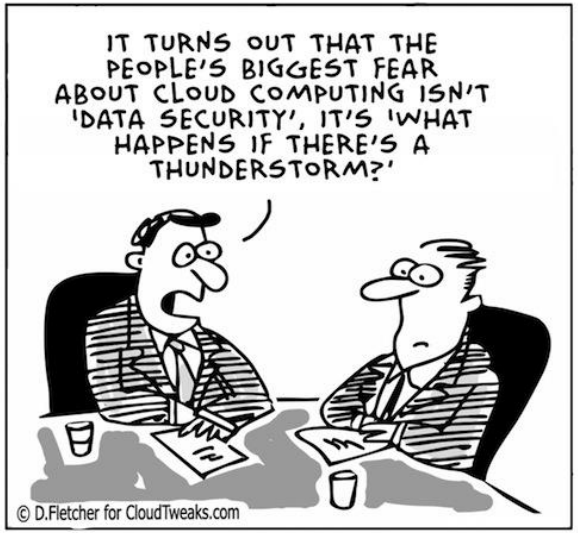
User-centred Data Products

By Marieke Peeters
18 June 2021
Xpert Session Xomnia

Why do 87% of data projects never make it into production?



Source: [Why do 87% of data science projects never make it into production?](#) From Venturebeat

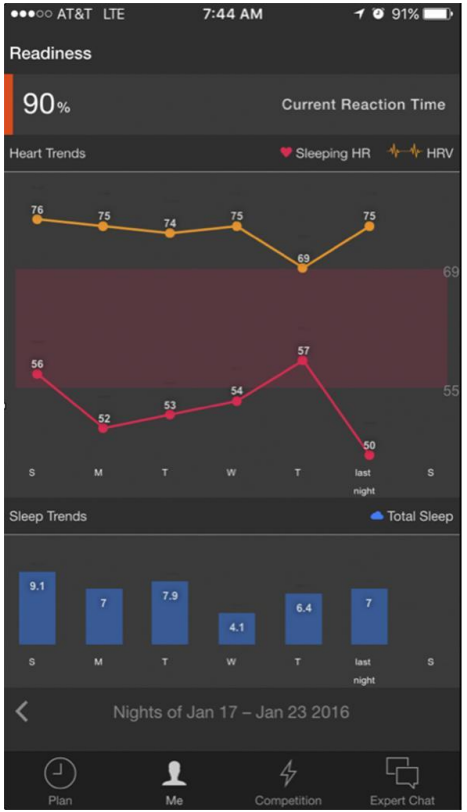
Common experiences with data projects

Have you ever experienced that the data solution you worked (hard) on:

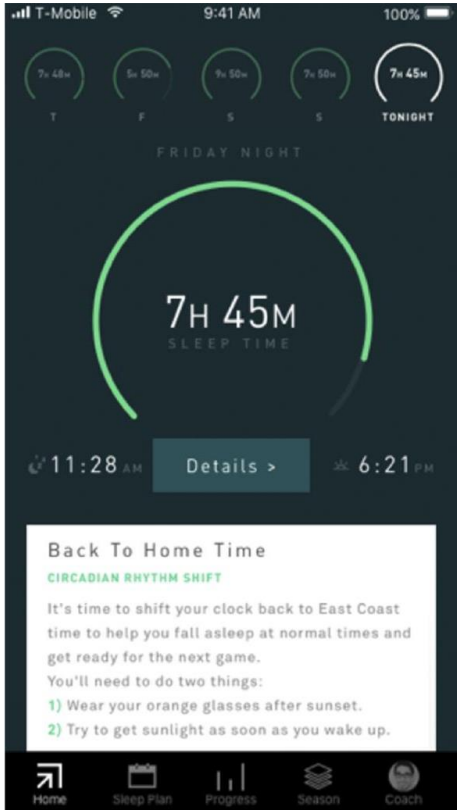
- wasn't valued or adopted by the business?
- went to production, but still wasn't really used in practice?
- wasn't delivering the expected / desired business value?

Sometimes to the point where management starts to complain about the return on investment of the entire data science team / department?

Example



Version 1: Rise DS solution



Version 2: solution developed together with IDEO designers

Source: [What Happens When Data Scientists and Designers Work Together]

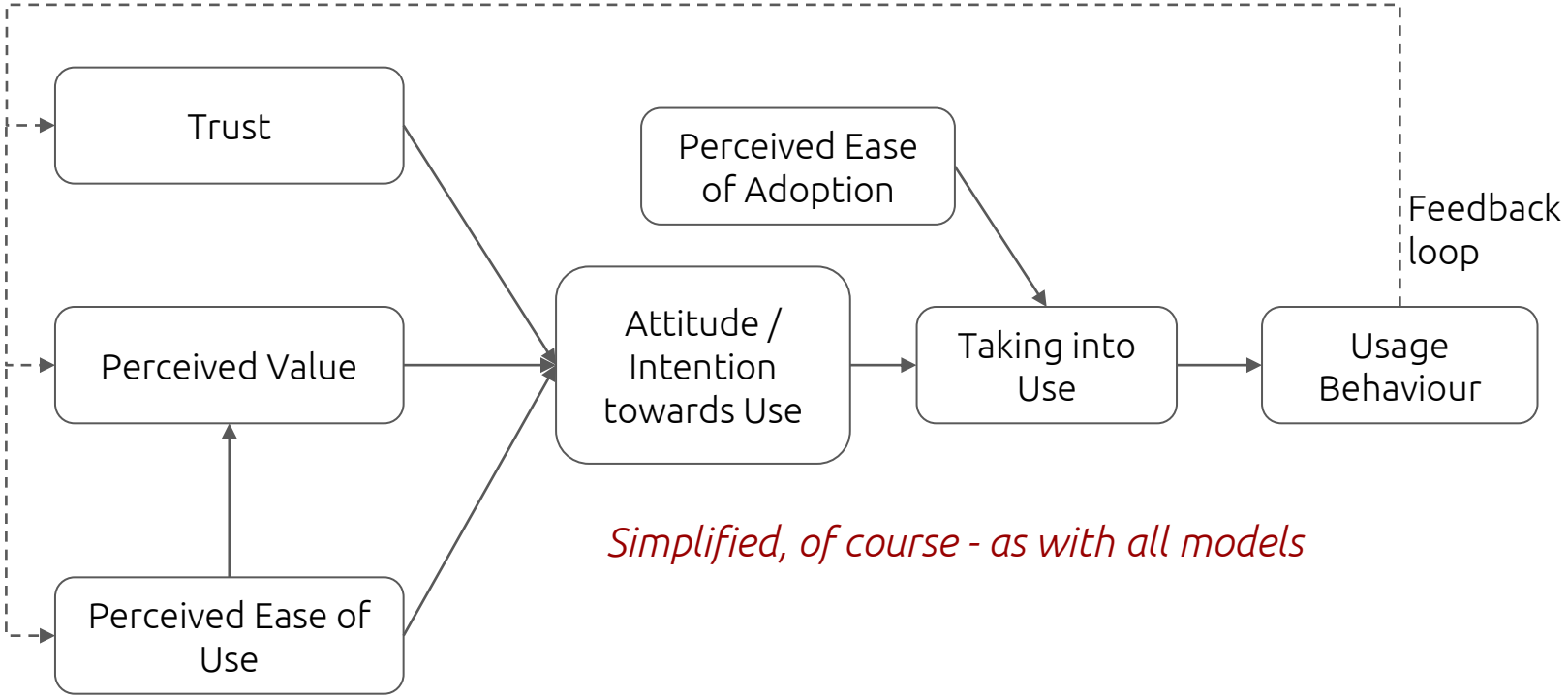
What makes DS/ML projects so likely to fail?

	User base / Business world	***Data experts / Data world***
	Deterministic thinking	Probabilistic thinking
	Desire for fully worked out plans and predictability	Uncertain / unpredictable ROI
	Place trust in experts / business rules; are risk-averse	Want to replace trusted parties / systems with unknown solution
	More natural collaboration between overlapping expertises	Mono-disciplinary teams, with in depth knowledge of new technologies

Source: [Data Science as a Product. Going from MVP to production. | by Tad Slaff](#) from Picnic

Wouldn't it be amazing if users and stakeholders felt our data products were “game changers?”

Why is a solution (not) adopted by a user?



Simplified, of course - as with all models

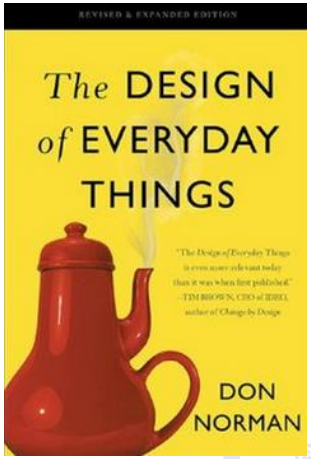
Source: Kaasinen, E. (2005). User acceptance of mobile services: Value, ease of use, trust and ease of adoption.

