

SWEN 422 Lecture 8

Digital Money 1

Dr Jennifer Ferreira

22 March 2024



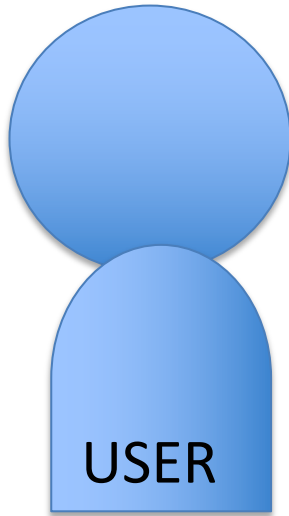
Agenda

- Review of previous lecture
- What is (digital) money?
- Digital money interfaces
- HCI and digital money research
 1. Critique and improve the design of current financial interactions
 2. Uncover everyday practices and design tools that support them
 3. Discover new ways of interacting with money and financial services

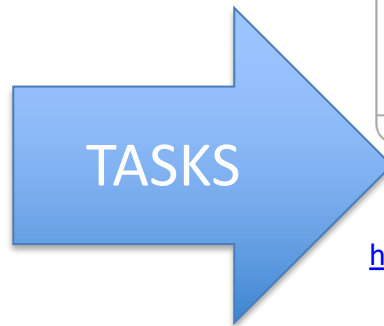
Human-Computer *Interaction*

- **Interaction**
 - between a biological information processor (i.e., the brain) and a mechanical information processor (i.e., the computer)
 - happens at the interface
- **Cognitive** processes define how the human brain processes input/information -> cognitive psychology
- **Representation** at the interface affects cognition

