.2999878    6001.400391     -
10     -4033.950195    951.2999878    6001.350098     -
11     -4033.82959     951.2999878    6001.196289     -
12     -4033.69873     951.2999878    6001.105469     -
13     -4033.800049    951.2999878    6000.900391     -
14     -4033.905029    951.2999878    6000.693848     -
15     -4033.996338    951.4074097    6000.603516     -
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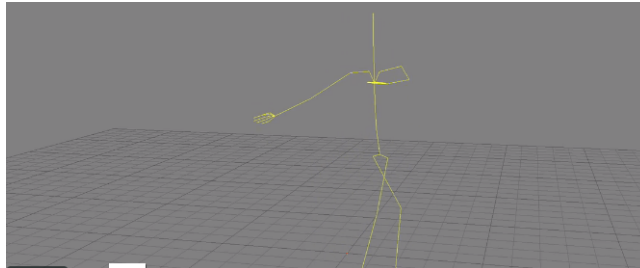**Figure 2:** *The Plaintext* mocap data in .htr format

Figure 3: *The Plaintext* in mocap animation. For video see https://vimeo.com/238730550

The Plaintext was a full body movement sequence (30 seconds) capturing a general state of being of one person as a message to be sent to another person. It was captured by the Perception Neuron motion capture system producing approximately 57,000 lines of numerical data representing the spatial and rotational information of each limb. (See Figures 2 & 3). *Materialization: text to speech of the numerical data recorded on magnetic audio tape and played on a cassette player.*
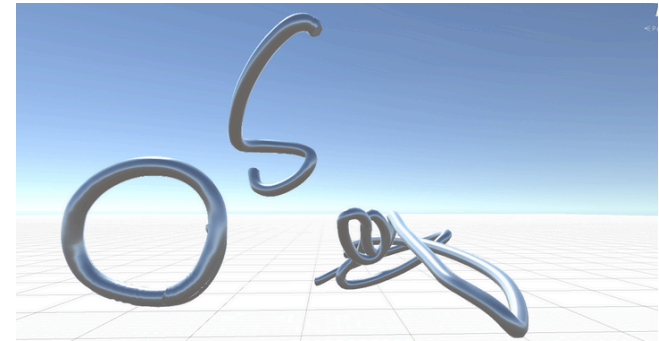

Figure 6: Three sample keys in VR using Quill, 3D package for the Oculus Rift in 3D .fbx file format

The Key was an arm and hand gesture (1 second) intended to unlock the movement sequence (Figures 4 & 5). It was captured using the Quill program in Oculus Rift (Figure 6). *Materialization: the 3D path of the gesture captured in VR space (looking like a squiggle) and cast as a bronze object.*

The Encryption Algorithm was a mathematical process whereby the mocap data was scrambled by applying the data from the key: each line of movement data was

subject to modification by a rolling series of mathematical functions (basic addition and subtraction) of the data from the key.
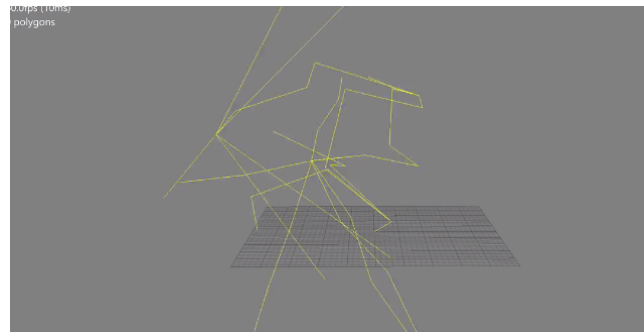

Figure 7: *The Ciphertext* in mocap animation. For video see https://vimeo.com/238730451
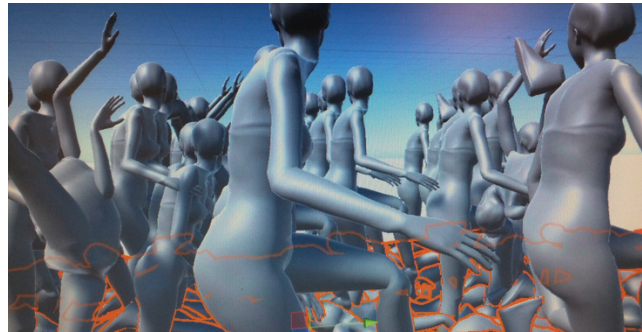

Figure 8: Alternate *Ciphertext*, on multiple bodies in Motion Builder

The Ciphertext or *Cryptogram* was the scrambled mocap data. When fed into an animation program such as Motion Builder the movement it generated was an obfuscation of the original sequence, making the affective and movement qualities unintelligible (Figures 7 & 8). *Materialization: a book containing the raw scrambled numerical data.*

Decryption, or "guessing the key," was a sort of game by which the recipient of the message wore the Oculus Rift running neural network gesture recognition software. By repeatedly attempting to perform the gesture represented by the bronze shape of The Key, the recipient would eventually hit the right gesture that the originator of the message provided. Once the gesture was recognized the scrambled data could – in theory – be decrypted and returned to plain text of coherent motion data, fed into Motion Builder again to produce an animation of the original sequence.

Conclusion

The Bronze Key art installation is the result of performative re-materializations of bodily data pointing to a complex or layered notion of the post-digital. The premise is that bodily gestures and motions are fundamentally personal and act as identifiers in the wider domain of data analytics and forensic data analysis. Retaining power over whether to be seen or not is important. It is a design issue of increasing importance.

Acknowledgements

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