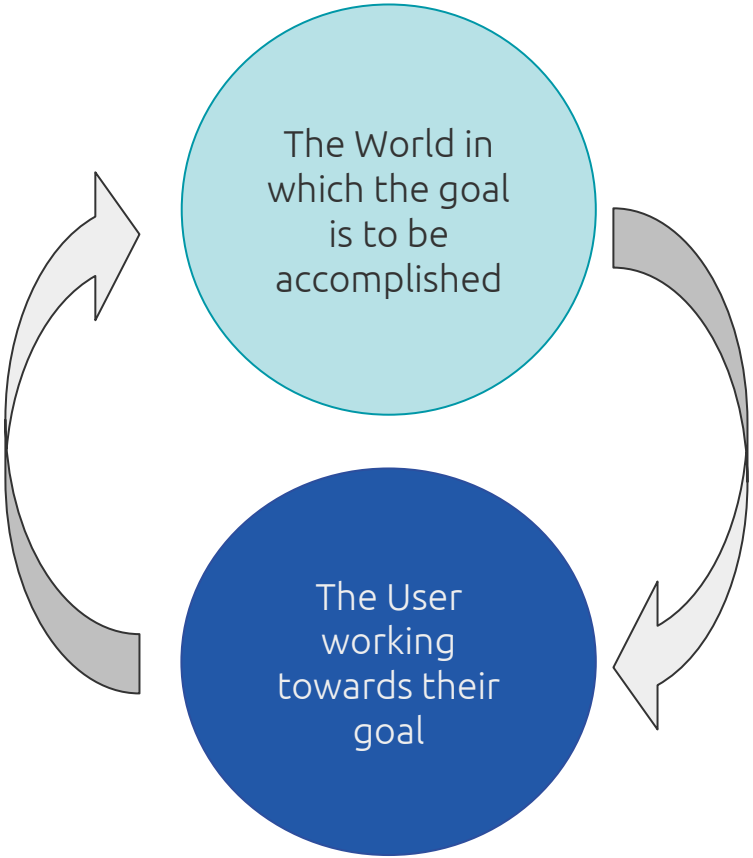
Alignment requires more than model performance

ML projects require good collaboration and understanding between business and data teams:

- Business teams should sufficiently understand how developed data driven solutions work.
- **Data teams should sufficiently understand how the model will be used.**

How a user perceives your product





Gulf of Execution

How do I use this system?

How do I work this?

What can I do?

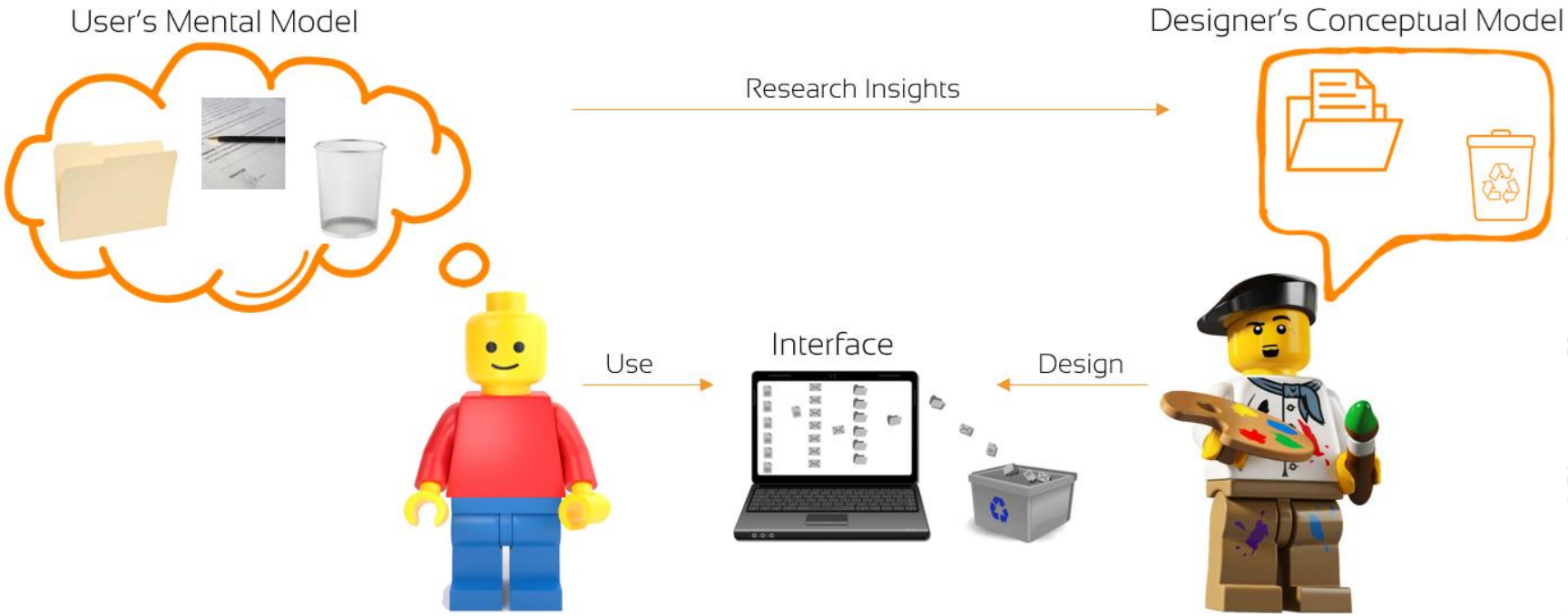
Gulf of Evaluation

What's the current system state?

What happened (after my previous action)?

Is this what I wanted?

A user's mental model



Source: [Understanding mental and conceptual models in product design]

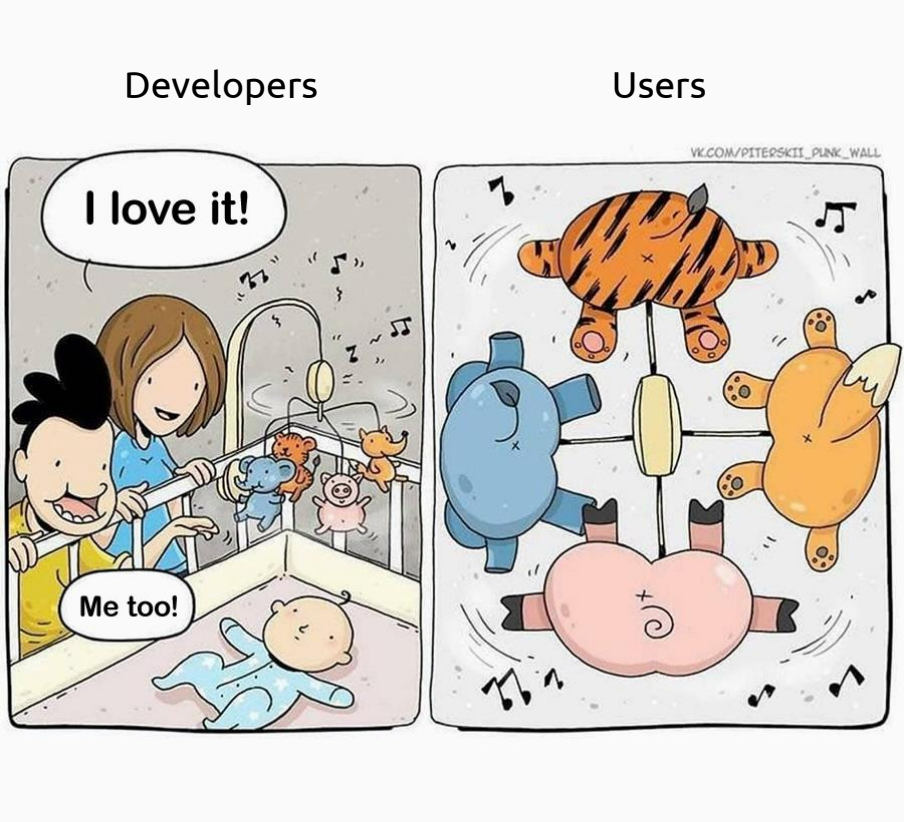
Help your user develop an accurate mental model

Example

A. Make your design conform to the users' mental models

B. Help your users create mental models that accurately reflect your design

It is all about different perspectives



PACT

People:
Who are the users?

Activities:
What would they do?

Context:
What is the context?

Technologies:
Which artefacts
can support them?

PACT





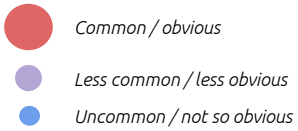

Spotting and using user errors to your advantage

Collect data and identify how to prevent that error in the future: it's a chance to improve your product.