Mental model

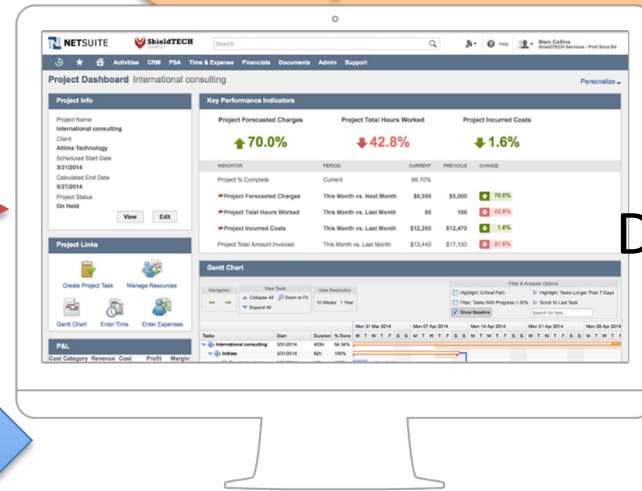


USER

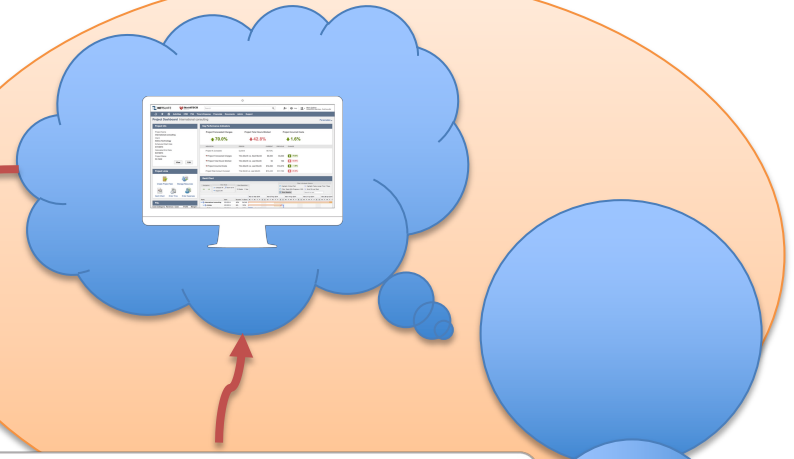


TASKS

Match



<https://www.netsuite.eu/products/experience/user-interface.shtml>



SYSTEM DESIGNER

Analyse tasks

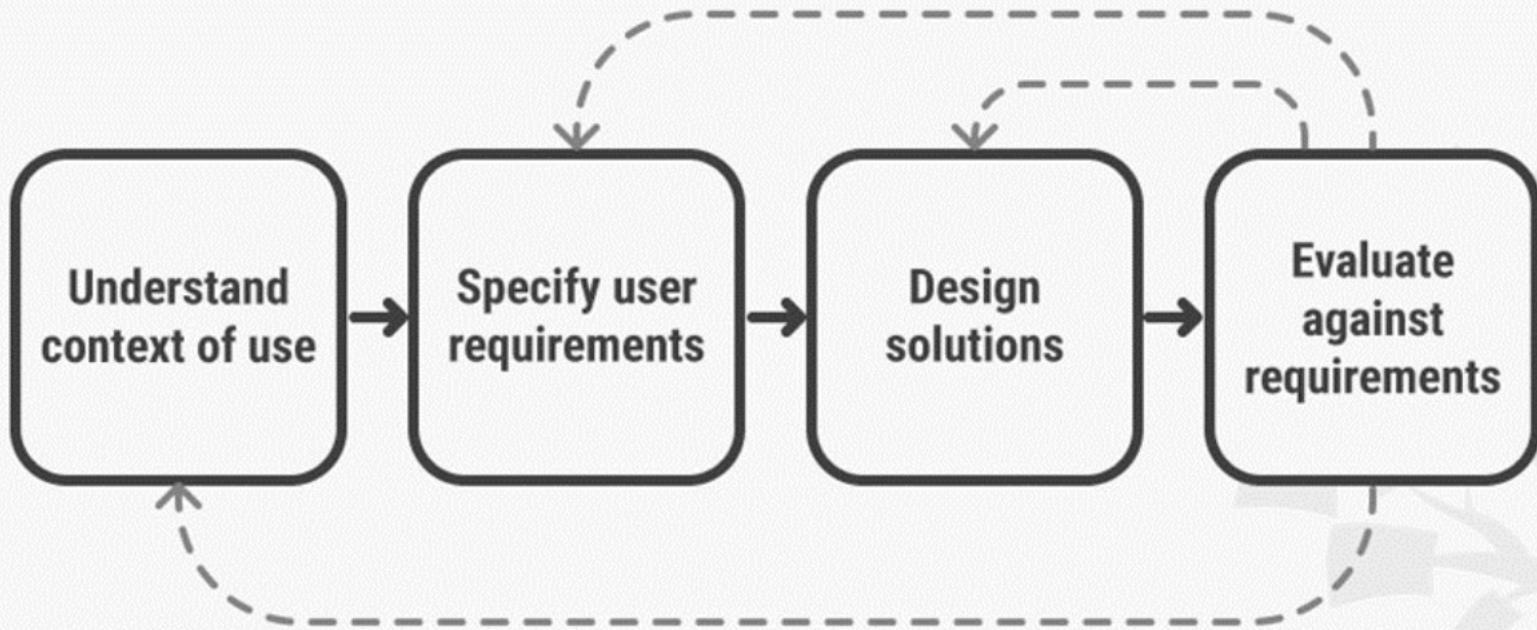
A classic HCI framework

Don Norman's (1988) framework of the relationship between the design of a conceptual model and a user's understanding of it

Consists of three interacting components:

- *The Designer's Model*
 - The model the designer has of how the system should work
- *System Image*
 - How the system actually works, which is portrayed to the user through the interface, manuals, help facilities, and so on
- *The User's Model*
 - How the user understands how the system works

How?



User-centered design is an iterative process that focuses on an understanding of the users and their context in all stages of design and development.

<https://www.interaction-design.org/literature/topics/user-centered-design>

What is money?





Image: <https://blog.dong-chinese.com/2019/05/10/insights-into-chinese-history-from-characters.html>

<https://www.moneymuseum.com/en/archive/cowry-shell-as-global-currency--25?&slbox=true>





Commodity money - has value from use as something other than money

Versus Fiat money - governments assign value, assign as legal tender

What is money?

money can be anything that can serve as a

- store of value, which means people can save it and use it later;
- unit of account, that is, provides a common base for prices; or
- medium of exchange, something that people can use to exchange for goods and services other than what it was originally exchanged for.

From: <https://www.imf.org/external/pubs/ft/fandd/2012/09/basics.htm>

What is money?

Eliminates the need for **double coincidence** of wants ([Jevons, 1875](#)).

Allows us to enter into exchanges **in the future**.

If it is accepted as money, it is money ([IMF, 2012](#)).

[Cigarettes as money in a WW2 POW camp](#)

Trust and belief

“The only backing of our money is universal **faith** and **trust** that the currency has value, and nothing more.”
([Principles of Economics 2nd Ed., 2017](#))

“**Trust** and **belief** then are now more than ever central to the valuation of money.” ([Vines et al., 2011](#))

When trust and belief break down

See Argentina & Brazil in the 1980/90s:

https://www.jstor.org/stable/158487?seq=1#metadata_info_tab_contents

See Turkey in 2005:

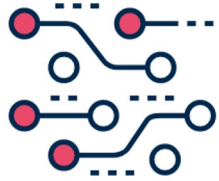
https://en.wikipedia.org/wiki/Revaluation_of_the_Turkish_lira

See Venezuela in 2018:

<https://www.dw.com/en/venezuelans-try-to-beat-hyperinflation-with-cryptocurrency-revolution/a-57219083>



What is digital money?



Bank of England



96% of money is held electronically (bank deposits)

4% of money is held physically in the form of cash (banknotes and coins)

Reserve Bank of New Zealand

~\$452 billion in bank deposits and ~\$8.6 billion in banknotes - 2023

[Video: Where does money come from?](#)

Cash use in New Zealand

Cash use is declining

- 96 percent of New Zealand's adult population use cash. Of that group, the older you are the more likely you are to use cash more frequently.
- Around 80 percent of New Zealanders carry at least some cash in their wallet.
- 30 percent of New Zealanders have cash stored somewhere other than a bank.
- There are no marked differences in cash use between the North and South Islands, nor by gender

[\[Survey by Reserve Bank of New Zealand\]](#)

Digital money

“any form of payment that is made possible by an electronic representation.” [[Reiss, 2019](#)]

“Digital money is the digital representation of value.” [[IMF](#)]

Who has the authority to *issue* (digital) money?

- Bank
 - Government (e.g. Central banks, Reserve Bank of New Zealand)
 - Commercial (e.g. ANZ, Westpac, etc.)

Sovereign currency
- Private (non-bank)
 - Corporation
 - Society
 - Community
 - Games

E.g. cryptocurrencies, community currencies, complementary currencies, local currencies, in-game currencies, etc.

Who has the authority to *issue* (digital) money?

- Bank **NEW ZEALAND \$, BRITISH £, JAPANESE ¥**
 - Government (e.g. Central banks, Reserve Bank of New Zealand)
 - Commercial (e.g. ANZ, Westpac, etc.)

} Sovereign currency
- Private (non-bank) **Bitcoin Bristol Pound Green Dollar**
 - Corporation
 - Society
 - Community
 - Games

} E.g. cryptocurrencies, community currencies, complementary currencies, local currencies, in-game currencies, etc.

