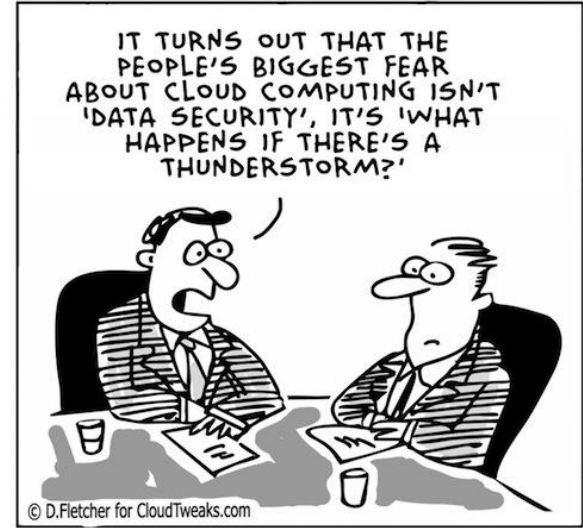


User-centred Data Products

By Marieke Peeters
18 June 2021
Xpert Session Xomnia



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



Common experiences with data projects

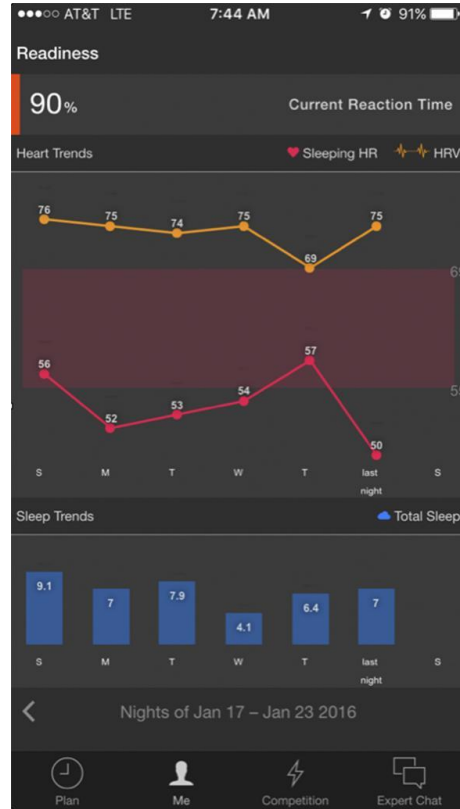
Have you ever experienced that the data solution you worked (hard) on:

- 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?

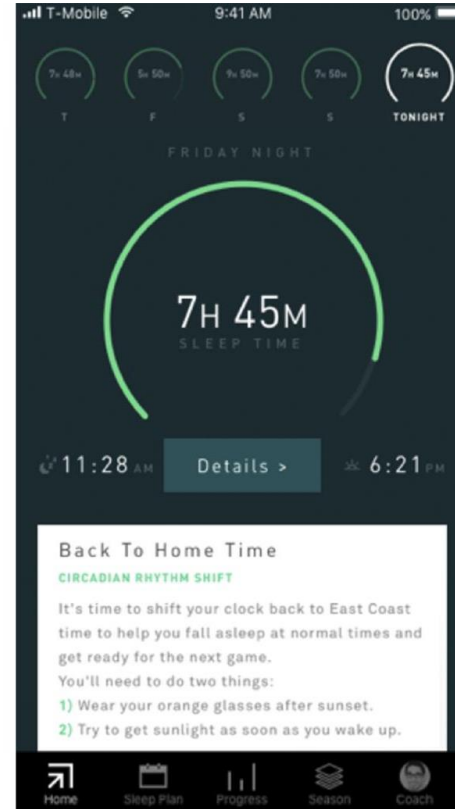
Sometimes to the point where management starts to complain about the return on investment of the entire data science team / department?



Example







Version 1: Rise DS solution



Version 2: solution developed together with IDEO designers

What makes DS/ML projects so likely to fail?

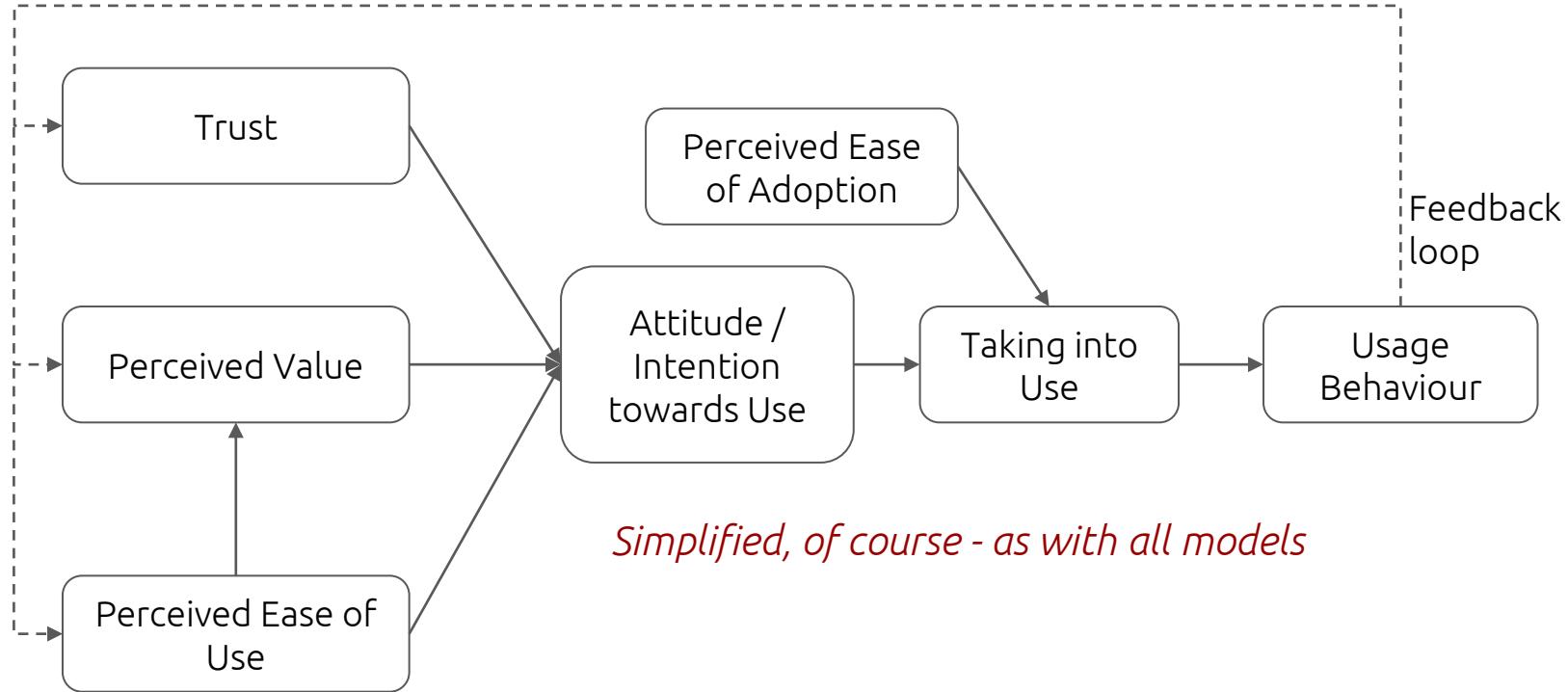
| | <i>User base / Business world</i> | <i>Data experts / Data world</i> |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------|----------------------------------------------------------------------|
|  | Deterministic 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 |



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



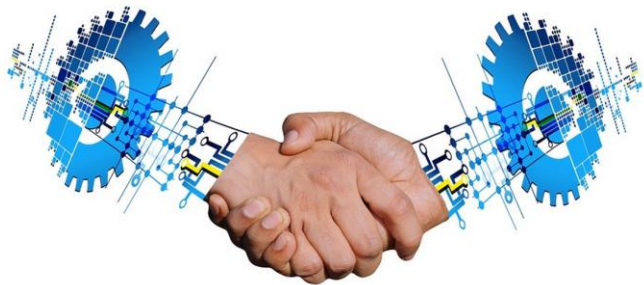
Why is a solution (not) adopted by a user?