Examples of potential causes:

- False assumptions about user knowledge
- Insufficiently intuitive design
- Unclear / misleading questions and options
- Insufficient training / documentation / supervision
- User base changed since design specification

Different types of data products



Form: how is the content received?	**Function: what content is the user consuming?**				
	Raw data	*Derived data*	*Algorithms*	*Decision support*	*Automated decision making*
APIs					
Dashboard & visualisations					
Web elements					

Source: [Designing Data Products. The 15 faces of Data Products are a… | by Simon O'Regan]

Examples of human-data product interaction

Example 1: Code usability - users of your code require a mental model of your code's,e.g., logic, functions, variables, and classes.

```
for i in range(n):
    for j in range(m):
        for k in range(l):
            temp_value = X[i][j][k] * 12.5
            new_array[i][j][k] = temp_value + 150
```

```
# Don't do this
temp = get_house_price_in_usd(house_sqft, house_room_count)
final_value = temp * usd_to_aud_conversion_rate


# Do this instead
house_price_in_usd = get_house_price_in_usd(house_sqft,
                                            house_room_count)
house_price_in_aud = house_price_in_usd * usd_to_aud_conversion_rate
```

Source: Data Scientists: Your Variable Names Are Awful. Here's How to Fix Them.

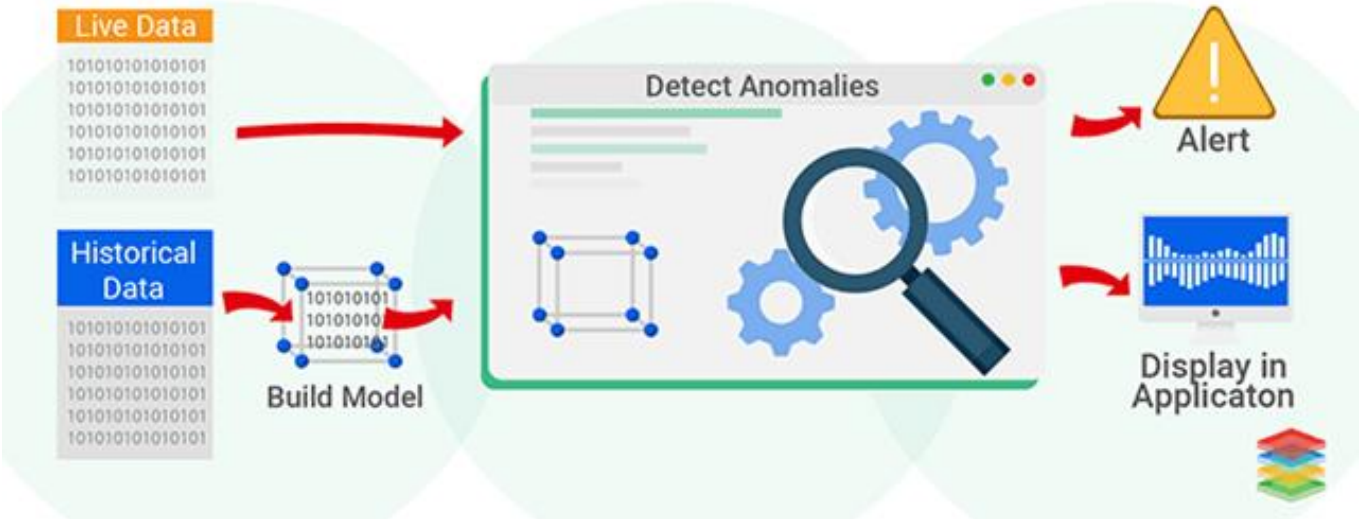
Examples of human-data product interaction

Example 2: API usability testing - APIs require a mental model of the services offered by your library / framework

Source: How to apply UX principles and methods to API usability - DeveloperRelations.com
Source: The Ultimate Guide to Usability Testing - Marvel Blog

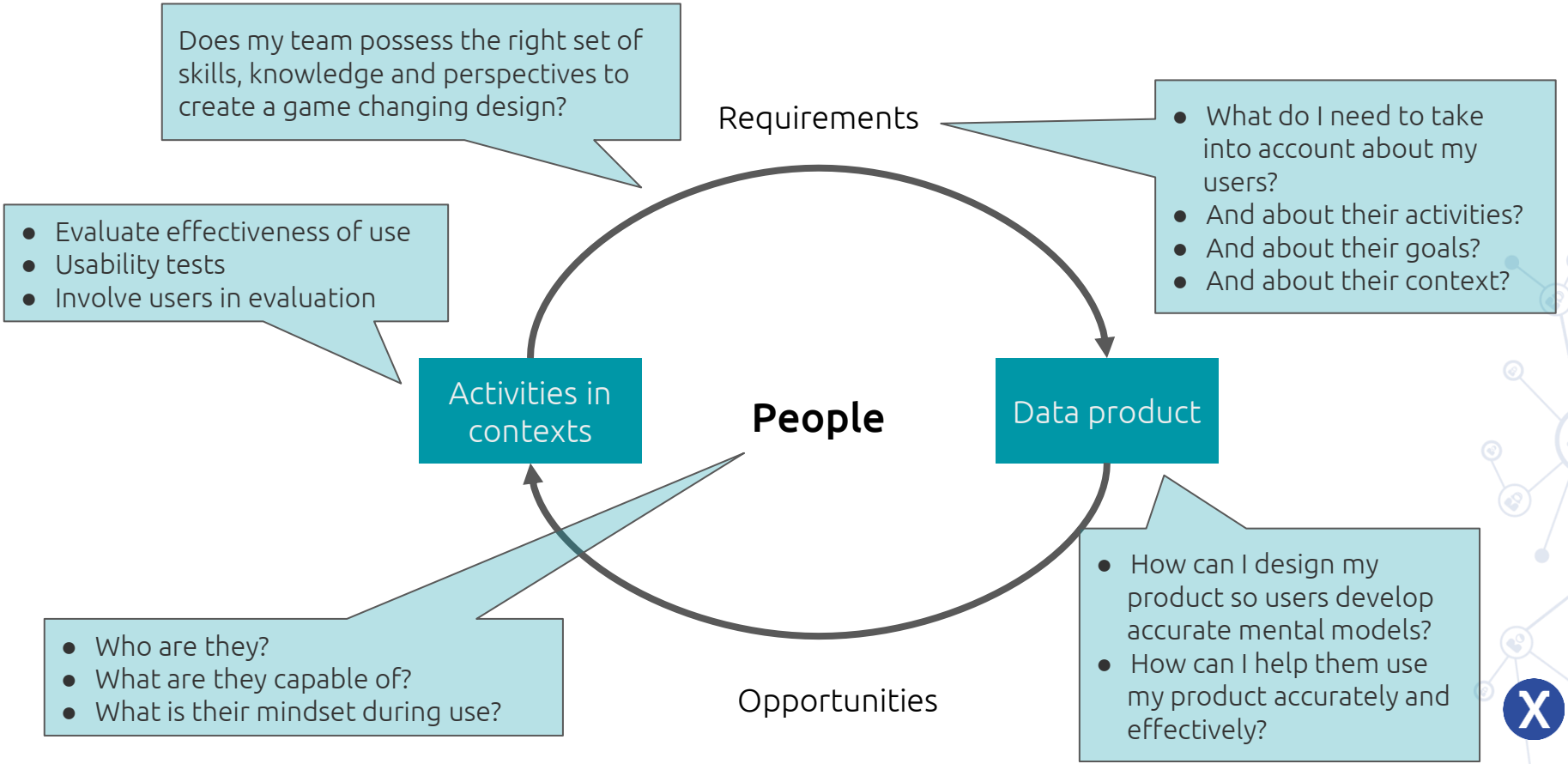
Examples of human-data product interaction

Example 3: Real time anomaly detection, requires a mental model of how to analyse and handle an incident



Computers becoming better in specialised tasks is scary, but offers new opportunities

User-centred design of a (data) product cheat sheet



A data solution doesn’t have to be perfect.

It should be valuable, usable, trustworthy, and adoptable for the user.

If it serves its user in doing a better job in a comfortable manner,
it is already creating business value.

It’s not (just) about optimizing model performance,
it’s about optimizing the performance of the system that surrounds it..

User-centred design focuses on the user:
How can your product help the user do a better job?