Robux

Digital money interfaces

Earliest interface - ATMs

Developed in the UK? US? in 1960s

“Sleepless tellers” - [Tillie the teller](#)

Ergonomics ([Hatta & Liyama, 1991](#))

Menu design to reduce card re-insertions ([Curran & King, 2008](#))

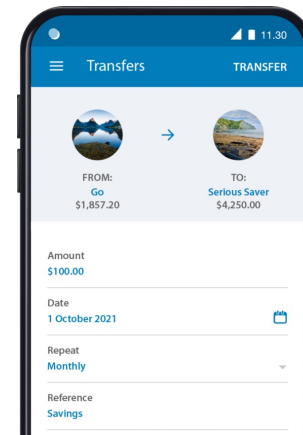
A brief history of the ATM ([Batiz-Lazo 2015](#))



More recent interfaces

- Mobile money & payments

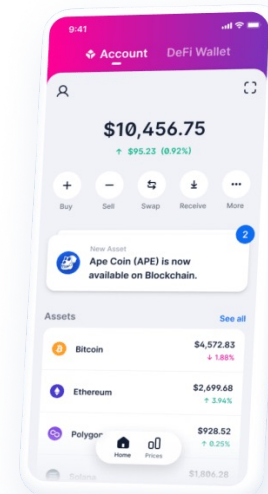
[Mobile Money and Payment: a literature review based on academic and practitioner – oriented publications \(2001 - 2011\)](#)



<https://www.anz.co.nz/banking-with-anz/ways-to-bank/gomoney/>

- Programmable money

[Programmable money: next-generation blockchain-based conditional payments](#)



<https://www.blockchain.com/wallet>

HCI and Digital Money Research

Why?

1. Evidence that existing tools do not meet people's needs
2. Design and innovation is being driven by commercial interests
3. Equity and ethical issues that need to be explored



HCI and Digital Money Research

Goals:

1. Critique and improve the design of current financial interactions
2. Uncover everyday practices and design tools that support them
3. Discover new ways of interacting with money and financial services



**Goal #1: Critique & improve the design of
current financial interactions**

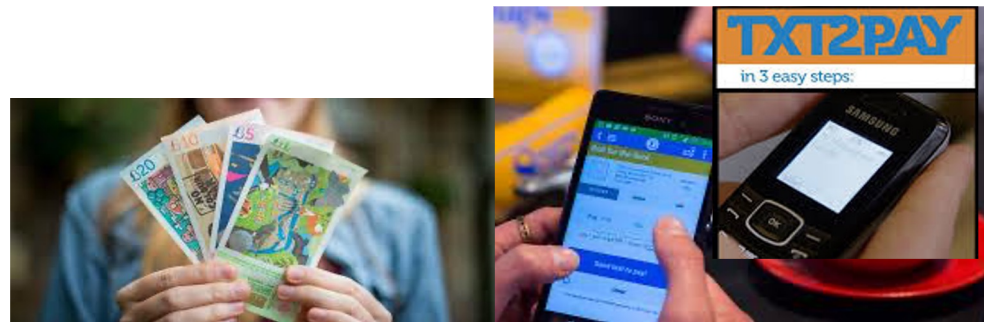
Spending Time with Money: From Shared Values to Social Connectivity

Context: Bristol Pound users in Bristol (UK) & Txt2Pay system (pay by text)

Research question: How do users make payments through mobile technology, and how does this impact on their activities, understandings and social interactions?

Research data: Online survey, interviews & observations

Jennifer Ferreira, Mark Perry, and Sriram Subramanian. 2015. **Spending Time with Money: From Shared Values to Social Connectivity**. In *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing (CSCW '15)*. Association for Computing Machinery, New York, NY, USA, 1222–1234



Spending Time with Money: From Shared Values to Social Connectivity

A £B transaction was more than just handing over money



Uses of the TXT2PAY transaction

To trust

To play

To think

To connect

To display

To talk

To learn

Uses of the TXT2PAY transaction

To trust

To play

To think

To connect

To display

To talk

“I think you spend more time talking to the cashiers which is quite nice. Because it's a novelty, you start joking about it.”

[interview participant]

To learn

Uses of the TXT2PAY transaction

To trust

To play

“Txt2Pay’s more fun because you can’t do that with normal money. You can’t do that with a card. You’re both standing there with your phones waiting for the first one to beep. And someone says “Oh is your name John” and I say “Yeah” and it’s quite nice.”

To think

[interview participant]

To connect

To display

To talk

To learn

Uses of the TXT2PAY transaction

To trust

To play

To think

To connect

“In my local cafe where I live I now am on first name terms with the manager, George. I say “George, if I pay you £B80 in Txt2Pay will you give me 60 pounds in cash?” [interview participant]

To display

To talk

To learn

Spending Time with Money: From Shared Values to Social Connectivity

Transactions are social interactions



Speeding up vs Slowing down

Seamful interactions [[Chalmers & Galani, 2014](#)]

Co-production [[Ostrom, 1996](#)]

[https://en.wikipedia.org/wiki/Elinor_Ostrom]

“...practices around making payments support people in making connections, to other people, to their communities, to the places they move through, to their environment, and to what they consume.” [[Ferreira & Perry, 2015](#)]

Studies of (complementary) money use

“re-thinking money provides a powerful means for restructuring the hierarchies and networks of economic exchange” ([Huttunen & Joutsenvirta, 2018](#))



Goal #1: Critique & improve the design of current financial interactions

- Diary Studies on internet payments:

Abrazhevich, D., & Markopoulos, P. (2002) **Diary Study on Internet Payment Systems**. Proceedings Vol 2 of the 16th British HCI Conference.

<https://pure.tue.nl/ws/portalfiles/portal/2329427/352065216000343.pdf>

- Ethnographic studies:

Scott Mainwaring, Wendy March, and Bill Maurer (2008) **From *meiwaku* to *tokushita*! lessons for digital money design from Japan**. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '08)*.

