



HUMAN-COMPUTER INTERACTION

THIRD
EDITION

DIX
FINLAY
ABOWD
BEALE



chapter 1

cognitive models

Cognitive models

- goal and task hierarchies
- linguistic
- physical and device
- architectural

Cognitive models

- They model aspects of user:
 - understanding
 - knowledge
 - intentions
 - processing
- Common categorisation:
 - Competence vs. Performance
 - Computational flavour
 - No clear divide

Goal and task hierarchies

- Mental processing as divide-and-conquer
- Example: sales report
 - produce report
 - gather data
 - . find book names
 - . . do keywords search of names database
 - *further sub-goals*
 - . . sift through names and abstracts by hand
 - *further sub-goals*
 - . search sales database - further sub-goals
 - layout tables and histograms - further sub-goals
 - write description - further sub-goals

goals vs. tasks

- goals – intentions
what you would like to be true
- tasks – actions
how to achieve it
- GOMS – goals are internal
- HTA – actions external
– tasks are abstractions

Issues for goal hierarchies

- Granularity
 - Where do we start?
 - Where do we stop?
- Routine learned behaviour, not problem solving
 - The unit task
- Conflict
 - More than one way to achieve a goal
- Error

Techniques

- Goals, Operators, Methods and Selection (GOMS)
- Cognitive Complexity Theory (CCT)
- Hierarchical Task Analysis (HTA) - Chapter 15

GOMS

Goals

- what the user wants to achieve

Operators

- basic actions user performs

Methods

- decomposition of a goal into subgoals/operators

Selection

- means of choosing between competing methods

GOMS example

```
GOAL: CLOSE-WINDOW
.   [select GOAL: USE-MENU-METHOD
      .   MOVE-MOUSE-TO-FILE-MENU
      .   PULL-DOWN-FILE-MENU
      .   CLICK-OVER-CLOSE-OPTION
GOAL: USE-CTRL-W-METHOD
      .   PRESS-CONTROL-W-KEYS]
```

For a particular user:

- Rule 1: Select USE-MENU-METHOD unless another rule applies
- Rule 2: If the application is GAME,
select CTRL-W-METHOD

Cognitive Complexity Theory

- Two parallel descriptions:
 - User production rules
 - Device generalised transition networks
- Production rules are of the form:
 - if condition then action
- Transition networks covered under dialogue models

Example: editing with vi

- Production rules are in long-term memory
- Model working memory as attribute-value mapping:
 - (GOAL perform unit task)
 - (TEXT task is insert space)
 - (TEXT task is at 5 23)
 - (CURSOR 8 7)
- Rules are pattern-matched to working memory,
 - e.g., LOOK-TEXT task is at %LINE %COLUMN is true, with LINE = 5 COLUMN = 23.

Four rules to model inserting a space

Active rules:

```
SELECT-INSERT-SPACE  
INSERT-SPACE-MOVE-FIRST  
INSERT-SPACE-DOIT  
INSERT-SPACE-DONE
```

New working memory

```
(GOAL insert space)  
(NOTE executing insert  
space)  
(LINE 5) (COLUMN 23)
```

SELECT-INSERT-SPACE
matches current working memory

```
(SELECT-INSERT-SPACE  
IF (AND (TEST-GOAL perform unit task)  
        (TEST-TEXT task is insert space)  
        (NOT (TEST-GOAL insert space))  
        (NOT (TEST-NOTE executing insert  
space)))  
THEN ( (ADD-GOAL insert space)  
        (ADD-NOTE executing insert space)  
        (LOOK TEXT task is at %LINE %COLUMN)))
```

Notes on CCT

- Parallel model
- Proceduralisation of actions
- Novice versus expert style rules
- Error behaviour can be represented
- Measures
 - depth of goal structure
 - number of rules
 - comparison with device description

Problems with goal hierarchies

- a post hoc technique
- expert versus novice
- How cognitive are they?