Appendix

References for those who want more

- AI Needs Human-Centered Design (Deloitte)
- What Happens When Data Scientists and Designers Work Together (Harvard business review)
- 10 rules for better dashboard design | by Taras Bakusevych
- Human-Centered API Design (API as a product.com)
- How NOT to design APIs. 7 mistakes explained on a single… | by Robert Konarskis
- How to apply UX principles and methods to API usability - DeveloperRelations.com
- User-Centric Web API Design. A Product Manager's Approach | by TribalScale Inc.
- How Positive Feedback Loops Are Hurting AI Applications (gitconnected)
- How a User Error Can Be a Constructive Tool (JoeytheITguy)
- Guidelines for Human-AI Interaction (Microsoft)
- The Ultimate Guide to Usability Testing - Marvel Blog

References for those who want more

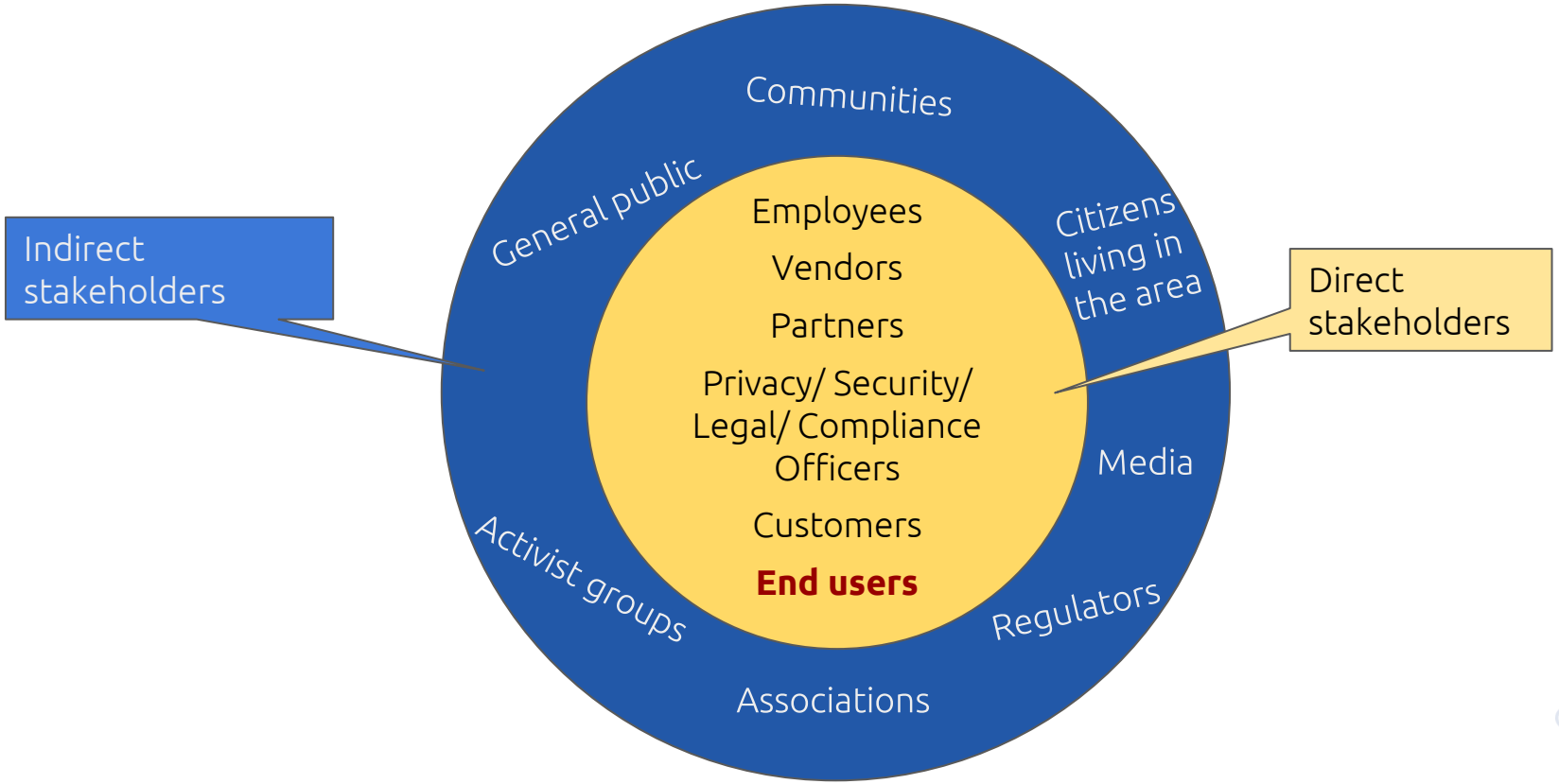
- Understanding mental and conceptual models in product design (UX Design)
- Preventing User Errors: Avoiding Conscious Mistakes (Nielsen Norman group)
- Nielsen Norman Group UX Research Cheat Sheet (Nielsen Norman Group)
- User-Centered Design: An Introduction (Usability geek)
- Creating user value with AI. A user-centred perspective to… | by Laila Goubran | IBM Design (Medium)
- How to Define a User Persona [2021 Guide] (Careerfoundry)
- UI-Patterns.com and another repository is this one: Next UI Patterns & Inspiration
- A (theoretical) methodological article about design science: Hevner, A. R. (2007). A three cycle view of design science research. *Scandinavian journal of information systems*, *19*(2), 4.
- Example of a more advanced human-AI interaction pattern: van Stijn, J. J., Neerincx, M. A., ten Teije, A., & Vethman, S. (2021). Team Design Patterns for Moral Decisions in Hybrid Intelligent Systems: A Case Study of Bias Mitigation. In *AAAI Spring Symposium: Combining Machine Learning with Knowledge Engineering*.
- Example of user-centred data science on the topic of Explainable AI: van der Waa, J., Schoonderwoerd, T., van Diggelen, J., & Neerincx, M. (2020). Interpretable confidence measures for decision support systems. International Journal of Human-Computer Studies, 144, 102493.

Don Norman on user-centred design

User-centred or human-centred design?

- Human-centred is slightly more modern wording, but also...
- It refrains from reducing human-ness to a person using technology, by including, for example:
    - all aspects of the human individual, e.g. their desires, cognition, social aspects, and other typical human characteristics
    - the larger socio-technical system, e.g. the human organisation & processes
    - non-users, e.g. data subjects, compliance officers, management, and other stakeholders

Different types of stakeholders you may come across

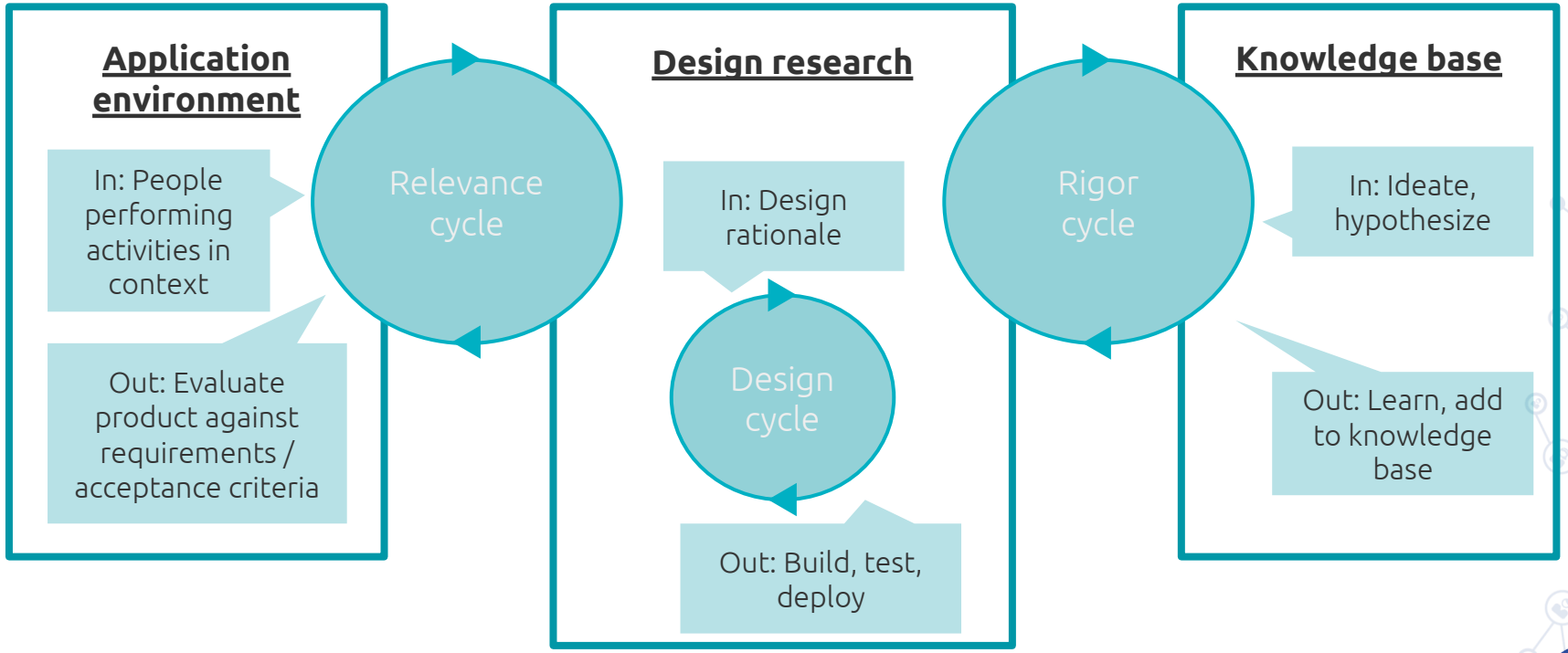


Additional principles of user-centred design

1. **Visibility of affordance**: it should be obvious on first sight what can be done with the product
2. **Reduce unnecessary mental effort** by the user:
    a. Maintain **consistency**. This increases predictability and familiarity.
    b. Familiarity: e.g. icons, interactions, wording, etc.
    c. Accessibility: should be easy and quick to find information - don't rely on the user's memory
    d. Legibility: text should be easy to read. Use short sentences.
    e. Offer **assistance**, e.g. a built-in tutorial or help function, correct for typos, etc.
3. Provide **adequate feedback**:
    a. Users rely on a **response following all of their actions**
    b. Build a dialogue between user and design (it's not a one-way street!)
4. Provide adequate **navigation mechanisms**, e.g. page numbers, scrolling bars, web history
5. **Let the user take charge**: most of the time, users already know what their needs are