Association for Computing Machinery, New York, NY, USA, 21–24.

DOI:<https://doi.org/10.1145/1357054.1357058>

Goal #1: Critique & improve the design of current financial interactions

- Interviews & Observations:

Ferreira, J., Perry, M., & Subramanian, S. (2015) **Spending Time with Money: from shared values to social connectivity**. In Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing (CSCW '15). ACM, New York, NY, USA, 1222-1234.

<https://doi.org/10.1145/2675133.2675230>

- Failure

J. Ondrus, K. Lyytinen and Y. Pigneur (2009) **Why Mobile Payments Fail? Towards a Dynamic and Multi-Perspective Explanation,** " 2009 42nd Hawaii International Conference on System Sciences, pp. 1-10.

<https://doi.org/10.1109/HICSS.2009.510>

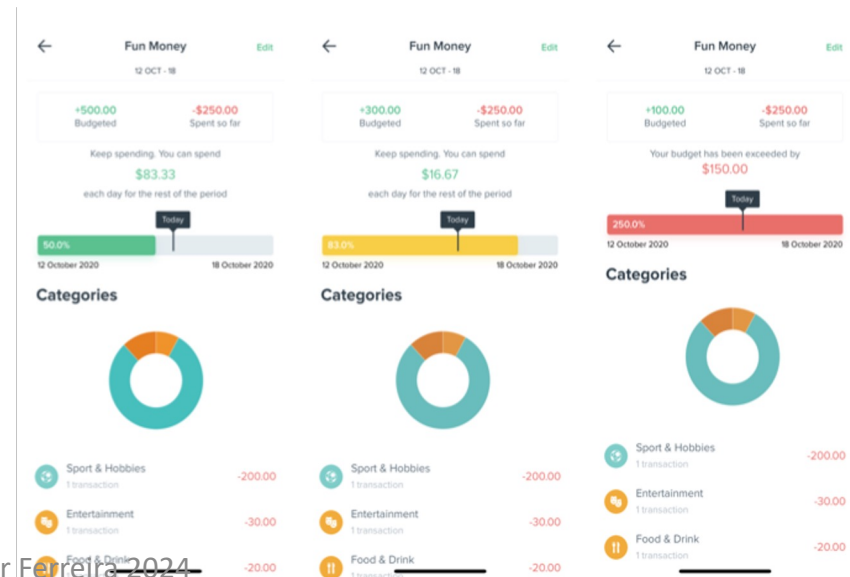
Goal #2: Uncover everyday practices and design tools that support them

Designing mobile applications for personal financial management: An exploratory user-centred design study

Annisha Akosah's 489 project (2020), now working at Xero

Personal financial management: a wide range of practices that include assessing, planning, forecasting, decision-making, goal-setting, evaluating, and using financial resources such as cash, credit, savings, and investments (Deacon & Firebaugh, 1988; Chen & Volpe, 1998).

Akosah A, Pantidi N, Ferreira J (upcoming) **Designing mobile applications for personal financial management: An exploratory user-centred design study**. In: Chou D., O'Sullivan C., Papavassiliou V. G. (eds) *FinTech Research and Applications: Challenges and Opportunities*. World Scientific Publishing.



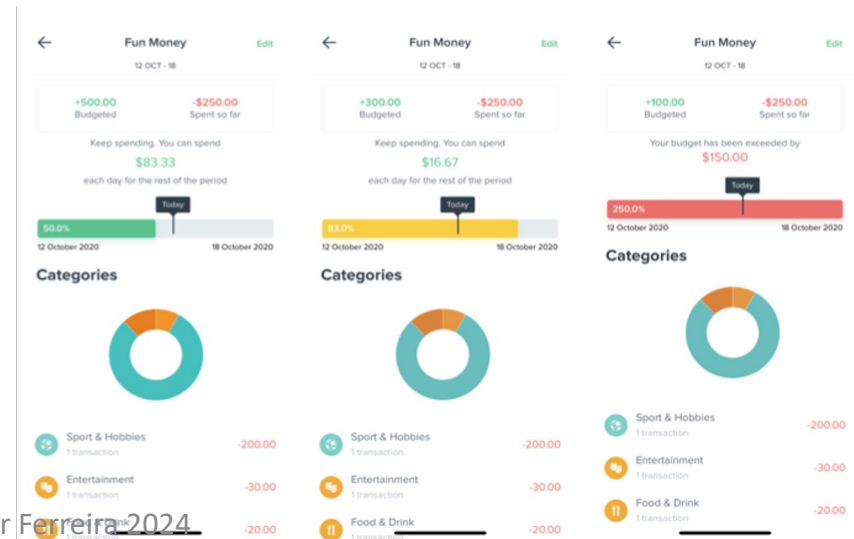
Designing mobile applications for personal financial management: An exploratory user-centred design study

Annisha Akosah's 489 project (2020), now working at Xero

Research question: What can we learn about mobile personal financial management by applying the user-centered design approach?