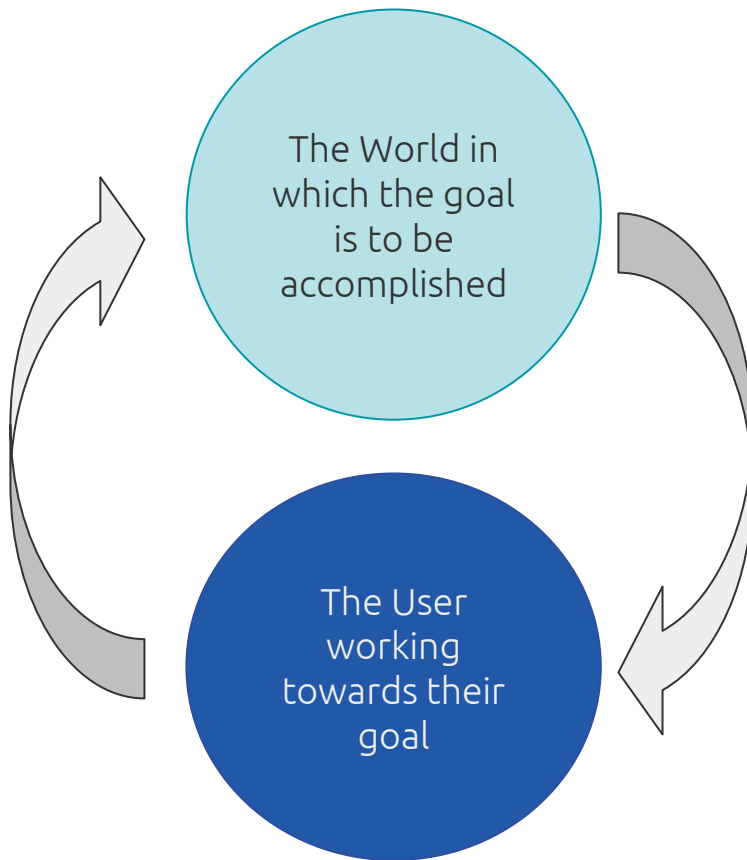
Alignment requires more than model performance

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

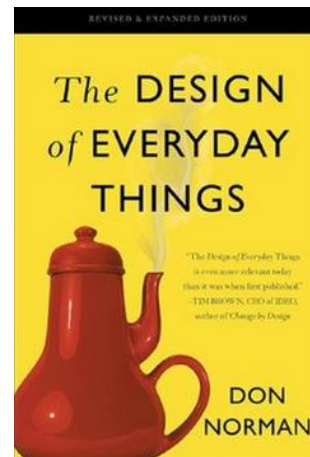


Gulf of Execution

How do I use this system?

How do I work this?

What can I do?



Gulf of Evaluation

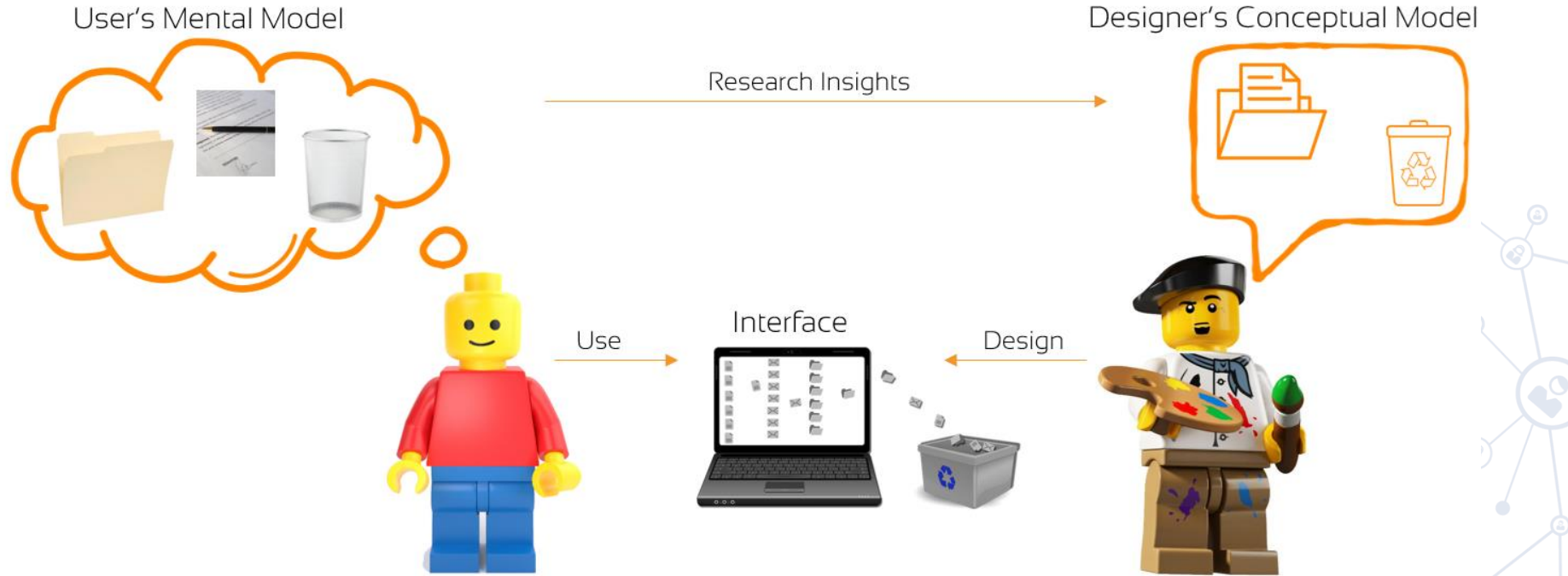
What's the current system state?

What happened (after my previous action)?

Is this what I wanted?



A user's mental model



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

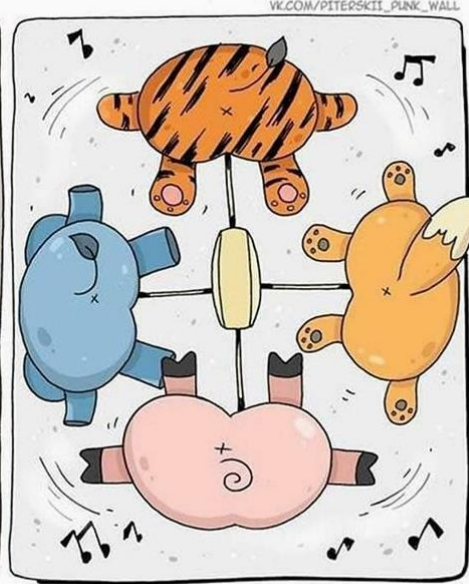


It is all about different perspectives

Developers



Users



PACT

People:

Who are the users?