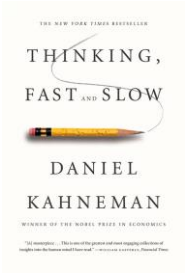
Design rationale and evaluation

Not just computer science knowledge, also human factors knowledge



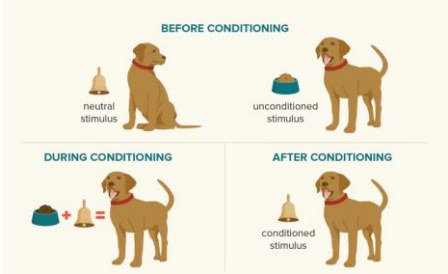
Hevner, A. R. (2007). A three cycle view of design science research. *Scandinavian journal of information systems, 19*(2), 4.

User-centred design uses human factors knowledge



System 1

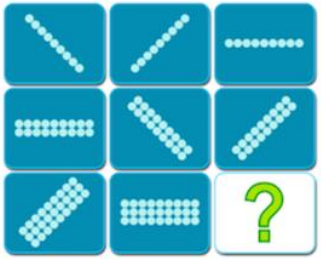
Fast / automatic
Emotional
Impulses / drives
Habits / beliefs



- Evolutionary old
- Rapid, parallel, automated
- Instincts & intuition
- Associative learning
- Conditioning
- Heuristics
- Biases

System 2

Slow / effortful
Logical / problem solving
Planning

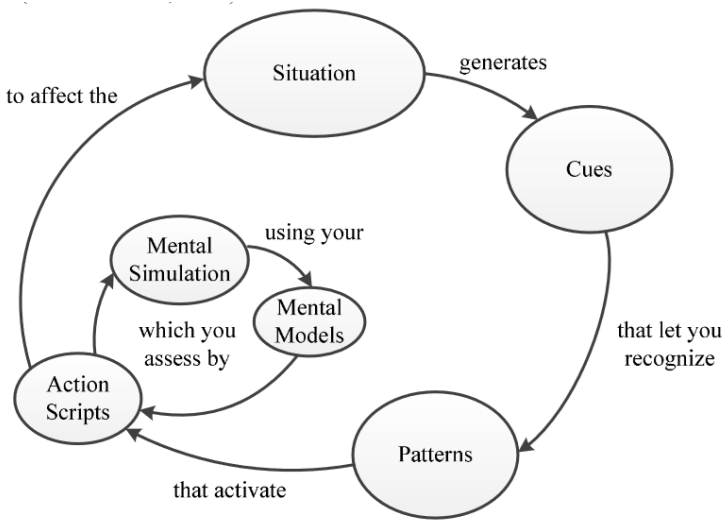


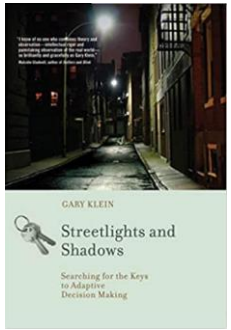
- Evolutionary recent
- Slow, sequential, deliberate
- Abstract reasoning, logic
- Hypothetical thinking
- Critical thinking / reflection
- Limited by working memory

Kahneman, D., & Tversky, A. (2013). Prospect theory: An analysis of decision under risk. In *Handbook of the fundamentals of financial decision making: Part I* (pp. 99-127).

User centred design uses human factors knowledge

The Recognition-Primed Decision (RPD) model (Klein, 2009)

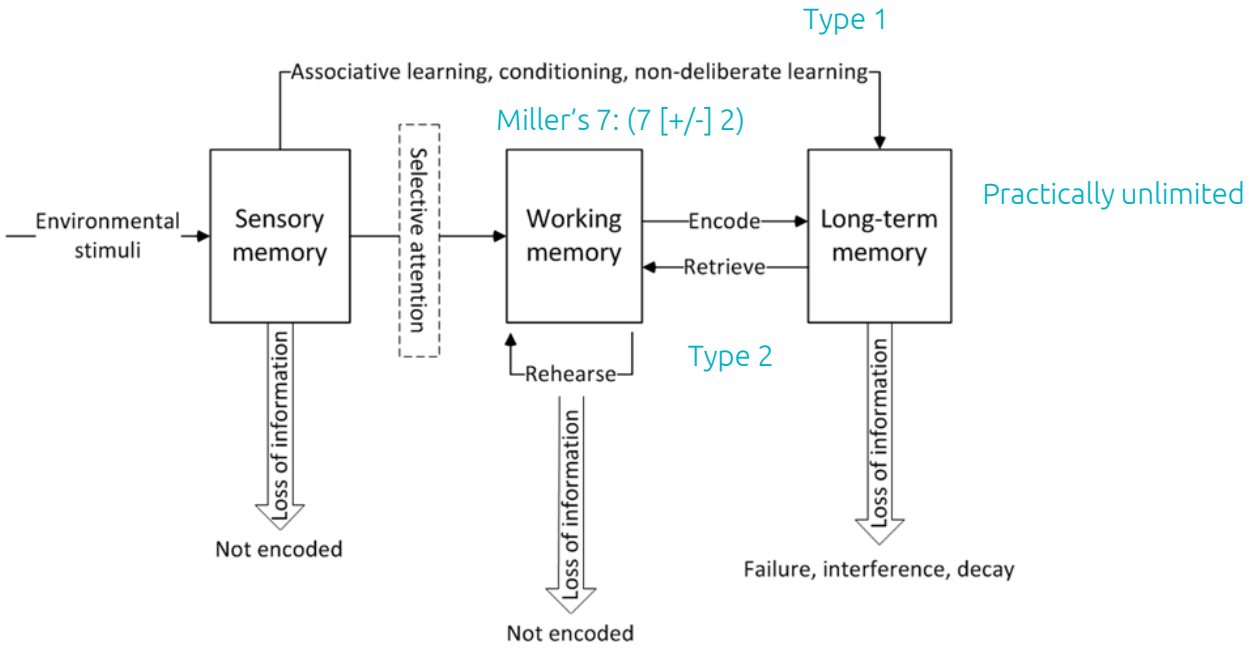


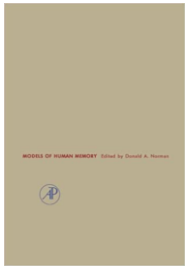


Klein, G., 2008. Naturalistic decision making. Human Factors 50, 456-460.
Klein, G., 2009. Streetlights and Shadows: Searching for The Keys to Adaptive Decision Making. The MIT Press, Cambridge, Massachusetts.

User-centred design uses human factors knowledge

About our memory system and how we learn





Norman, D. A. (Ed.). (2013). *Models of human memory*. Elsevier.

Specifying your evaluation set-up: IMPACT

IMPACT (Benyon et al.)

Intention:	Clarify objectives and hypotheses/claims
Metrics & measures:	What, how and why
People:	Target group & participants
Activities:	Derive activities from use cases
Context:	Social, ethical, physical, etc. aspects
Technologies:	Hardware and software

Formats used in UCD

Method	Cost	Output	Sample size	When to use
Focus groups	Low	Non-statistical	Low	Requirements gathering
Usability testing	High	Statistical & non-statistical	Low	Design & evaluation
Card sorting	High	Statistical	High	Design
Participatory design	Low	Non-statistical	Low	Design
Questionnaires	Low	Statistical	High	Requirements gathering & evaluation
Interviews	High	Non-statistical	Low	Requirements gathering & evaluation

Generative methods used in User-Centred Design

DISCOVERY

Generative methods are used to explore existing practices/environments in regards to WHY, WHAT and HOW devices are used to build task related workflows for the purposes of new device design.

