2014

How easily understandable are complex multi-layered system maps
Holmen, Alfred Clatworthy and Jun, Gyuchan Thomas

Suggested citation:
Complex multi-layered system maps
Does zoom in/out interaction help for better systems understanding?

Alfred Clatworthy Holmen
Thomas Jun
Loughborough Design School
Loughborough University, UK
Background
System/Process Maps

Soft system models
Workflow models
Business process modelling
Hard system models
Cognitive Work Analysis

IDEF3
UML
IDEF0
Influence diagrams
Real time system modelling
Data Flow Diagrams
Entity Relation Diagram
Flowcharts
Object Oriented modelling
State Transition Diagrams
SysML
Mapping/Modelling allows us to

- Identify complexity
- Aid understanding
- Improve communication
Basic elements of modelling methods

Nodes

Links

Nodes

Hierarchical links

Sequential links

Information links

goal

start

state1

state2

state3

sub-task1

sub-task2

process content diagrams

process state transition diagrams

communication diagrams

data flow diagrams

person1

person2

person3

activity1

activity2

data storage
Activity view

Stakeholder view

Information/material view

Sequential link

Hierarchical link

Information link
Study 1–Perceived ease of use and usefulness

Patient Discharge Processes

Reality

Activity view

Information /material view

Information link

Sequential link

Hierarchical link

Flowchart

State transition diagram

Process content diagram

Swim lane activity diagram

Stakeholder diagram

Communication diagram

Sequence diagram

Stakeholder view

Healthcare workers

Human Factors & Complex Systems Group
Loughborough Design School
1. Stakeholder diagrams
2. Information diagrams

**KEY**
- Information resource
  - content

**Referrals**
△ has types of

**Transitional care requests**
△ has types of
- Assessment notification to the Huntingdon transitional care team (Fax1)
  - reason patient needs support on discharge
  - reason for admission
  - expected discharge date
  - patient information
- Assessment notification to the Huntingdon transitional care team (Fax2)
  - date MDT agreed patient is ready for discharge
  - date patient fit for transfer/discharge
  - what health will provide on the agreed date of transfer/discharge
  - what social care services TCT has agreed to supply
  - Is TCT able to deliver on the agreed date

**Discharge summary**
△ has types of
- TTO
- patient information

**Discharge summary (form 1)**
- GP information
- info. given to patient
- outpatient appointment

**Discharge summary (form 2)**
- consultant
- date admission/discharged
- diagnosis
- other problems
- investigation
- GP action needed
- information to patient
- follow up

**Discharge summary (form 3)**
- admission detail
- diagnosis detail
- non-operative treatment
- operation
- main investigation/results
- adverse events
- postscript
3. Process content diagrams

Patient discharge process from ward consists of:

1. Decide discharge date
   - MDT discusses a need for transitional care
   - Nurse requests transitional care assessment
   - TCT assesses patient condition
   - MDT decides discharge date
   - TCT confirms transitional care service

2. Prepare for patient discharge
   - Doctor drafts discharge summary
   - Ward pharmacist confirms discharge summary
   - Pharmacy technician checks medicine need
   - Hospital pharmacy prepares TTO medicine

3. Implement patient discharge
   - Nurse runs through discharge checklist
   - Nurse discharges patient

4. Transfer patient information
   - Ward clerk sends discharge summary to GPs (pt's, facility's), and central record
4. Flowcharts

Start

Multidisciplinary team discusses a need for transitional care.