Activities:

What would they do?

Context:

What is the context?

Technologies:

Which artefacts
can support them?



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

-  Common / obvious
-  Less common / less obvious
-  Uncommon / not so obvious

| Form: how is the content received? | Function: what content is the user consuming? | | | | |
|---------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| | <i>Raw data</i> | <i>Derived data</i> | <i>Algorithms</i> | <i>Decision support</i> | <i>Automated decision making</i> |
| <i>APIs</i> |  |  |  |  |  |
| <i>Dashboard & visualisations</i> |  |  |  |  |  |
| <i>Web elements</i> |  |  |  |  |  |



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



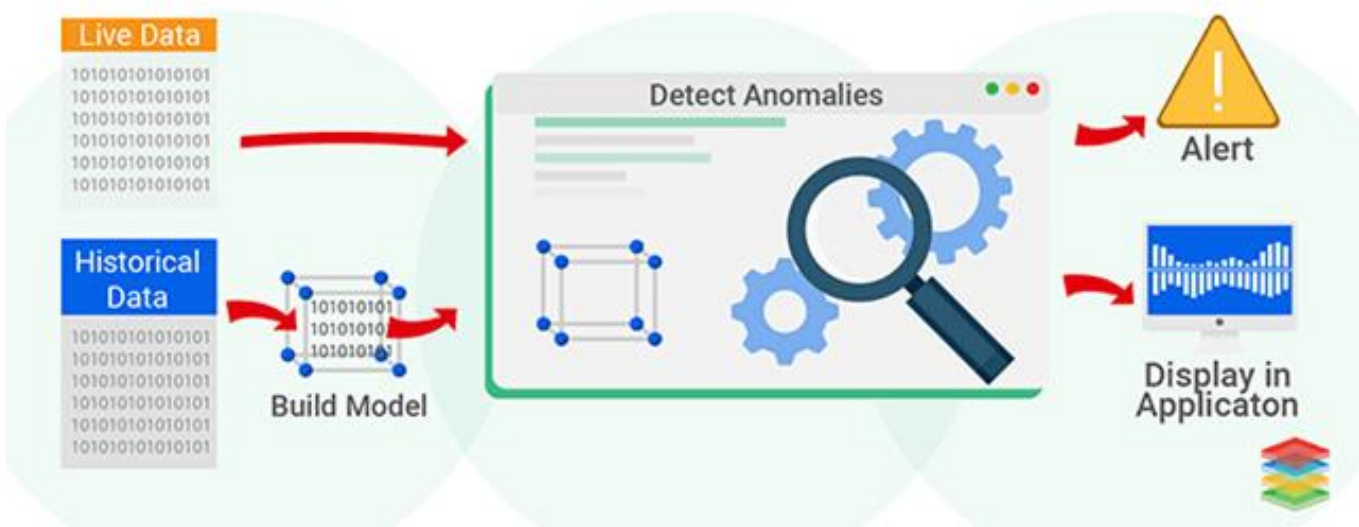
Source: [How to apply UX principles and methods to API usability - DeveloperRelations.com](#)

Source: [The Ultimate Guide to Usability Testing - Marvel Blog](#)



Examples of human-data product interaction

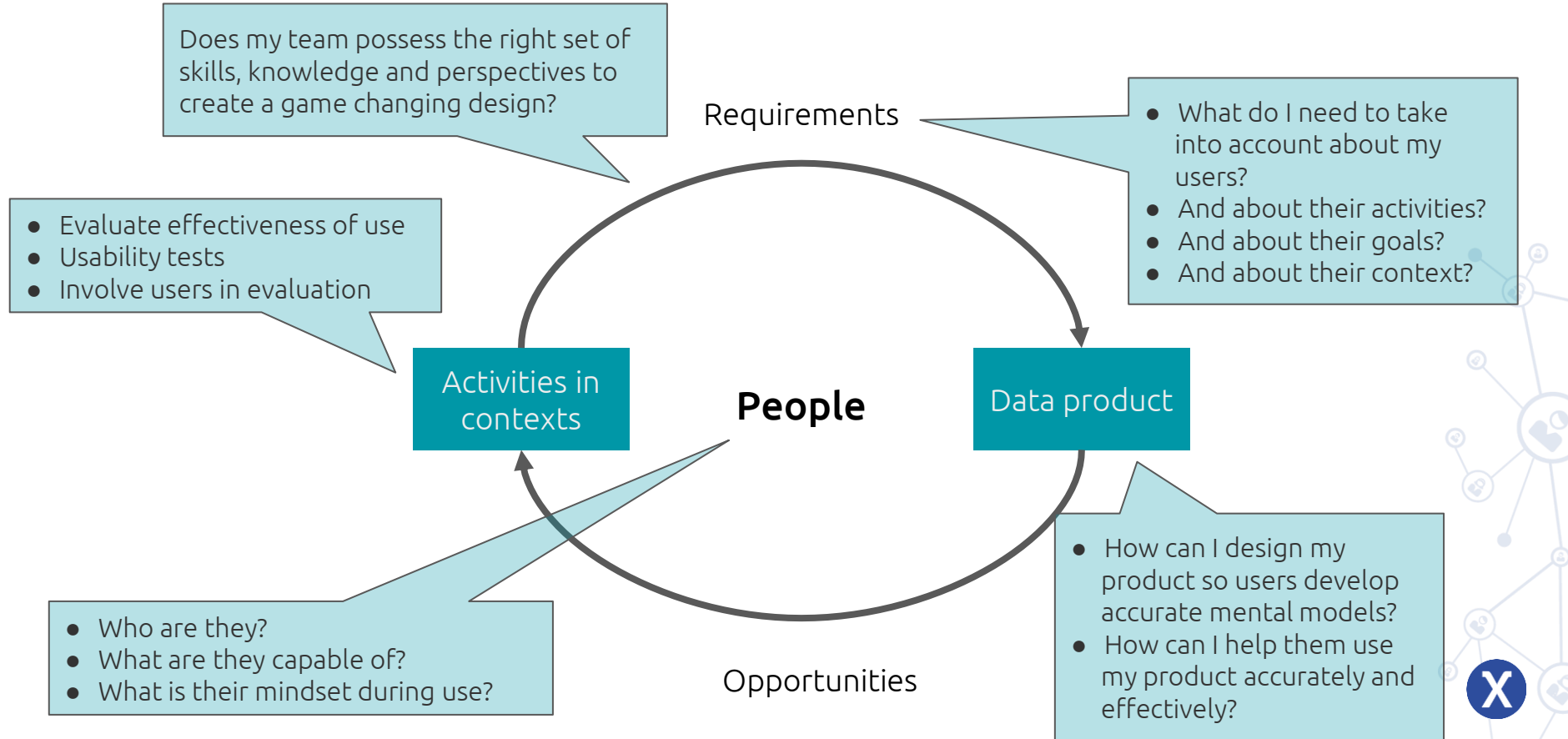
Example 3: Real time anomaly detection, requires a mental model of how to analyse and handle an incident



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?