- Contextual inquiry
- Known user error
- Task analysis
- Post market surveillance

DESIGN

Generative methods assist in defining the user interface.

- Human factors in design
- Design of instructional materials
- Design of training

Evaluative methods used in User-Centred Design

FORMATIVE

Evaluative methods in order to assess usability and efficacy throughout the design process in order to refine the design, and promote e.g. privacy, security, and responsibility by design.

- Expert review
- Task analysis
- Heuristic analysis
- Simulated use study
- Cognitive walkthrough

SAFETY

Evaluative methods intended to promote safety, manage risk, determine critical task delineation.

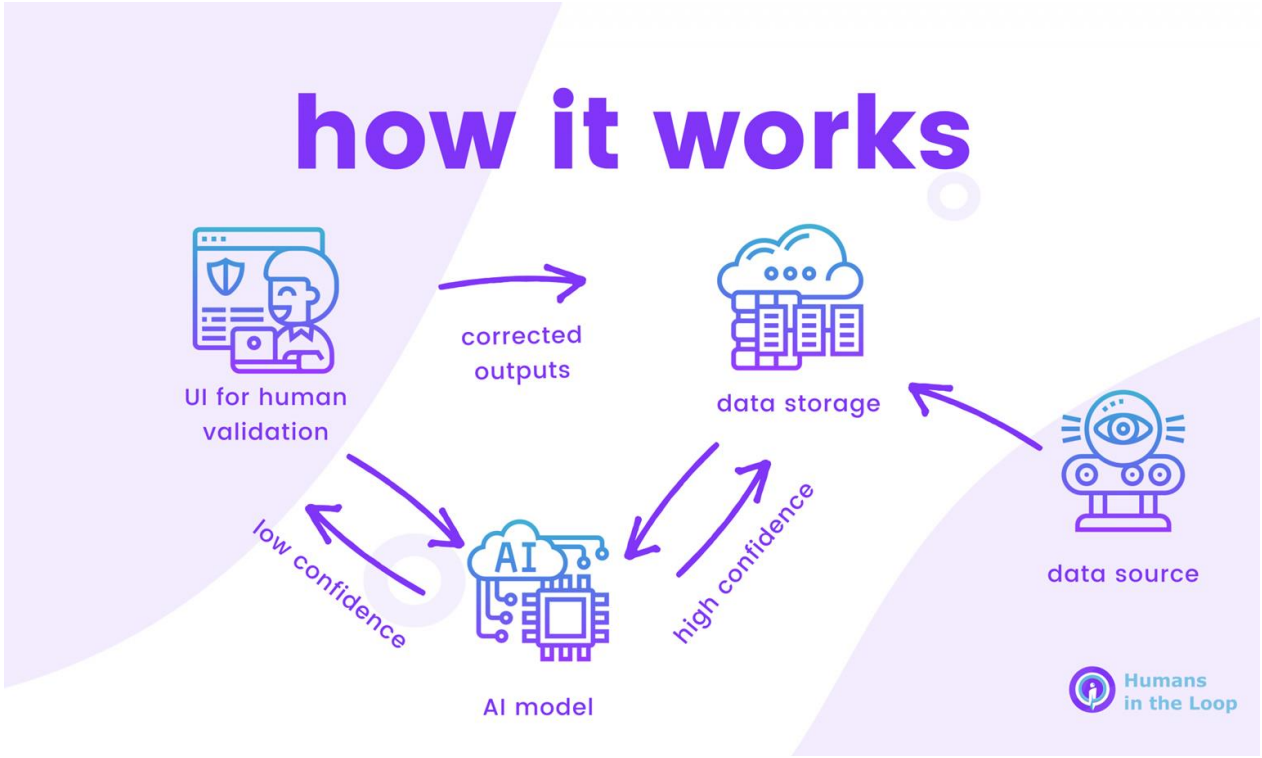
- Use related risk analysis
- Root cause analysis
- Responsible AI analysis

VALIDATION

Final testing to demonstrate and document usability as well as effectiveness of risk mitigations.

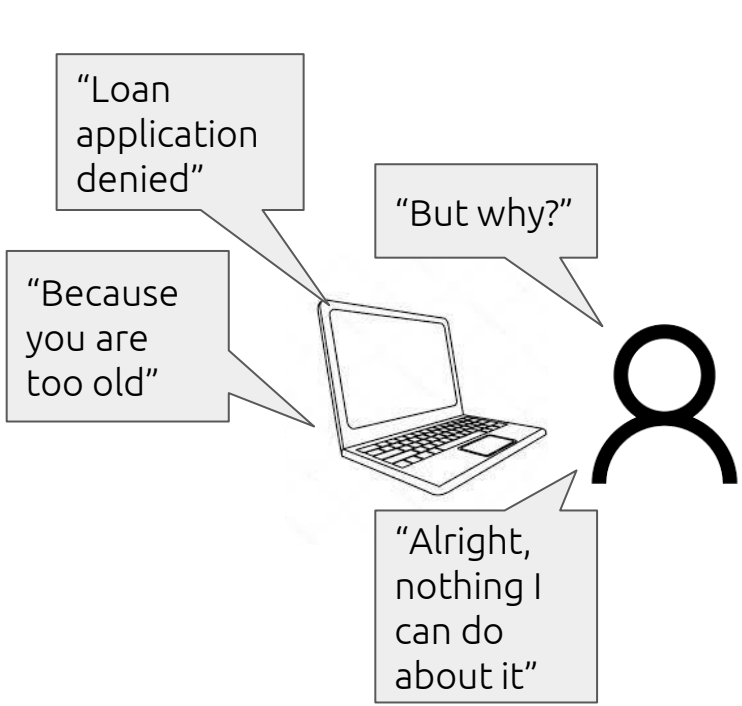
- Usability testing
- Effectiveness testing
- Acceptability testing

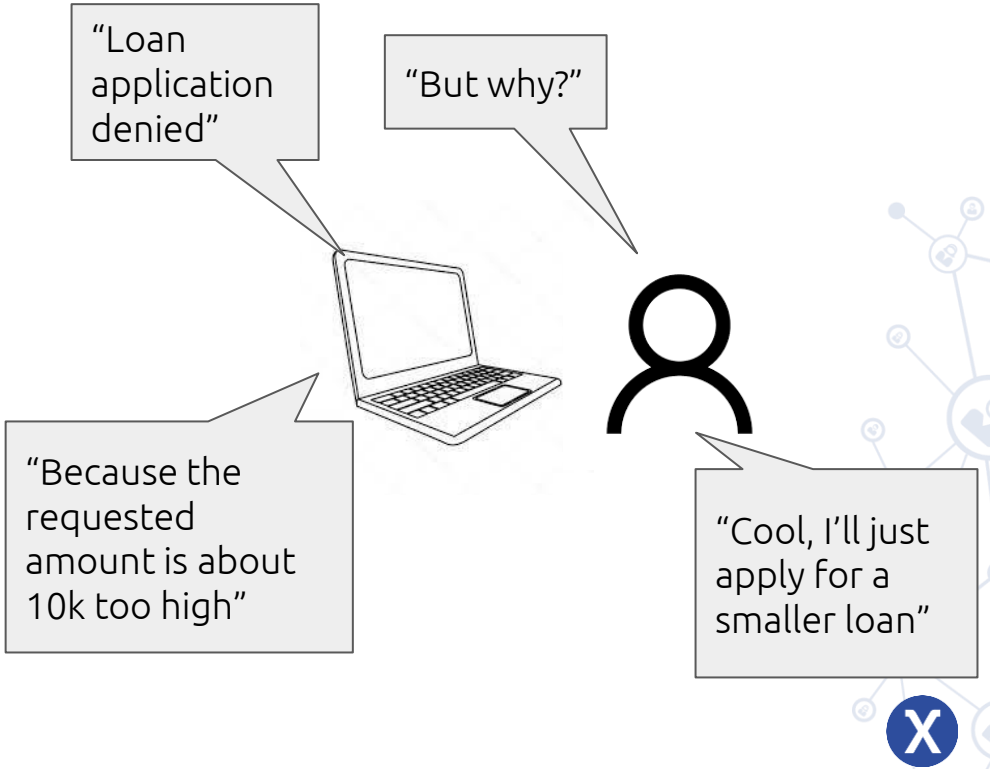
Human-in-the-loop AI



Source: [What is a Human in the Loop? - Definition - Human-in-the-Loop AI]

Example: human-in-the-loop to solve “actionability problem”





Examples of human-in-the-loop

Google's DeepMind AI outperforms doctors in identifying breast cancer from X-ray images

Zachary Hendrickson Jan 3, 2020, 6:28 AM

■ ■ ■

However, research has shown that AI performs best when it complements traditional, human intelligence rather than supplants it entirely. While some, like investment mogul Vinod Khosla, believe radiologists are an endangered species in healthcare, a follow-up study from many of the same researchers involved in the 2018 Stanford study suggests that "human-in-the-loop" workflows that utilize AI as a time-saving triage tool perform better than either AI or human doctors on their own.