No need

Nurse requests assessment for transitional care

Assessment notification (Fax1) created

TCT assesses pt's need

Intermediate care team summary created

MDT decides discharge date

Assessment notification (Fax2) created by nurse

TCT confirms transition care service

Assessment notification (Fax2) confirmed

Doctor drafts a discharge summary

discharge summary created

Ward pharmacist confirms discharge summary

need corrections

no problems

Ward pharmacist confirms discharge summary

discharge summary confirmed

Pharmacy technician checks a medicine need

enough for 21 days

not enough

Hospital pharmacy dispenses medicine

KEY

○ Start / End

□ Activity step

□ Decision point

□ Document created

TCT: Transitional Care Team

MDT: Multidisciplinary Team

FTC: To Take Out
5. Swim lane activity diagrams
6. State transition diagrams

- Patient admitted to ward
  - At multidisciplinary meeting: MDT discusses needs for transitional care

- Patient discussed at MDT
  - Transitional care needed:
    - Nurse requests assessment using fax1 form
    - TCT assesses pt transitional care needs
    - MDT decides discharge date
    - Nurse fills out fax2 form and faces to TCT
    - TCT fills out intermediate care summary
    - TCT confirms discharge date using fax2
  - Transitional care Not needed:
    - MDT decides discharge date

- Patient confirmed discharge date
  - Doctor generates discharge summary

- Patient drafted discharge summary
  - Corrections needed:
    - Ward pharmacist confirms discharge summary
  - No corrections needed:

- Patient completed discharge summary
  - not enough TTO medicine:
    - Pharmacy technician transfers discharge summary to hospital pharmacy with TTO medicine order
    - Hospital pharmacy dispenses TTO medicine
  - enough TTO medicine for 21 days:
    - Pharmacy technician transfers discharge summary to hospital pharmacy w/o order

KEY
- patient state 1
  - transition condition
  - transition action
- patient state 2
7. Communication diagrams
8. Sequence diagrams
9. Data flow diagrams

[Diagram showing steps for patient discharge with decision points and data flow between steps.]

KEY:
- Data flow
- Material flow
- Activity
- Data/materiel storage

Steps:
1. Decide discharge date
2. Prepare for pt discharge
3. Implement pt discharge
4. Transfer pt info
10. IDEF0

KEY
input → process (task) → output

- guides, procedures
- human resources
- discharge summary
- discharge checklist
- TTO medicine

Decision
- criteria for transitional care provision
- patient condition
- discharge date
- A1
- MDT
- TCT
- Nurse

Prepare for pt discharge
- BNF
- A2
- Doctor
- Hospital pharmacy
- Ward pharmacist
- Pharmacy technician

Implement pt discharge
- A3
- Nurse
- TTO medicine

Transfer pt info
- A4
- Ward clerk
Diagram Acceptance

Diagram Acceptance Model

Perceived Usefulness

Perceived Ease of Use

Behavioral Intention to Use

Actual Diagram Use

(Davis, F.D., 1989)
Findings

Ease of use

Usefulness

(Jun, G., et. al., 2010)
Findings

- A single diagram cannot effectively capture the full range of perspectives present in complex healthcare.

State Transition Diagram
Study II – Choice and Usage

Reality

Adult mental health service for intake and treatment

State Transition Diagram

Communication Diagram

Free Form Diagram

Organisation Diagram

Care Pathway

Geographic Map

Service Blueprint

Healthcare workers

*Further actions - medication management - psychological treatment - carers' needs assessment - management of financial and housing issues
Study II – Choice and usage
Diagram Choice and Usage Model

Diagram Characteristics

- Individual Differences
- Social Influence
- Facilitating Conditions

Perceived Usefulness

- Choice to use certain diagrams

Perceived Ease of Use

- Actual use of certain diagrams

(Adjusted from Venkatesh, V., 2008)
Diagram Choice and Usage Model

Diagram Characteristics

- Diagram’s relevance to issues discussed
- Diagram’s consistency with participant’s mental models
- Participant’s communication style (visual/non-visual)
- Participant’s familiarity with real pathways

Individual Differences

- Perceived Usefulness
- Perceived Ease of Use

Choice to use certain diagrams

(Jun, G., under review)
Study III - Workshops

Reality

Safer Medicine Management Pathways

Patient at home with sufficient medicine (less than 3 weeks)
- Patient visits GP
- No change in medicine
- Patient goes home

Patient at home with sufficient medicine
(over 4 medicines)
- Medicine dispensed (ready to be collected)
- Otherwise
  - Patient/carer collects medicine