A group of approximately 25 people are posed in front of a two-story brick building. Some individuals are standing on the ground in front of the entrance, while others are sitting or standing on the windowsills of the upper floor. The building has several windows and doors, with some numbers visible above the entrances. The entire image is overlaid with a semi-transparent blue filter.

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

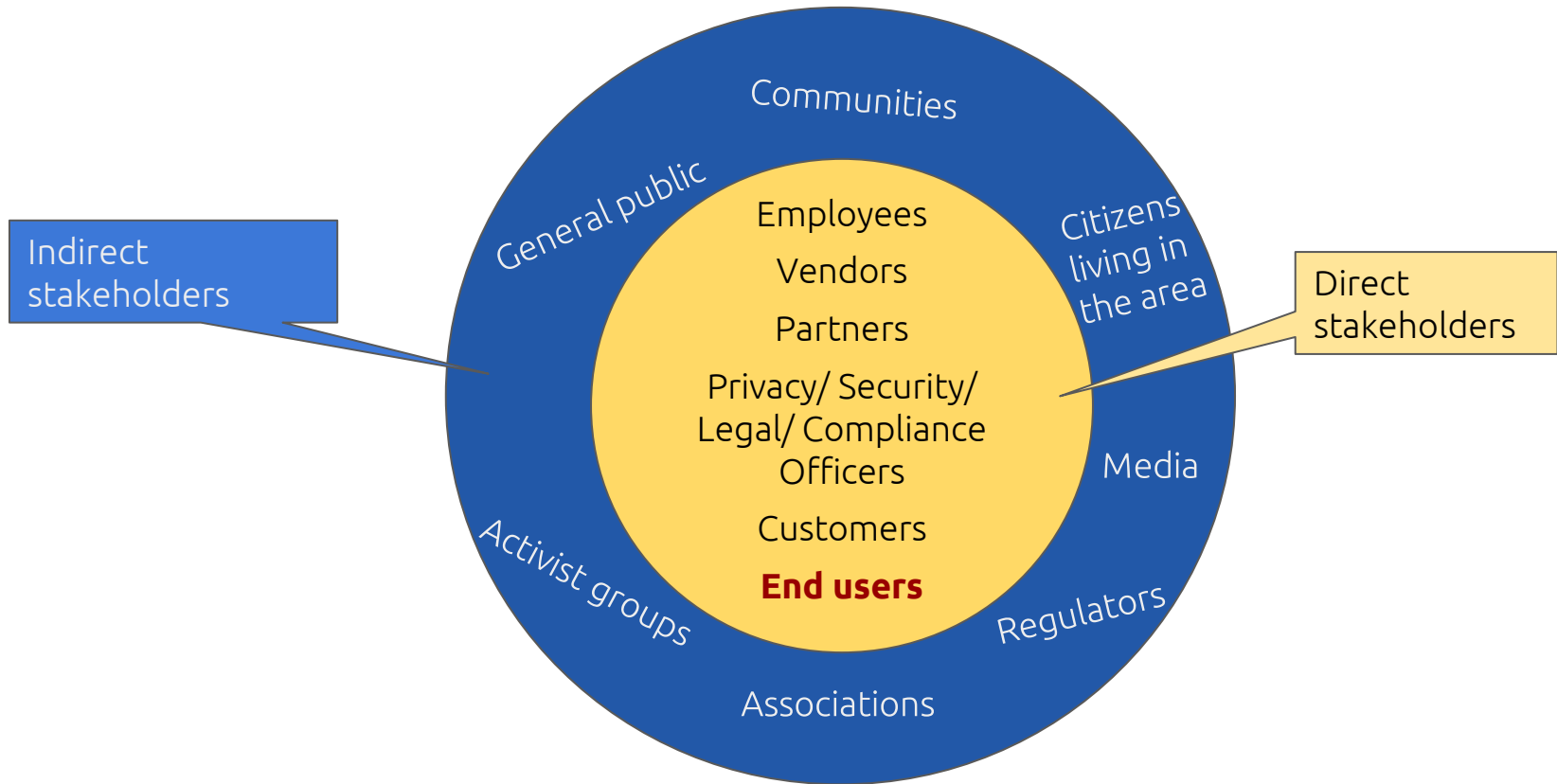


User-centred or human-centred design?

- 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



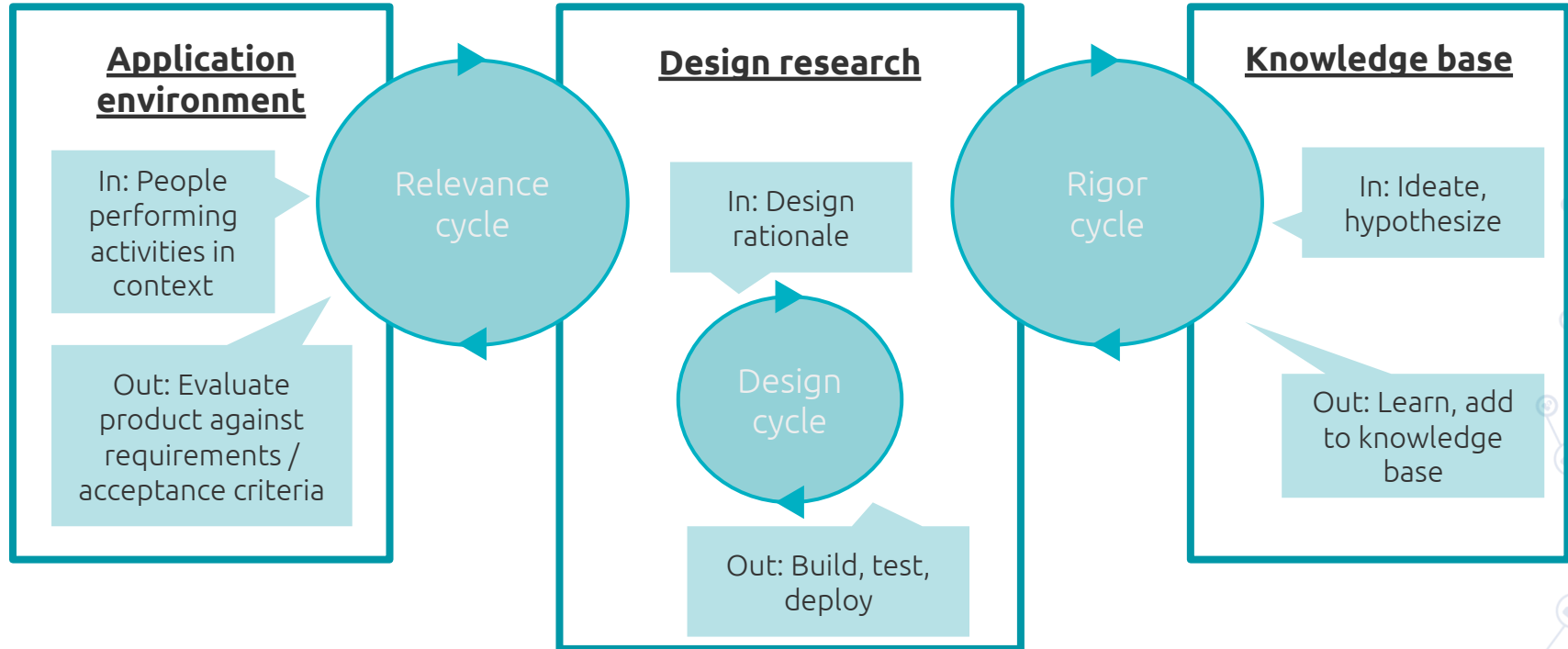
Additional principles of user-centred design