Linguistic notations

- Understanding the user's behaviour and cognitive difficulty based on analysis of language between user and system.
- Similar in emphasis to dialogue models
- Backus–Naur Form (BNF)
- Task–Action Grammar (TAG)

Backus-Naur Form (BNF)

- Very common notation from computer science
- A purely syntactic view of the dialogue
- Terminals
 - lowest level of user behaviour
 - e.g. CLICK-MOUSE, MOVE-MOUSE
- Nonterminals
 - ordering of terminals
 - higher level of abstraction
 - e.g. select-menu, position-mouse

Example of BNF

- Basic syntax:
 - nonterminal ::= expression
- An expression
 - contains terminals and nonterminals
 - combined in sequence (+) or as alternatives (|)

draw line	::=	select line + choose points + last point
select line	::=	pos mouse + CLICK MOUSE
choose points	::=	choose one choose one + choose points
choose one	::=	pos mouse + CLICK MOUSE
last point	::=	pos mouse + DBL CLICK MOUSE
pos mouse	::=	NULL MOVE MOUSE+ pos mouse

Measurements with BNF

- Number of rules (not so good)
- Number of + and | operators
- Complications
 - same syntax for different semantics
 - no reflection of user's perception
 - minimal consistency checking

Task Action Grammar (TAG)

- Making consistency more explicit
- Encoding user's world knowledge
- Parameterised grammar rules
- Nonterminals are modified to include additional semantic features

Consistency in TAG

- In BNF, three UNIX commands would be described as:

copy ::= cp + filename + filename | cp + filenames + directory
move ::= mv + filename + filename | mv + filenames + directory
link ::= ln + filename + filename | ln + filenames + directory

- No BNF measure could distinguish between this and a less consistent grammar in which

link ::= ln + filename + filename | ln + directory + filenames

Consistency in TAG (cont'd)

- consistency of argument order made explicit using a parameter, or semantic feature for file operations
- Feature Possible values
Op = copy; move; link
- Rules
file-op[Op] ::= command[Op] + filename + filename
 | command[Op] + filenames + directory
command[Op = copy] ::= cp
command[Op = move] ::= mv
command[Op = link] ::= ln

Other uses of TAG

- User's existing knowledge
- Congruence between features and commands
- These are modelled as derived rules

Physical and device models

- The Keystroke Level Model (KLM)
- Buxton's 3-state model
- Based on empirical knowledge of human motor system
- User's task: acquisition then execution.
 - these only address execution
- Complementary with goal hierarchies

Keystroke Level Model (KLM)

- lowest level of (original) GOMS
- six execution phase operators
 - Physical motor: K - keystroking
P - pointing
H - homing
D - drawing
 - Mental M - mental preparation
 - System R - response
- times are empirically determined.
$$T_{execute} = TK + TP + TH + TD + TM + TR$$

KLM example

GOAL: ICONISE-WINDOW

[select

GOAL: USE-CLOSE-METHOD

. MOVE-MOUSE-TO- FILE-MENU

. PULL-DOWN-FILE-MENU

. CLICK-OVER-CLOSE-OPTION

GOAL: USE-CTRL-W-METHOD

PRESS-CONTROL-W-KEY]

- compare alternatives:
 - USE-CTRL-W-METHOD vs.
 - USE-CLOSE-METHOD
- assume hand starts on mouse

USE-CTRL-W-METHOD		USE-CLOSE-METHOD	
H[to kbd]	0.40	P[to menu]	1.1
M	1.35	B[LEFT down]	0.1
K[ctrlW key]	0.28	M	1.35
		P[to option]	1.1
		B[LEFT up]	0.1
Total 2.03 s		Total 3.75 s	

Architectural models

- All of these cognitive models make assumptions about the architecture of the human mind.
- Long-term/Short-term memory
- Problem spaces
- Interacting Cognitive Subsystems
- Connectionist
- ACT

Display-based interaction

- Most cognitive models do not deal with user observation and perception
- Some techniques have been extended to handle system output
(e.g., BNF with sensing terminals, Display-TAG)
but problems persist
- Exploratory interaction versus planning



Chapter 2

socio-organizational
issues and stakeholder
requirements

socio-organizational issues and stakeholder requirements

- Organizational issues affect acceptance
 - conflict & power, who benefits, encouraging use
- Stakeholders
 - identify their requirements in organizational context
- Socio-technical models
 - human and technical requirements
- Soft systems methodology
 - broader view of human and organizational issues
- Participatory design
 - includes the user directly in the design process
- Ethnographic methods
 - study users in context, unbiased perspective

Organisational issues

Organisational factors can make or break a system

Studying the work group is not sufficient

- any system is used within a wider context
- and the crucial people need not be direct users

Before installing a new system must understand:

- who benefits
- who puts in effort
- the balance of power in the organisation
- ... and how it will be affected

Even when a system is successful

... it may be difficult to measure that success

Conflict and power

CSCW [?] = computer supported *cooperative* work

- people and groups have conflicting goals
- systems assuming cooperation will fail!

e.g. computerise stock control

stockman loses control of information

⇒ subverts the system

identify stakeholders – not just the users

Organisational structures

- Groupware affects organisational structures
 - communication structures reflect line management
 - email – cross-organisational communication

Disenfranchises lower management
⇒ disaffected staff and 'sabotage'

Technology *can* be used to change management style and power structures

- but need to know that is what we are doing
- and more often an accident !