Patient admitted to hospital
- When patient needs hospital care
  - Patient goes to hospital
  - Patient takes own medicine to hospital
  - When patient ready to go home
    - Hospital discharges patient
    - Hospital provides medicine for 0/2/4 weeks
    - Hospital informs GP and pharmacy
  - Pharmacy checks prescription
  - Pharmacy contacts GP for enquiry (if required)
  - Pharmacy dispenses medicine

Patient at home with sufficient medicine
- Patient admitted to hospital
- When patient has appointment at GP
  - Patient visits GP
  - When no change in medicine
    - Patient goes home
  - When need for medicine change
    - GP issues prescription
    - GP calls pharmacy
    - Patient drops it to pharmacy
  - When pharmacy offers delivery and patient chooses to get it
    - Pharmacy delivers medicine to patient's home
  - Otherwise
    - Patient/carer collects medicine

Patient with low on medicine
- When patient/carer does it him/herself
  - Patient/carer fills in the repeat prescription slip
  - Patient/carer drops the repeat prescription slip at GP (visit/call?)
  - Patient/carer collects repeat prescription (within 48 hrs?)
  - Patient/carer drops repeat prescription to pharmacy
    - When pharmacy has agreed to act on behalf of patient (prescription collection service)
      - Pharmacy contacts patient
      - Pharmacy fills in the repeat prescription slip
      - Pharmacy drops the repeat prescription slip to GP
      - Pharmacy collects a repeat prescription from GP

Patient at home with sufficient medicine
- Patient takes medicine
- New (repeat) prescription at pharmacy
- Patient admitted to hospital
- When patient/carer drops in the repeat prescription slip
- When patient/carer picks up the repeat prescription (within 48 hrs?)
- When pharmacy contacts patient
Issues

- Not enough time for systems mapping
- Inconsistent and uneven participation
- Potential of using online engagement
- How to present complex system maps?
How might we rapidly equip and empower the care community to fight Ebola?

**THE CHALLENGE**

Follow this challenge 413 followers

SHARE THIS

**IDEAS**

139 ideas

**IMPACT**

Starts in 13 days

---

**RESEARCH**

165 contributions

---

Let’s collect examples of the Ebola epidemic so everyone can contribute better! Check out our Inspiration Tools.

---

**Situation Understanding**

**JIGZAW**

Insights
Influence Plans
Campaign Plans
Hypotheses
Consequences
Information Gaps

---

**Situation Awareness**

Data sharing
Data collection
Stock tracking
Data collection
Simple and scalable
COP – Situation Awareness
Accountability and traceability

---

**Strengthen Health Care Capacities**

**MISSION #1**

How might we enhance the

---

**Add your contribution**
The first iteration of the NHS gather submission phase has now completed and you can’t add new ideas. You can still prioritise, debate and comment on all ideas and we encourage you to participate.

The debate and prioritization phase will continue and meanwhile we will present people’s views to the NHS board. Reflect on the process so far, what we have learned and how we can improve. All ideas, points and comments that have been put forward during this test session will be carried over through the different phases of the gather space and will not be lost.

We will keep you up to date via the NHS Citizen blog (nhscitizen.demsoc.org), our mailing list and twitter.

RANDOM IDEAS

**Physical & Mental Health should be assessed together.**

The NHS spends millions on drugs for things like hypertension, asthma, epilepsy, depression, anxiety, stroke, heart, etc. Some of these conditions in the early stages, might be due to what is happening in that patient’s life at that time, i.e. unemployment, bereavement, worry over a family member, finances, etc....
Study IV - Interactive zoom in/out

Patient Discharge Processes

- Transitional care team
- Hospital Pharmacy
- Home, Nursing/care home, Interim beds
- GPs (pt’s, facility’s)
- Nurse Multidisciplinary team
- Doctor (SHO, HO)
- Ward pharmacist
- Pharmacy technician
- Ward clerk
- Central record
- Ward
- Medicine storage
- Nurse
- Multidisciplinary team
- Doctor (SHO, HO)
- Nurse