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

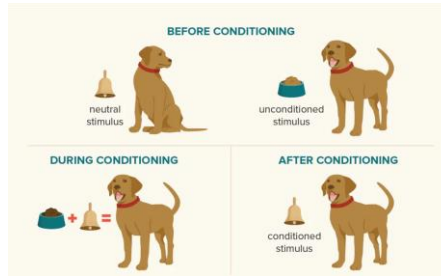
Not just computer science knowledge, also human factors knowledge



User-centred design uses human factors knowledge

System 1

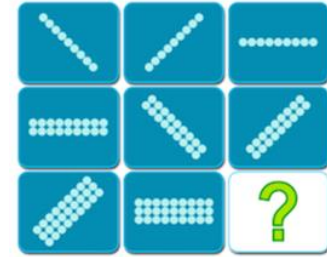
Fast / automatic
Emotional
Impulses / drives
Habits / beliefs



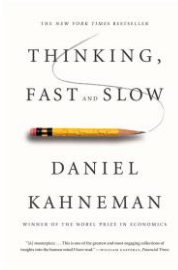
- Evolutionary old
- Rapid, parallel, automated
- Instincts & intuition
- Associative learning
- Conditioning
- Heuristics
- Biases

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

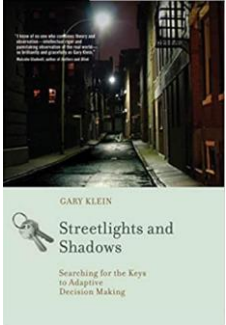
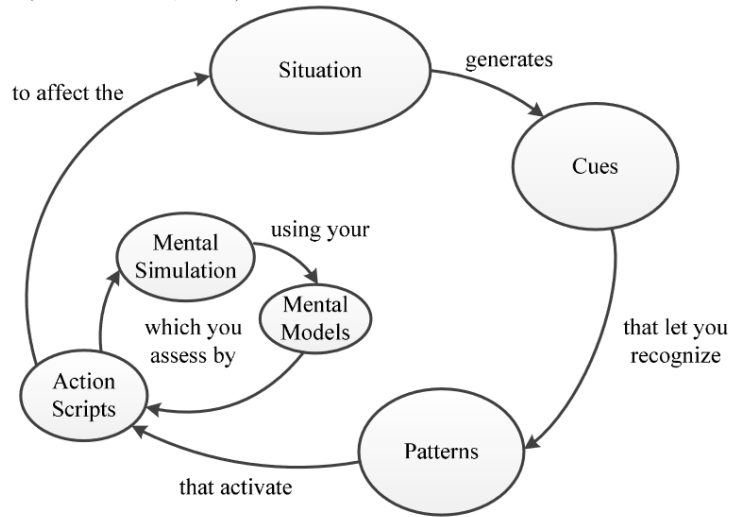


Kahneman, D., & Tversky, A. (2013). [Prospect theory: An analysis of decision under risk](#). In *Handbook of the fundamentals of financial decision making: Part I* (pp. 99-127).



User centred design uses human factors knowledge

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



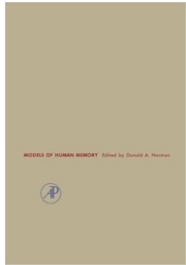
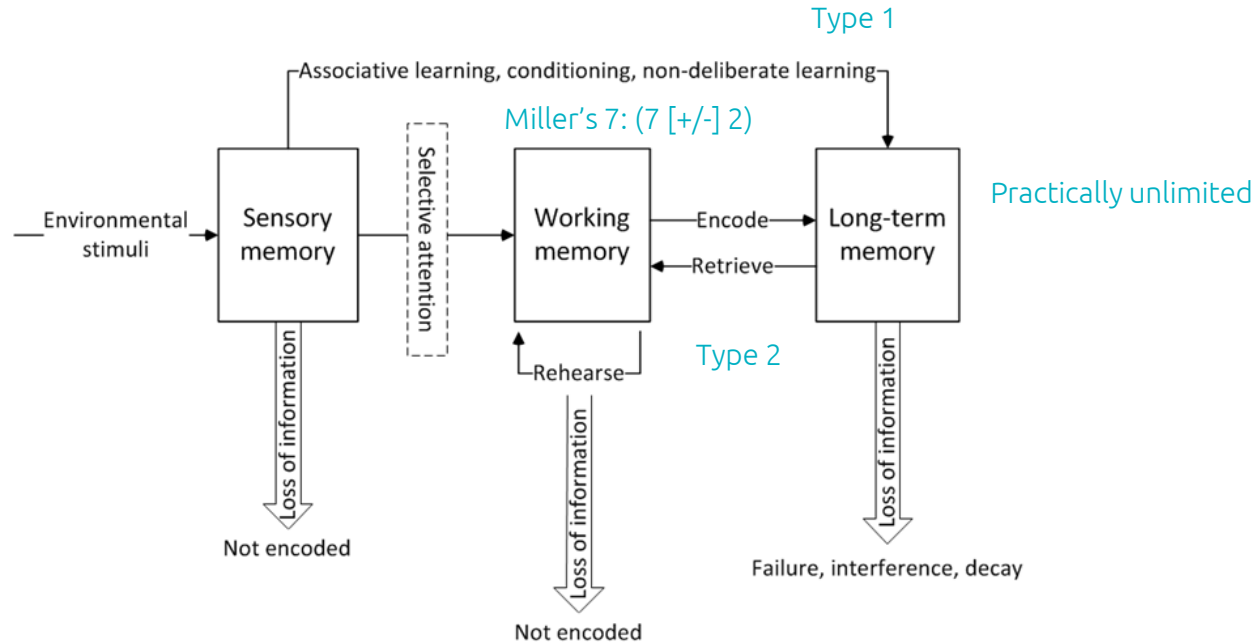
[Klein, G., 2008. Naturalistic decision making. Human Factors 50, 456-460.](#)

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.