Research approach: Interviews, iterative prototyping, usability evaluations

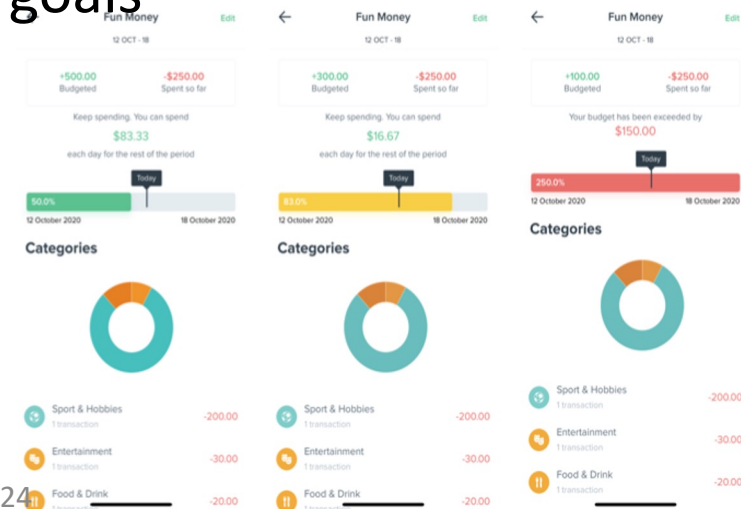
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Designing mobile applications for personal financial management: An exploratory user-centred design study

Problems with existing tools:

- Non-mobile tools quickly become out of date
- People are concerned with privacy and security of their data
- Current tools do not have good support for
 - Categorisation of spending
 - Constraining spending and setting goals
 - Adjusting timescales



People do not stick to accounting rules

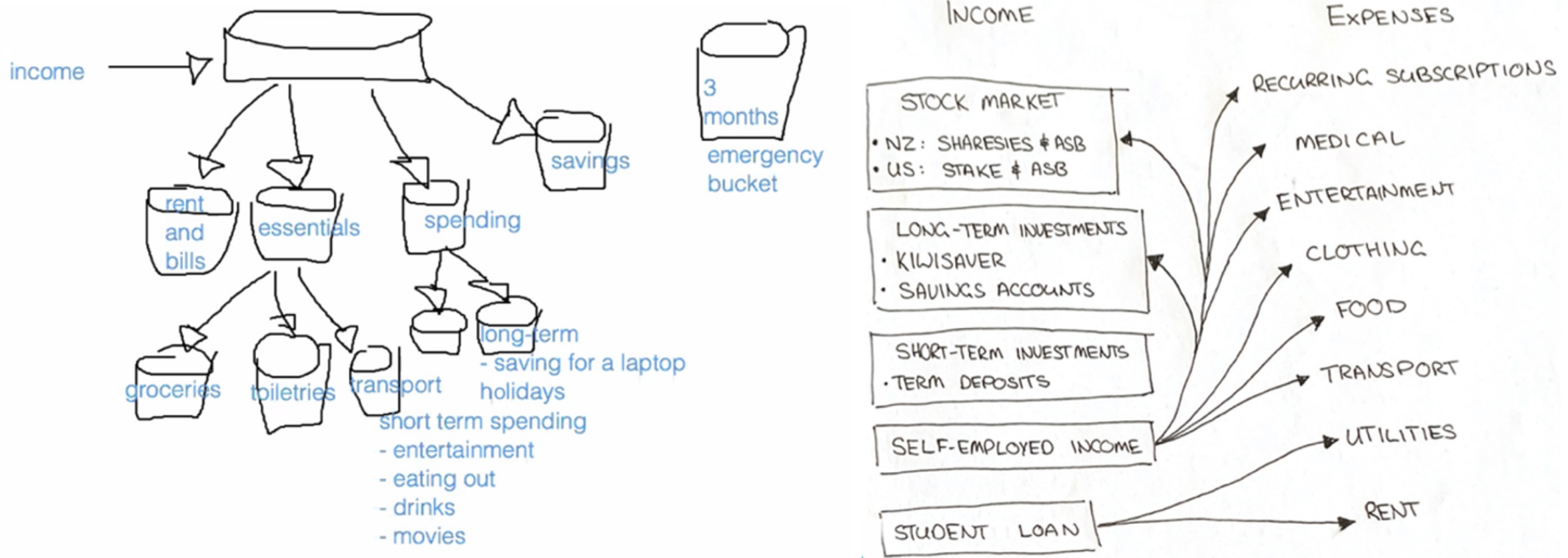
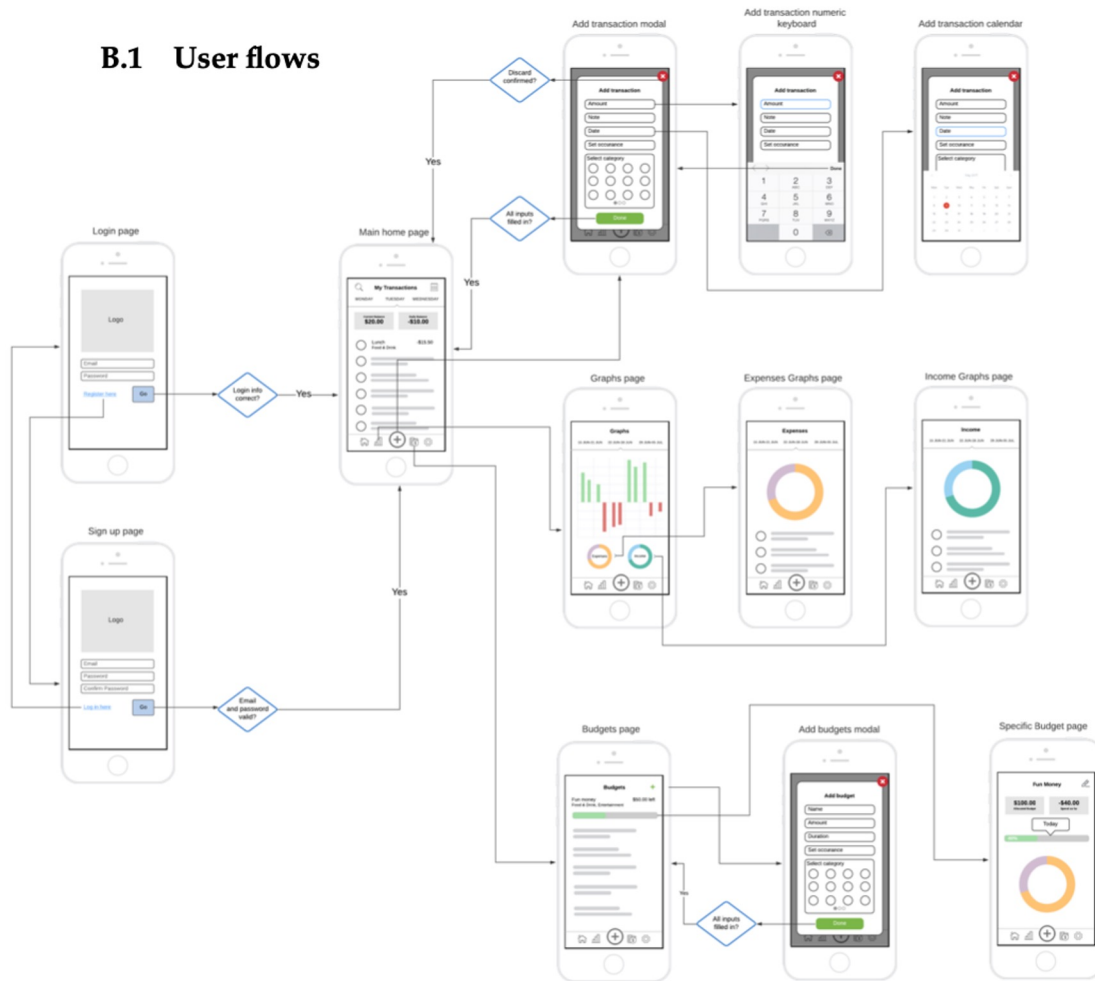