1. Assessment notification (Fax 1) (pt detail, reason for transition care)
2. Assessment notification (Fax 2) (discharge date)
3. Assessment notification (Fax 2) (confirmation, name of carer)
4. Discharge summary
5. TTO medicine
6. TTO medicine
7. Discharge summary
8. Discharge summary

20 students

Reality

Zoom in/out
Hospital Pharmacy

5. discharge summary

5. TTO medicine

5.1 TTO medicine

Pharmacy technician

Nurse

Central record

Ward pharmacist

Ward clerk

Nurse

Medicine storage

5.1 TTO medicine

5.1 discharge summary

5.1 discharge date

5. discharge summary

6. discharge summary

6. TTO medicine

6.1 discharge summary

7. discharge summary

7. discharge summary

3. Assessment notification (Fax2) [confirmation, name of carer]

Transitional care team

GPs (pt’s, facility’s)

Home, Nursing/care home, Interim beds

Human Factors & Complex Systems Group
Loughborough Design School
1. Assessment notification (Fax1) [pt detail, reason for transition care]
2. Assessment notification (Fax2) [discharge date]
3. Assessment notification (Fax2) [confirmation, name of carer]
4. discharge summary
5. discharge summary
6. discharge summary
7. discharge summary

Ward

Central record

Transitional care team

Hospital Pharmacy

GPs (pt's, facility's)

Home, Nursing/care home, Interim beds

Doctor (SHO, HO)

Ward clerk

Pharmacy technician

Ward pharmacist

Nurse Multidisciplinary team

Medicine storage

Medicine

0. Transitional Care needed

1.1 discharge date

5.1 TTO medicine

5.1 TTO medicine

5.1 discharge summary

5.1 discharge summary

5.1 discharge summary

7. discharge summary

7. discharge summary
Evaluation – Performance and preference

- Time taken till participants felt they had a good understanding of the map contents
- Usability - Questionnaire
  - Easily understandable (ease of use)
  - Helpful in understanding and communicating how the system works (usefulness)
  - Enjoyable to use the map
- Semi-structured interviews
## Results - Time

<table>
<thead>
<tr>
<th>Interaction</th>
<th>Ave</th>
<th>Std</th>
<th>Max</th>
<th>Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zoom in/out</td>
<td>6 min</td>
<td>55 sec</td>
<td>8 min</td>
<td>5 min</td>
</tr>
<tr>
<td>interaction</td>
<td>57 sec</td>
<td></td>
<td>56 sec</td>
<td>52 sec</td>
</tr>
<tr>
<td>No interactions</td>
<td>7 min</td>
<td>49 sec</td>
<td>8 min</td>
<td>6 min</td>
</tr>
<tr>
<td></td>
<td>27 sec</td>
<td></td>
<td>54 sec</td>
<td>12 sec</td>
</tr>
</tbody>
</table>
Results - Questionnaire

1. Easily understandable

2. Helpful in better understanding and communicating

3. Enjoyable
# Results - Interviews

<table>
<thead>
<tr>
<th></th>
<th>Positive</th>
<th>Negative</th>
<th>Etc</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Zoom in/out</strong></td>
<td>Fun and easy</td>
<td>Daunting and overwhelming</td>
<td>Top-down vs bottom-up</td>
</tr>
<tr>
<td>interaction</td>
<td>Interesting</td>
<td>Hard to control</td>
<td>Clearer instruction</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>No</strong></td>
<td>Easy and useful</td>
<td>Complicated, unclear and overwhelming</td>
<td>Better use of colour</td>
</tr>
<tr>
<td><strong>interactions</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Conclusion

- Interactive zoom in/out map took less time in understanding
- Interactive zoom in/out map was rated better in the interview (more fun)
- However, little difference between them in terms of perceived ease of use and usefulness
Diagram Choice and Usage Model

Diagram Characteristics

Individual Differences

Social Influence

Facilitating Conditions

Perceived Usefulness

Perceived Ease of Use

Choice to use certain diagrams

Actual use of certain diagrams

Perceived Fun?