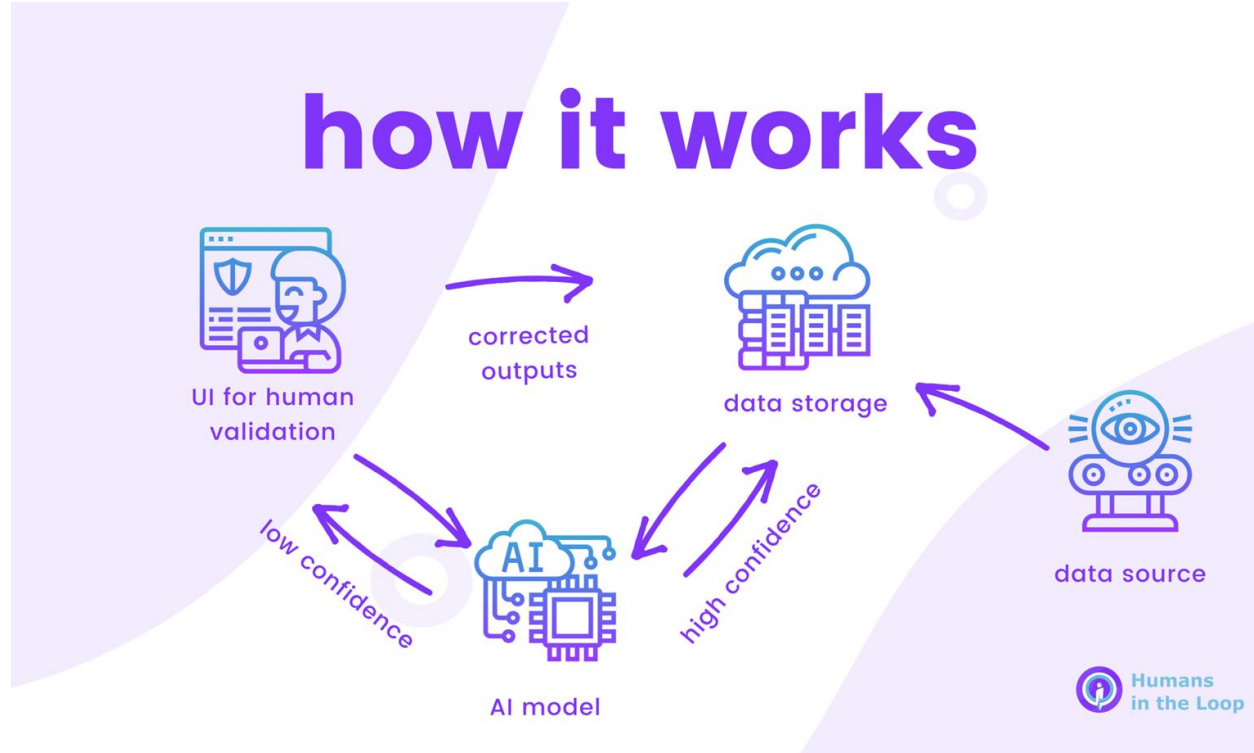
Usability testing

Effectiveness testing

Acceptability testing



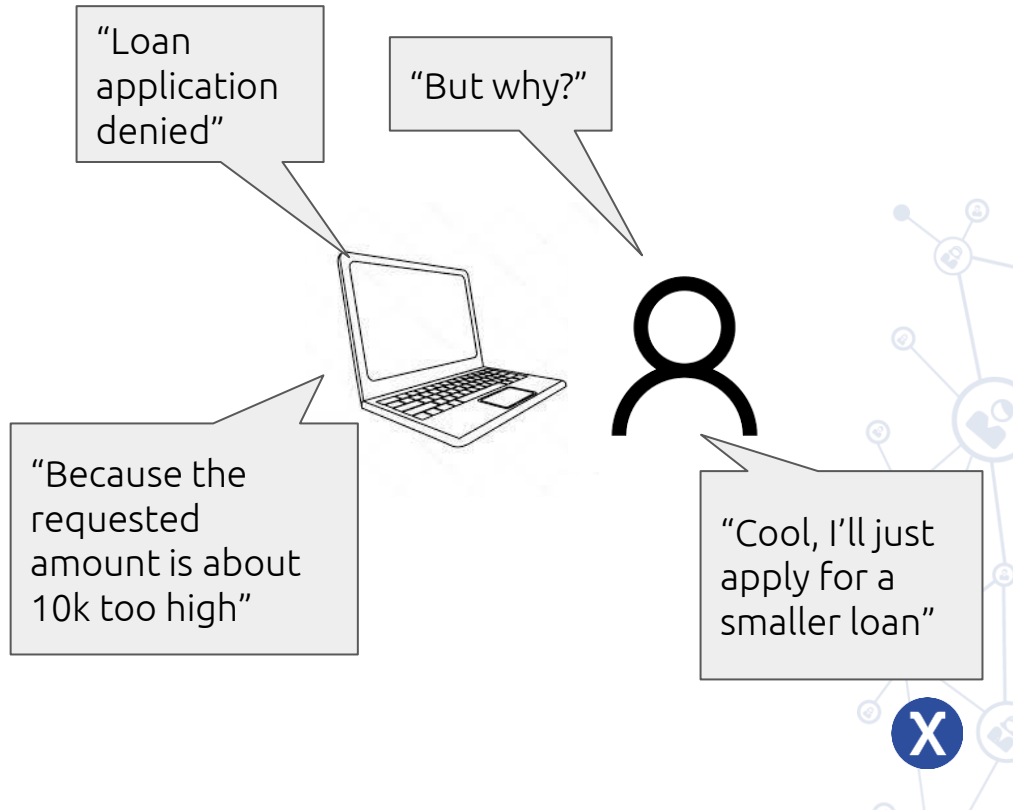
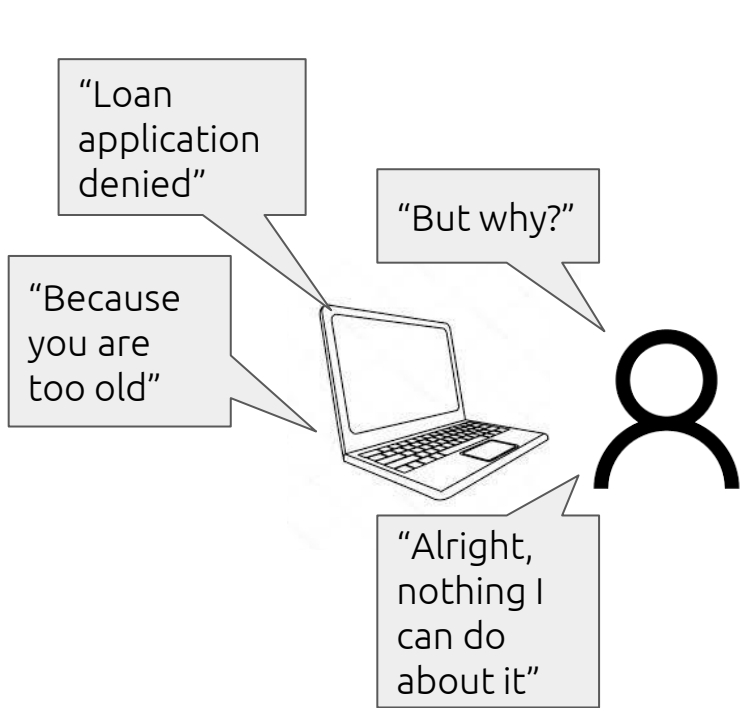
Human-in-the-loop AI



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.