Figure 2 When asked to draw a map of their finances, Alice drew the image on the left depicting money buckets and Diego drew his income and expenses using boxes linked with arrows (right).

B.1 User flows



Functional requirements (FR):

- FR1 Log income and expenses over a given period of time. Users should have the ability to either manually input this data or set it as a fixed recurring value.
- FR2 Perform categorisation of income and expenses into more granular groups (e.g. Food Drink, Entertainment).
- FR3 Visualise income and expenses using graphical representations and allow a view of different and customisable timescales.
- FR4 Auto-predict and suggest common entries when adding new transactions for faster manual logging of transactions.
- FR5 Create budgets to represent the allocation of funds to specific categories. Using the logging (FR1) and categorisation (FR2) features, this should track the user's spending against the set budget. Notifying the user in the form of a push notification when they are close to the upper limit of the budget is desirable.
- FR6 Search and filter through transactions.
- FR7 Support multiple accounts as separate 'wallets' for one given user.
- FR8 User authentication and data encryption to enforce privacy and security, as well as maintaining data persistence.

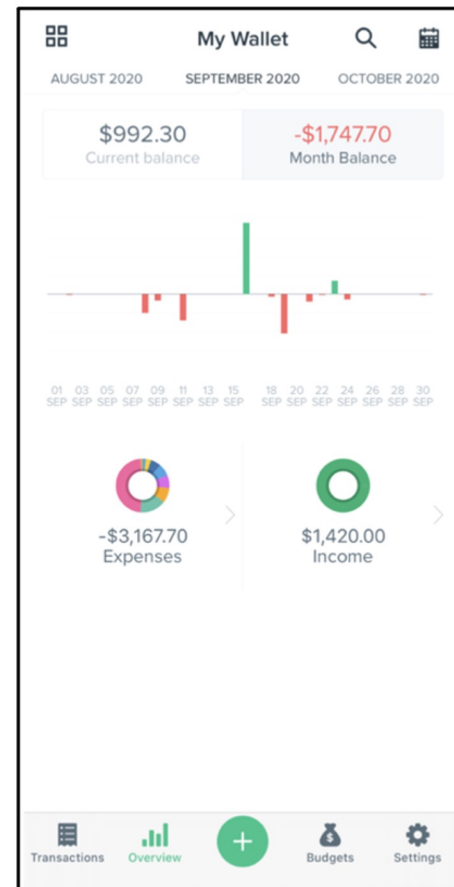
Non-functional requirements (NFR)

- NFR1 Privacy and security
- NFR2 Accessibility and availability.

Designing mobile applications for personal financial management: An exploratory user-centred design study

Conclusions:

- Small screen limitations
- Trade-off between tedious text input and privacy & control
- Opportunities to interact with different timescales is difficult to convey in the UI
- Platforms conventions



Goal #2: Uncover everyday practices and design tools that support them

Understanding users

Khairuddin, I. E., & Sas, C. (2019) **An Exploration of Bitcoin Mining Practices: Miners' Trust Challenges and Motivations**. Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems, 629:1-629:13. <https://doi.org/10.1145/3290605.3300859>

Allen, M.W., Edwards, R., Hayhoe, C.R. *et al.* **Imagined interactions, family money management patterns and coalitions, and attitudes toward money and credit**. *J Fam Econ Iss* 28, 3–22 (2007). <https://doi.org/10.1007/s10834-006-9048-1>

Snow, S., & Vyas, D. (2015) **Fixing the Alignment: An Exploration of Budgeting Practices in the Home**. Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems, 2271–2276. <https://doi.org/10.1145/2702613.2732808>

Lewis, M., & Perry, M. (2019) **Follow the Money: Managing Personal Finance Digitally**. Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems, 390:1-390:14. <https://doi.org/10.1145/3290605.3300620>

Joseph Jofish Kaye, Mary McCuiston, Rebecca Gulotta, and David A. Shamma. 2014. Money talks: tracking personal finances. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '14)*. Association for Computing Machinery, New York, NY, USA, 521–530. DOI:<https://doi-org.helicon.vuw.ac.nz/10.1145/2556288.2556975>

Goal #2: Uncover everyday practices and design tools that support them

UI Design

Merdenyan, Burak, Kocyigit, Orkun, [Bidar, Reihaneh](#), Cikrikcili, Onur, & Salman, Y. Batu (2014) **Icon and user interface design for mobile banking applications**. *International Journal of Advances in Computer Science and Its Applications*, 4(2), pp. 55-59.