Invisible workers

Telecommunications improvements allow:

- neighbourhood workcentres
- home-based tele-working

Many ecological and economic benefits

- reduce car travel
- flexible family commitments

but:

- 'management by presence' doesn't work
- presence increases perceived worth
- problems for promotion

Barriers to tele-working are managerial/social
not technological

Benefits for all?

Disproportionate effort

who puts in the effort \neq who gets the benefit

Example: shared diary:

- effort: secretaries and subordinates, enter data
- benefit: manager easy to arrange meetings
- result: falls into disuse

Solutions:

- coerce use !
- design in symmetry

Free rider problem

no bias, but still problem

possible to get benefit without doing work

if everyone does it, system falls into disuse

e.g. electronic conferences

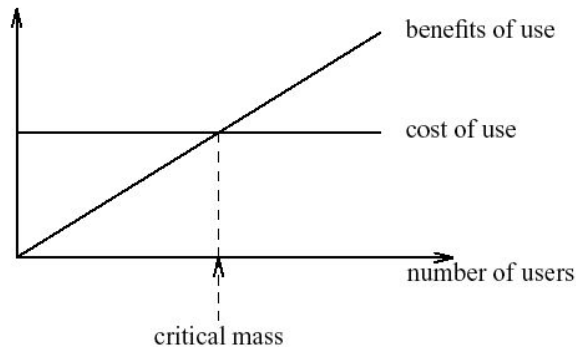
– possible to read but never contribute

solutions:

strict protocols (e.g., round robin)

increase visibility – rely on social pressure

Critical mass



Early telephone system:

few subscribers – no one to ring

lots of subscribers – never stops ringing!

Electronic communications similar:

benefit \propto number of subscribers

early users have negative cost/benefit

need critical mass to give net benefits

How to get started?

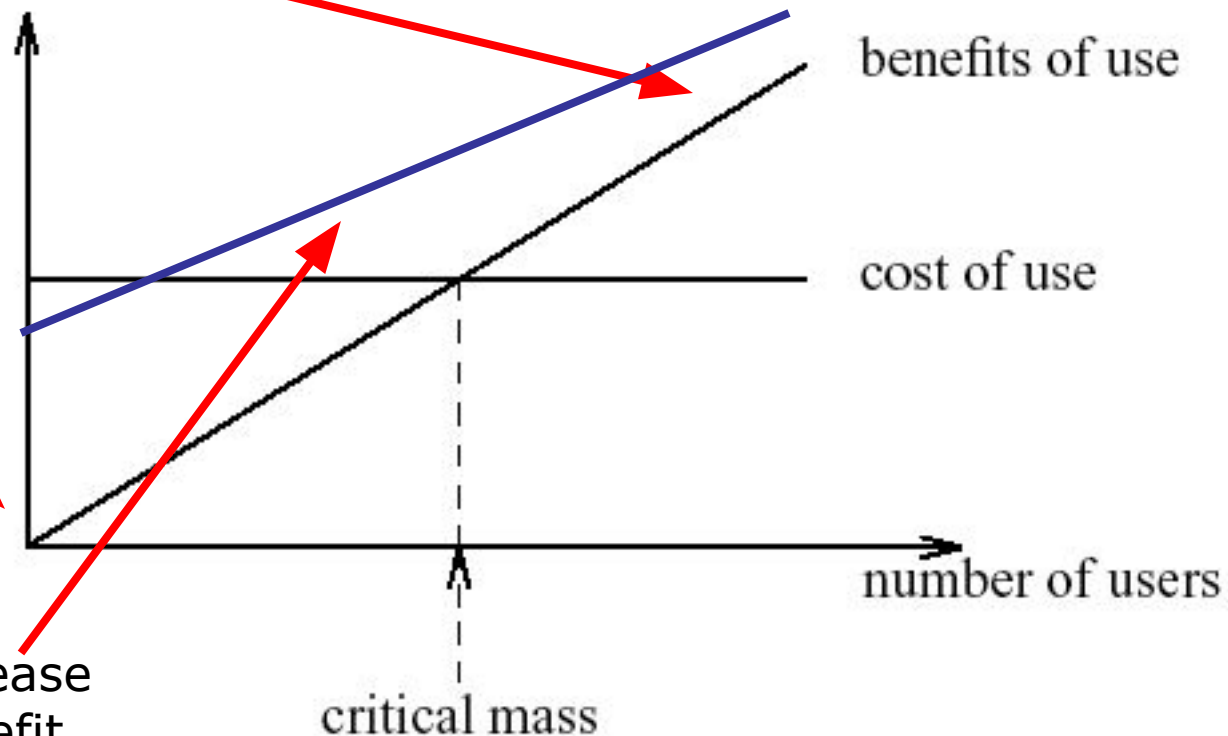
- look for cliques to form core user base
- design to benefit an initial small user base

Critical mass

strong benefit when
lots of users

.. but little benefit
for early users

solution – increase
zero point benefit



Evaluating the benefits

Assuming we have avoided the pitfalls!