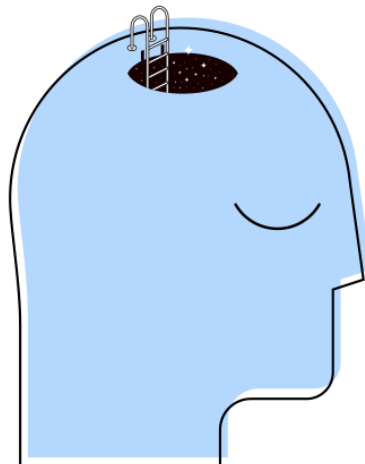
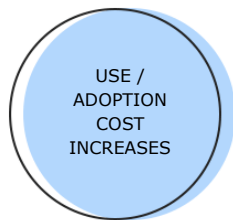
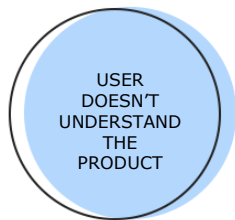


An illustrative example about the design of doors



Prevent mental model mismatch

Mental model mismatch



TO CREATE USER-FRIENDLY
PRODUCTS FOR USERS

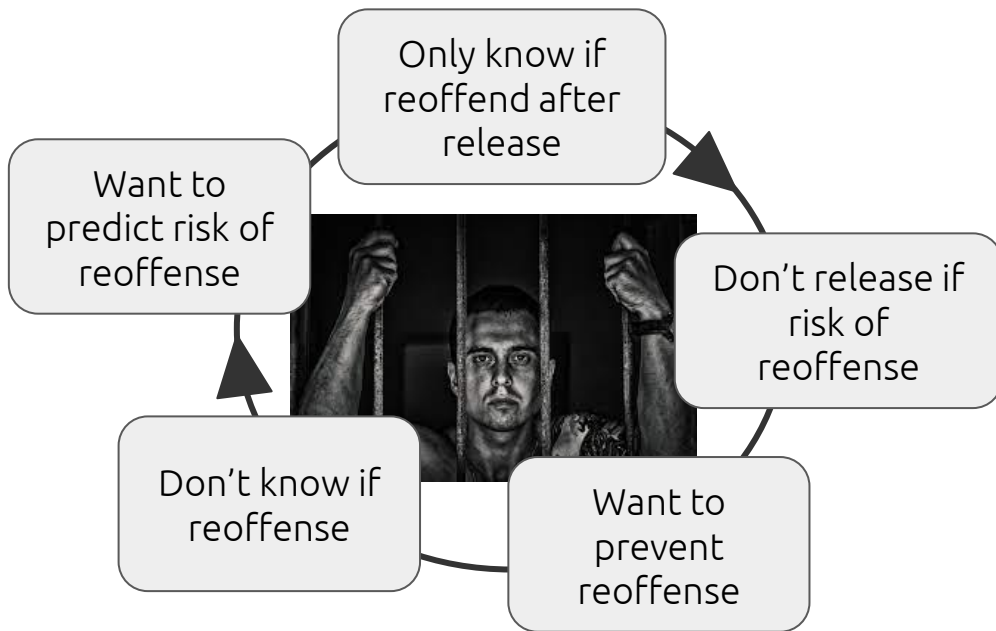


**You need to
see things
from the
user's point
of view**



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



 Reset Your Password


Create a new password

Your password must meet the following requirements:

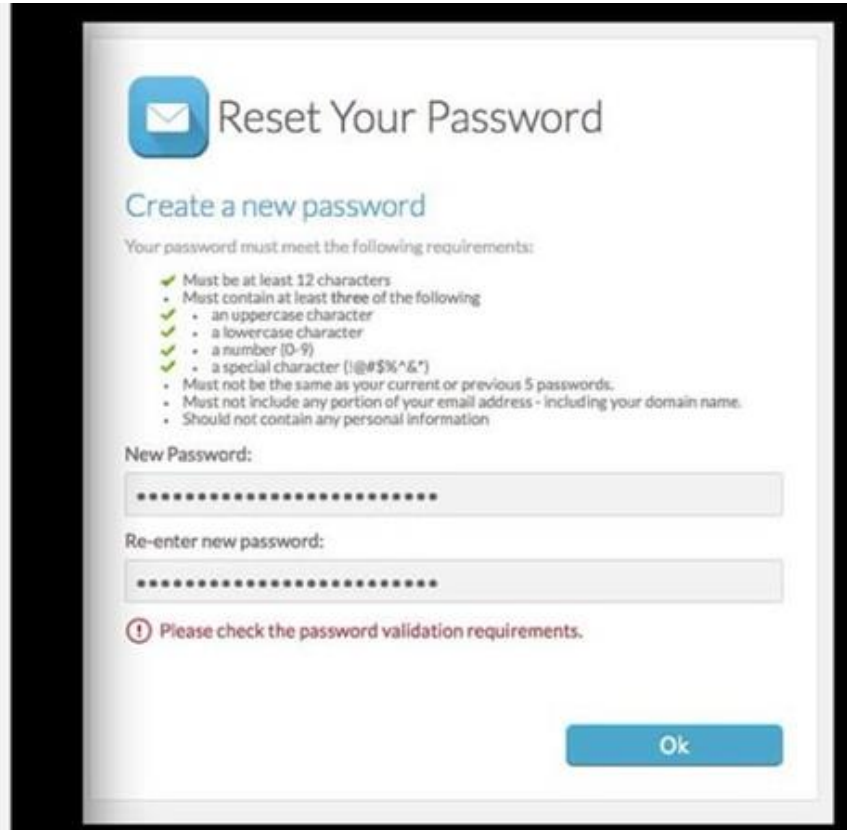
- Must be at least 12 characters
- Must contain at least three of the following:
 - an uppercase character
 - a lowercase character
 - a number (0-9)
 - a special character (!@#\$%^&*)
- Must not be the same as your current or previous 5 passwords.
- Must not include any portion of your email address - including your domain name.
- Should not contain any personal information


New Password:

Re-enter new password:

 Please check the password validation requirements.

Ok



 Reset Your Password


Create a new password

Your password must meet the following requirements:

- ✓ Must be at least 12 characters
- ✓ Must contain at least three of the following:
 - ✓ an uppercase character
 - ✓ a lowercase character
 - ✓ a number (0-9)
 - ✓ a special character (!@#\$%^&*)
- Must not be the same as your current or previous 5 passwords.
- Must not include any portion of your email address - including your domain name.
- Should not contain any personal information

New Password:

Re-enter new password:

 Please check the password validation requirements.

Ok



Examples of problematic design

Login

RYANAIR

HOME · F.A.Q. · FEES

FLIGHTS · SERVICES · CAR · HOTEL · PAYMENT · ITINERARY

Passenger(s)

All passenger names must match those in the passport/accepted travel document

Duplicate names must not be entered for passengers ?

Passenger 1

Title First name Last name

Travel Insurance

| | INSURANCE | INSURANCE PLUS |
|----------------------------------------------------------------------------------|-----------|----------------|
| Medical Expenses up to £2,500,000 (excess of £75, double excess for aged 65+) | ✓ | ✓ |
| Personal Belongings up to £1,500 (excess of £75)* | ✓ | ✓ |
| Cancellation circumstances (excess of £15) | ✓ | ✓ |
| Ticket Refund In case of Ryanair cancellation | ✓ | ✓ |

VIEW POLICY

Please select a country of residence

- United Kingdom
- Ireland
- Germany
- Spain
- France
- Italy
- Sweden
- Austria
- Belgium
- Denmark
- Don't Insure Me
- Finland
- Hungary
- Latvia
- Lithuania
- Malta

BOOKING SUMMARY

► Passenger(s)

✈ London (Stansted) → Faro
Sun, 31 Aug 2014 20:55 - 23:45

▼ 1 Adult, 29.99 GBP

1 x Adult Fare 29.99 GBP

Discount Pay by debit card: 29.99 GBP

Pay by credit card: 30.59 GBP

TOTAL 29.99 GBP



Examples of problematic design

* - Denotes Required Information

> 1 Donation > 2 Confirmation > Thank You!