Hulikal Muralidhar, S., Bossen, C., Mehra, A., & O'Neill, J. (2018). **Digitizing Monetary Ecologies: Intended and Unintended Consequences of Introducing a Financial Management App in a Low-Resource Setting**. Proceedings of the ACM on Human-Computer Interaction, 2(CSCW), 72:1-72:17. <https://doi.org/10.1145/3274341>

Akosah A, Pantidi N, Ferreira J (upcoming) **Designing mobile applications for personal financial management: An exploratory user-centred design study**. In: Chou D., O'Sullivan C., Papavassiliou V. G. (eds) *FinTech Research and Applications: Challenges and Opportunities*. World Scientific Publishing.

N. Ramasubbu and R. Balan, "The Digital Wallet: Opportunities and Prototypes" in *Computer*, vol. 42, no. 04, pp. 100-102, 2009. <https://apollo.smu.edu.sg/papers/balan-digitalwallet-ieeecomputer.pdf> SWEN422 Dr Jennifer Ferreira 2024

**Goal #3: Discover new ways of interacting
with money and financial services**

Goal #3: Discover new ways of interacting with money and financial services

Novel interfaces & materials

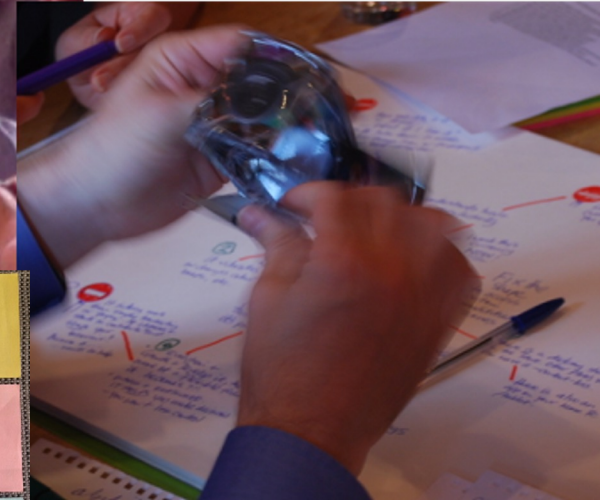
Ferreira J, Perry M (2014) **Building an Alternative Social Currency: Dematerialising and rematerialising digital money across media.** HCI Korea 2014, Seoul, Korea



<https://doi.org/helicon.vuw.ac.nz/10.1145/3170427.3186607>



<https://cacm.acm.org/magazines/2011/8/114948-skinput/fulltext?mobile=false>



Goal #3: Discover new ways of interacting with money and financial services

Materialising the blockchain [[Khairuddin et al., 2019](#)]

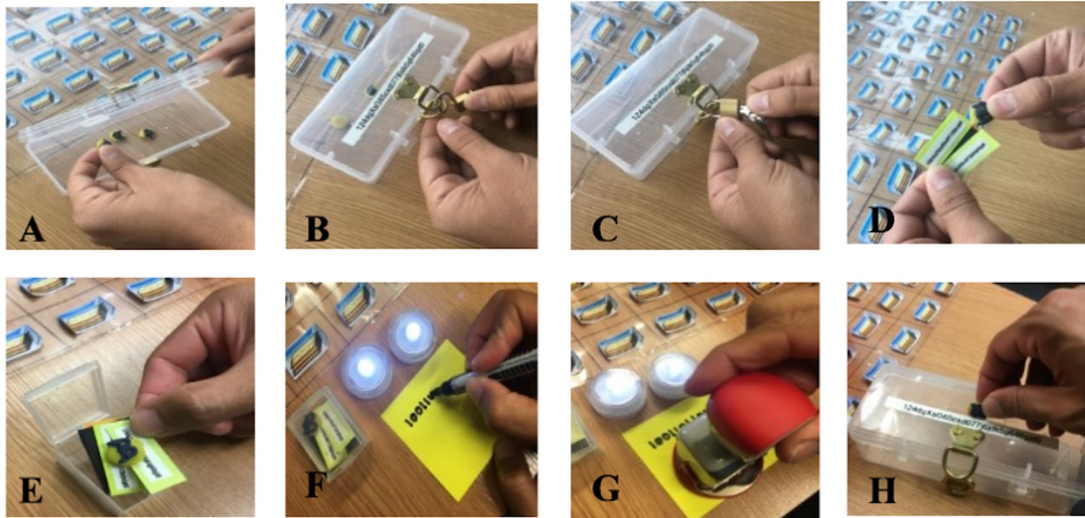
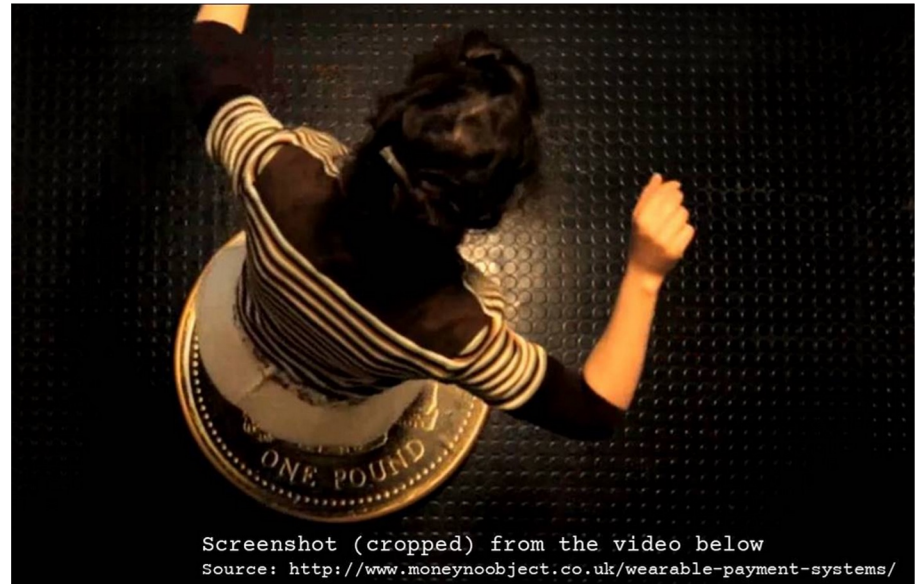
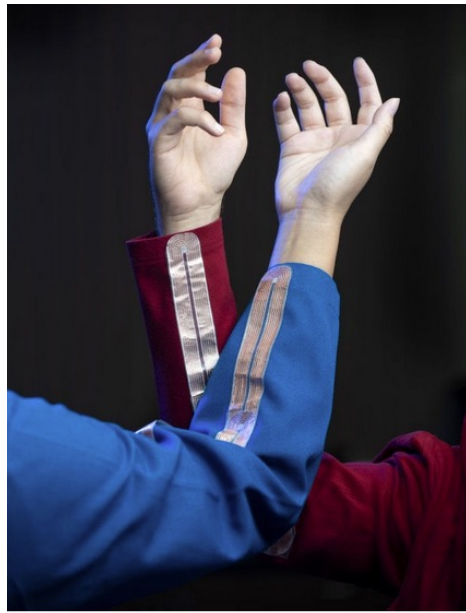