5 cybersecurity trends for 2020

With industry-known strains morphing into new killers and regulators dutifully watching for errors, companies are leaning on their infosec teams more than ever.

Credit: Elizabeth Regan

■ ■ ■

"What we try to do is not remove the human from the loop, but make the human in the loops' job easier," Matt Scholl, chief of the computer security division at the National Institute of Standards and Technology (NIST), told CIO Dive.

An illustrative example about the design of doors

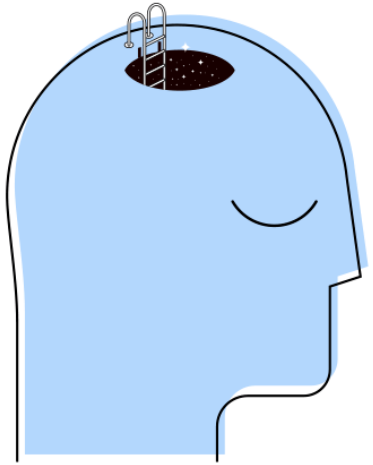
Prevent mental model mismatch

Mental model mismatch

USER DOESN'T UNDERSTAND THE PRODUCT

USE / ADOPTION COST INCREASES

USERS GET FRUSTRATED AND QUIT



TO CREATE USER-FRIENDLY PRODUCTS FOR USERS

↓

You need to see things from the user's point of view

Source: [Using mental models for better UX design]

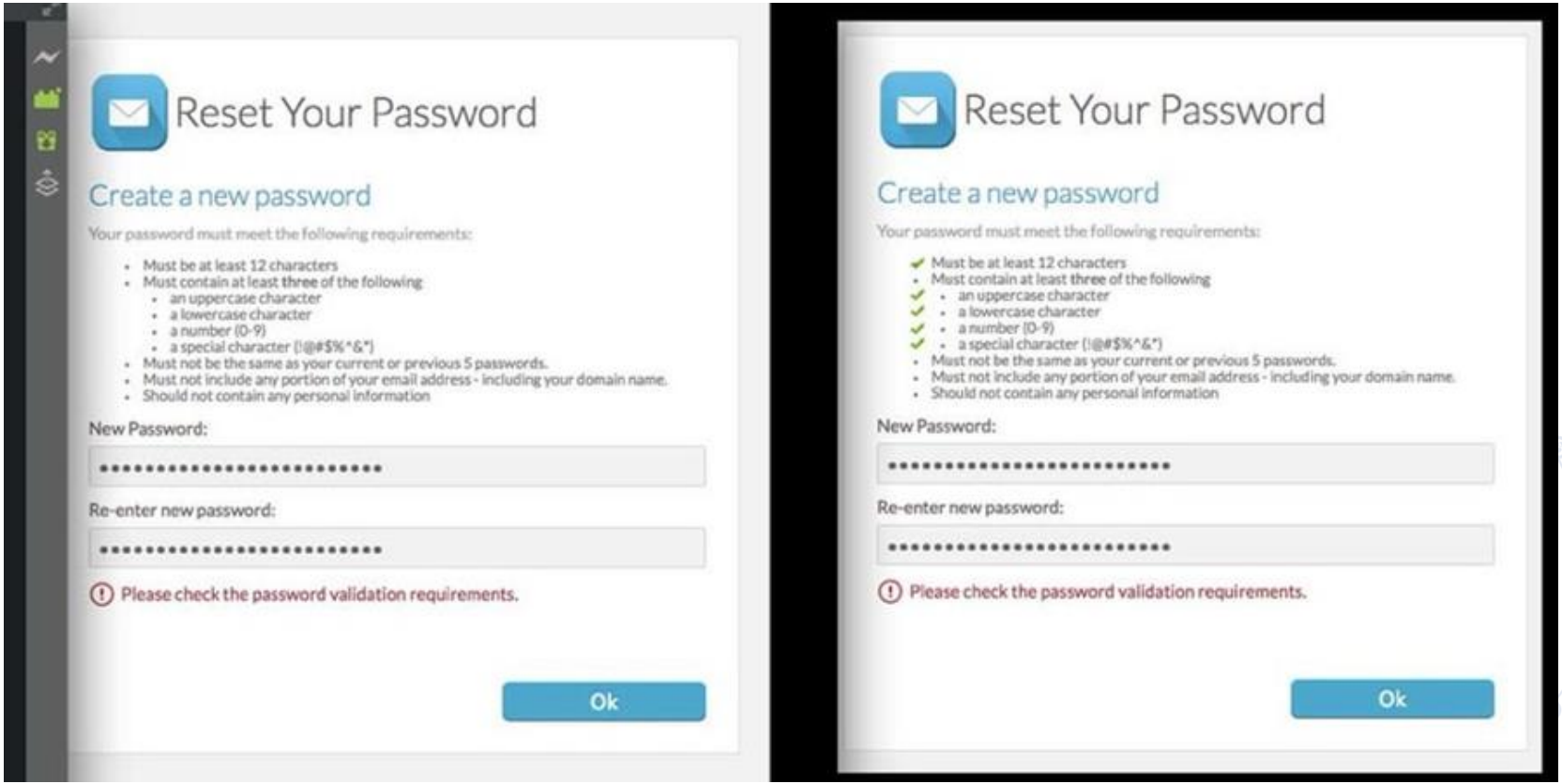
Examples of human-data product interaction

Feedback loops with unknown false negatives, require for a mental model at socio-technical system level.

Examples of human-data product interaction

Long term psychological impact: misdirection, addiction, compulsive behaviors, etc. Requires a mental model representing long-term human-AI interactions at grand scale.

Examples of problematic design



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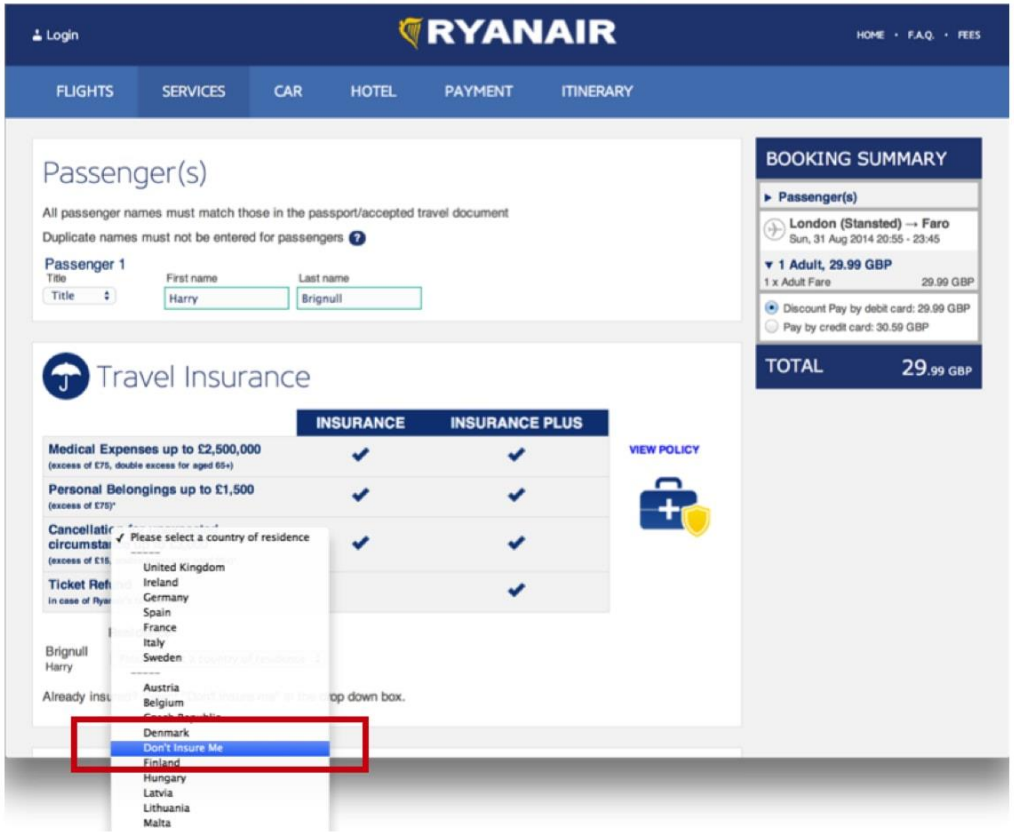