Donor Information

First Name*

Last Name*

Company

Address 1*

Address 2

City*

State*

Zip Code*

Country*

Phone

Fax

Email*

Donation Amount* ☒ None ☐ \$50 ☐ \$75 ☐ \$100 ☐ \$250 ☐ Other
(Check a button or type in your amount) Other Amount \$

Recurring Donation ☐ I am interested in giving on a regular basis.
(Check if yes) Monthly Credit Card \$ For Months

Honorarium and Memorial Donation Information

I would like to make this donation ☐ To Honor ☐ In Memory of

Name

Acknowledge Donation to

Address

City

State

Zip

Additional Information

Please enter your name, company or organization as you would like it to appear in our publications:

Name

☐ I would like my gift to remain anonymous.

☐ My employer offers a matching gift program. I will mail the matching gift form.

☐ Please save the cost of acknowledging this gift by not mailing a thank you letter.

Comments
(Please type any questions or feedback here)

How may we contact you? ☐ E-mail ☐ Postal Mail ☐ Telephone ☐ Fax

I would like to receive newsletters and information about special events by: ☐ E-mail ☐ Postal Mail

☐ I would like information about volunteering with the

Donate online with confidence. You are on a secure server.
If you have any problems or questions, please contact [support](#).



Examples of problematic design



Examples of problematic design



Examples of problematic design

Hyperspace - Production - DUBLIN PEDIATRICS

Desktop Action Patient Care Referrals Reports Tools Weblinks Help

Back Fwd Home Schedule In Basket Chart Encounter Tel Enc Refill Orders Only Staff Msg Sec Pt Msg Print Secure Log Out

Epic Home **Zztest, Ad**

MRN: 18774711 DOB: 4/15/1950 Age: 60 yea Sex: M Allergies: No Known Allergies PCP: NO Type: (None)* FSC: BX35, HN35 Online: Basic Alerts: **!!!**

Snapshot

Chart Review Snapshot ADVANCE DIRECTIVE/CODE STATUS Report Snapshot

Demographics

AD ZZTEST 123 Easy St
60 year old male Xxx, Xx 99999
Home: 999-999-9999

Problem List

Chronic

- ESOPHAGEAL REFLUX
- Other
- ASTHMA NOS W/O STATUS ASTHM
- ESSENTIAL HYPERTENSION NOS
- ERRONEOUS ENCOUNTER

Health Maintenance

| | Overdue | Due On | Due Soon |
|----------------------------------------|---------|------------|----------|
| CREATININE | | 04/15/1950 | |
| INFLUENZA VACCINE | | 09/01/2010 | |
| LIPID SCREENING | | 04/15/1985 | |
| PNEUMOCOCCAL VACCINE (PNEUMOVAX) | | 04/15/1952 | |
| POTASSIUM | | 04/15/1950 | |
| TDAP VACCINE | | 04/15/1961 | |
| UNIVERSAL HIV SCREENING DISCUSSION | | 04/15/1963 | |
| VARICELLA ZOSTER VACCINE (ZOSTAVAX) | | 04/15/2010 | |
| COLORECTAL CANCER SCREENING DISCUSSION | | 08/02/2011 | |

Allergies

No Known Allergies

Medications

PREVPAC Pack
lisinopril (PRINIVIL, ZESTRIL) 10mg Tab
tramadol (ULTRAM) 50mg Tab
fluticasone (FLONASE) 50mcg Nasal Susp
PREVPAC (PREVPAC) Pack
ranitidine (ZANTAC) 300mg Tab

Immunizations/Injections

None

Significant History/Details

Tobacco: Not on File
Alcohol: Not on File
3 open orders
Language: UNKNOWN

Specialty Comments

No comments regarding your specialty

Family Comments

None

Reminders and Results

None

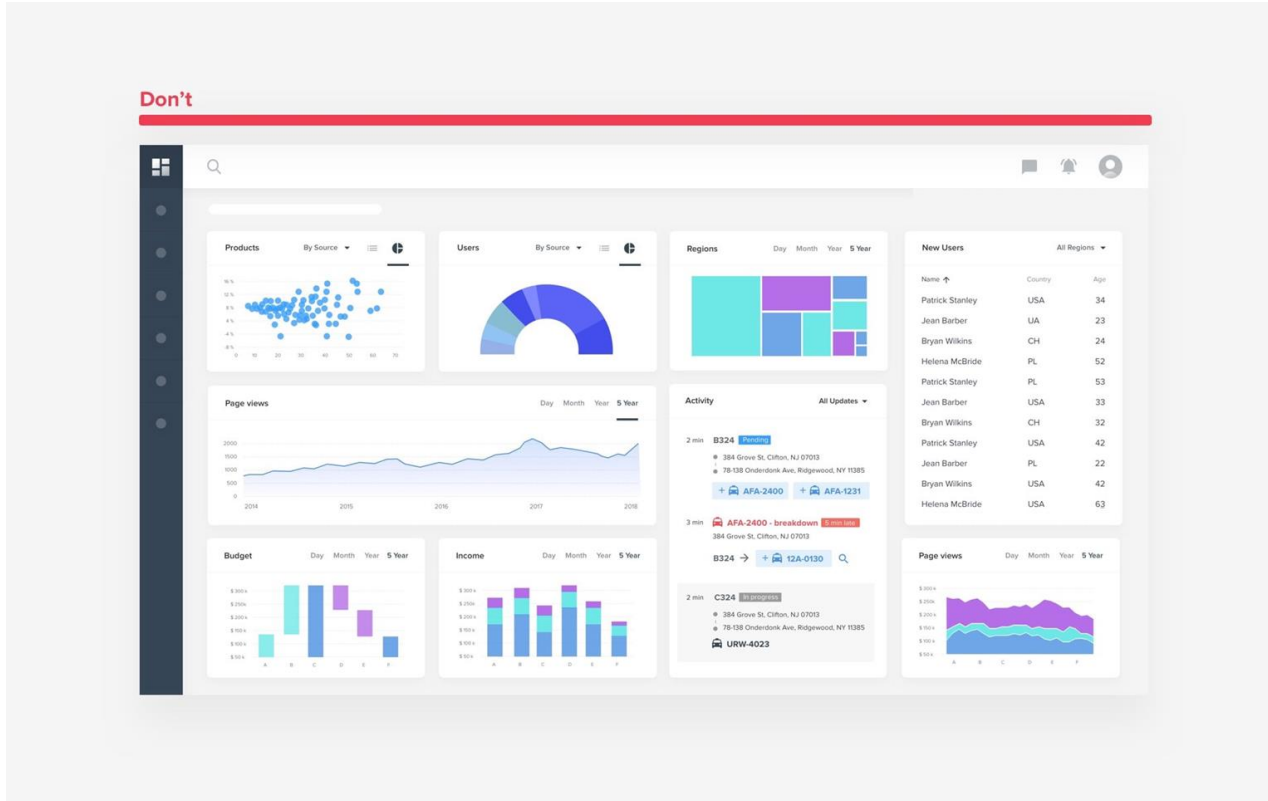
Hotkey List

Exit Workspace

JODIM CC'd Charts, CC'd Results, Result Notes, Results, Addendum, Charts CC'd To Me, Expiring Ord, Open Charts, 9:54 AM

Start Epic Hyperspace - Product... Microsoft PowerPoint - [...]

Examples of problematic design



Examples of problematic design

```
{
  "checkIn": "20151001",
  "lastNight": "20151002",
  "checkOut": "20151003",
  "roomId": "12345",
  "propId": "1234",
  "ownerId": "123",
  "numAdult": "2",
  "numChild": "0",
  "offerId": "1",
  "voucherCode": "",
  "referrer": "",
  "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