Figure 2: Interacting with BlockKit Objects

- A- Placing bitcoins in the wallet**
- B- Securing the wallet with password**
- C- Logging in to the wallet**
- D- Creating a bitcoin transaction**
- E- Placing the transaction in a block**
- F- Solving the block puzzle through miners' computational power**
- G- Recording the time for the proof-of-work**
- H- Sending the bitcoins to receiver's wallet**

Goal #3: Discover new ways of interacting with money and financial services

<https://moneyness.info/dance-hug-pay/#>



[UCI invention lets people pay for purchases with a high-five](#)

Equity & Ethical issues

Digital Equity

“a digital divide exists when a group’s access to digital technologies and resources differs along one or more dimensions of social, economic, cultural, or national identity.”

Problems of access and knowledge lead to exclusion from physical, intellectual, digital, social, economic, cultural, and/or national life, resulting in gaps between those that have access and those that do not.

Equality - each person receives an equal share of resources despite what they already have, or don’t have.

Equity - resources are shared based on what each person needs in order to adequately level the playing field.

Ethics

Ethics is about making the best possible decisions concerning people, resources and the environment.

System of principles and values that helps us make those decisions.

- [NZ Institute of IT Professionals Code of Ethics](#)
- [ACM Code of Ethics](#)
- [IEEE Code of Ethics](#)

Ethical values e.g., integrity, honesty, trustworthiness, responsibility

Equity & ethical issues

Covid-19

Cryptocurrencies

Cashless society



(Financial) Literacy

Poverty

2 Billion Unbanked ([2017](#))

Aging population



DDoS attack 3 September 2021



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September 8, 2021
2:15 PM NZST
Last Updated 21 days ago

Asia Pacific

New Zealand banks, post office hit by outages in apparent cyber attack

2 minute read

By Paulina Duran

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


CERT NZ  @CERTNZ · Sep 8

CERT NZ is aware of a DDoS attack targeting a number of New Zealand organisations. We are monitoring the situation and are working with affected parties where we can.

 3

 107

 130



Equity & ethical questions

For any system:

Who benefits and who gets left behind?

Whose life is made easier and whose is made more difficult?

Are we satisfied with the status quo? Or can we think of ways to do better?

Equity & Inclusion

Woldmariam, M. F., Ghinea, G., Atnafu, S., & Grønli, T. M. (2014, June). **Mobile money system design for illiterate users in rural Ethiopia**. In International Conference of Design, User Experience, and Usability (pp. 482-491). Springer, Cham.

Al-Muwil, A., Weerakkody, V., El-haddadeh, R. et al. **Balancing Digital-By-Default with Inclusion: A Study of the Factors Influencing E-Inclusion in the UK**. *Inf Syst Front* 21, 635–659 (2019).
<https://doi-org.helicon.vuw.ac.nz/10.1007/s10796-019-09914-0>

Kaushik Ghosh, Tapan S. Parikh, and Apala Lahiri Chavan. 2003. **Design considerations for a financial management system for rural, semi-literate users**. In *CHI '03 Extended Abstracts on Human Factors in Computing Systems (CHI EA '03)*. Association for Computing Machinery, New York, NY, USA, 824–825. DOI:<https://doi-org.helicon.vuw.ac.nz/10.1145/765891.766014>

Tandon, U., Siri, L., Mehra, A., & O'Neill, J. (2019). **Designing a financial management smartphone app for users with mixed literacies**. Proceedings of the Tenth International Conference on Information and Communication Technologies and Development, 1–5.
<https://doi.org/10.1145/3287098.3287131>

Bátiz-Lazo B., Haigh T., Stearns D.L. (2016) **Origins of the Modern Concept of a Cashless Society, 1950s–1970s**. In: Batiz-Lazo B., Efthymiou L. (eds) *The Book of Payments*. Palgrave Macmillan, London. https://doi.org/10.1057/978-1-137-60231-2_10