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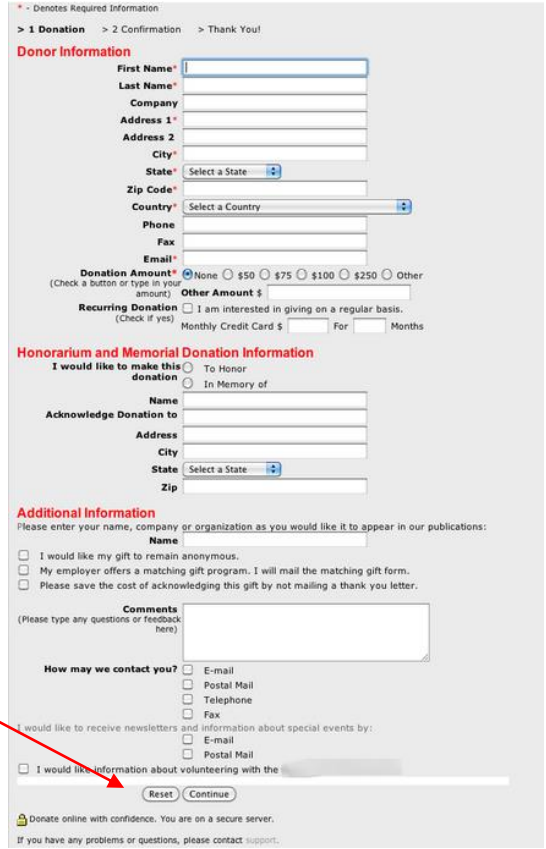

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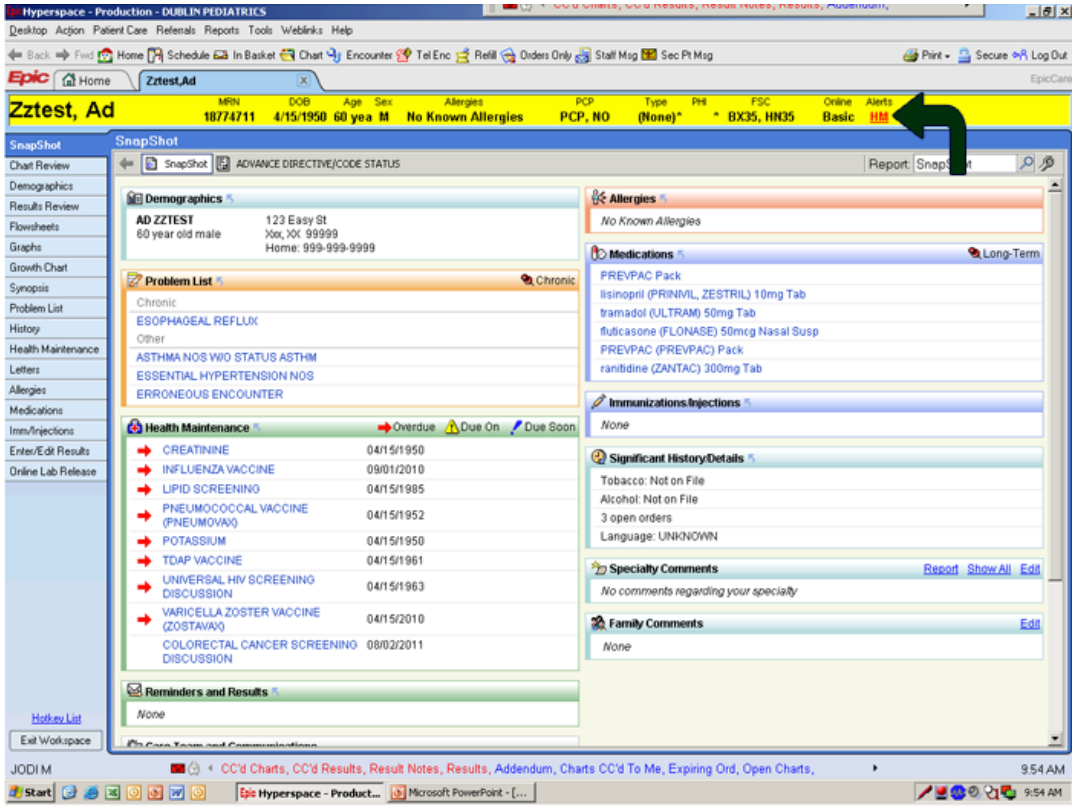

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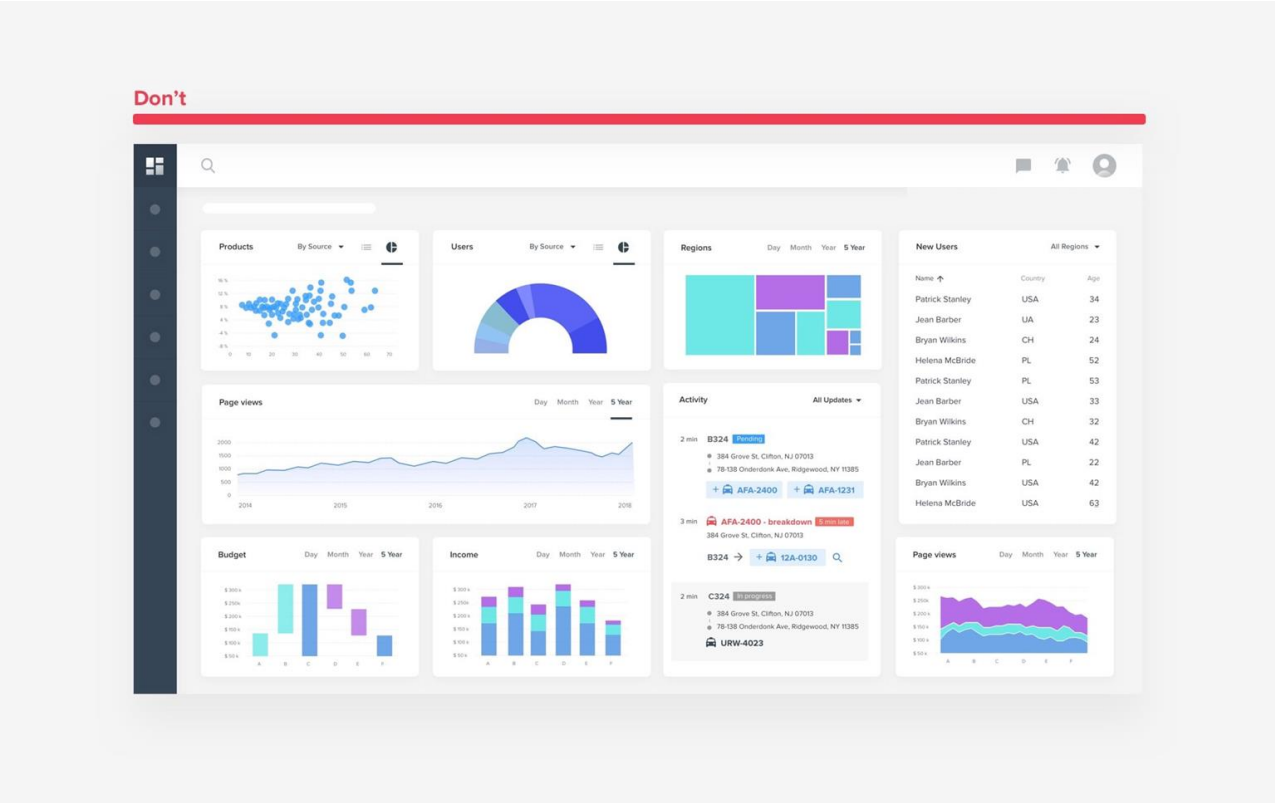

Examples of problematic design

```
{
    "checkIn": "20151001",
    "lastNight": "20151002",
    "checkOut": "20151003",
    "roomId": "12345",
    "propId": "1234",
    "ownerId": "123",
    "numAdult": "2",
    "numChild": "0",
    "offerId": "1",
    "voucherCode": "",
    "referer": "",
    "agent": "",
    "ignoreAvail": false,
    "propIds": [
        1235,
        1236
    ],
    "roomIds": [
        12347,
        12348,
        12349
    ]
}
```

Examples of problematic design

Common Error Codes

Error Code	Error Meaning
1009	Not allowed for this role
1010	No write access
1016	Usage limit exceeded in last 5 minutes
1020	Usage limit exceeded in last 5 minutes
1021	Account has no credit
1022	Not whitelisted

Examples of problematic design

Please observe the following guidelines when using the API

1. Calls should be designed to send and receive only the minimum required data.

2. Only one API call at a time is allowed, You must wait for the first call to complete before starting the next API call.

3. Multiple calls should be spaced with a few seconds delay between each call.

4. API calls should be used sparingly and kept to the minimum required for reasonable business usage.

5. Excessive usage within a 5 minute period will cause your account to be blocked without warning.

6. We reserve the right to disable any access we consider to be making excessive use of the API functions at our complete discretion and without warning.

Examples of problematic design