How do we measure our success?

- job satisfaction and information flow

 - hard to measure

- economic benefit

 - diffuse throughout organisation

But ..

- costs of hardware and software

 - ... only too obvious

Perhaps we have to rely on hype!

capturing requirements

- need to identify requirements within context of use
- need to take account of
 - stakeholders
 - work groups and practices
 - organisational context
- many approaches including
 - socio-technical modelling
 - soft system modelling
 - participatory design
 - contextual inquiry

who are the stakeholders?

- system will have many stakeholders with potentially conflicting interests
- stakeholder is anyone effected by success or failure of system
 - primary - actually use system
 - secondary - receive output or provide input
 - tertiary - no direct involvement but effected by success or failure
 - facilitating - involved in development or deployment of system

who are the stakeholders?

Example: Classifying stakeholders – an airline booking system

An international airline is considering introducing a new booking system for use by associated travel agents to sell flights directly to the public.

Primary stakeholders: travel agency staff, airline booking staff

Secondary stakeholders: customers, airline management

Tertiary stakeholders: competitors, civil aviation authorities, customers' travelling companions, airline shareholders

Facilitating stakeholders: design team, IT department staff

who are the stakeholders?

- designers need to meet as many stakeholder needs as possible
 - usually in conflict so have to prioritise
 - often priority decreases as move down categories e.g. primary most important
 - not always e.g. life support machine

socio-technical modelling

- response to *technological determinism*
- concerned with technical, social, organizational and human aspects of design
- describes impact of specific technology on organization
- information gathering: interviews, observation, focus groups, document analysis
- several approaches e.g.
 - CUSTOM
 - OSTA

CUSTOM

- Six stage process - focus on stakeholders
 - describe organizational context, including primary goals, physical characteristics, political and economic background
 - identify and describe stakeholders including personal issues, role in the organization and job
 - identify and describe work-groups whether formally constituted or not
 - identify and describe task-object pairs i.e. tasks to be performed and objects used
 - identify stakeholder needs: stages 2-4 described in terms of both current and proposed system - stakeholder needs are identified from the differences between the two
 - consolidate and check stakeholder requirements against earlier criteria

OSTA

- Eight stage model - focus on task
 - primary task identified in terms of users' goals
 - task inputs to system identified
 - external environment into which the system will be introduced is described, including physical, economic and political aspects
 - transformation processes within the system are described in terms of actions performed on or with objects
 - social system is analyzed, considering existing internal and external work-groups and relationships
 - technical system is described in terms of configuration and integration with other systems
 - performance satisfaction criteria are established, indicating social and technical requirements of system
 - new technical system is specified

soft systems methodology

- no assumption of technological solution - emphasis on understanding situation fully
- developed by Checkland
- seven stages
 - recognition of problem and initiation of analysis
 - detailed description of problem situation
 - rich picture
 - generate root definitions of system
 - CATWOE
 - conceptual model - identifying transformations
 - compare real world to conceptual model
 - identify necessary changes
 - determine actions to effect changes

CATWOE

- **Clients:** those who receive output or benefit from the system
- **Actors:** those who perform activities within the system
- **Transformations:** the changes that are affected by the system
- **Weltanschauung:** (from the German) or World View - how the system is perceived in a particular root definition
- **Owner:** those to whom the system belongs, to whom it is answerable and who can authorize changes to it
- **Environment:** the world in which the system operates and by which it is influenced

Participatory design

In participatory design:

workers enter into design context

In ethnography (as used for design):

designer enters into work context

Both make workers feel valued in design

... encourage workers to 'own' the products

Participatory Design

- User is an active member of the design team.
- Characteristics
 - context and work oriented rather than system oriented
 - collaborative
 - iterative
- Methods
 - brain-storming
 - storyboarding
 - workshops
 - pencil and paper exercises

ETHICS

- participatory socio-technical approach devised by Mumford
 - system development is about managing change
 - non-participants more likely to be dissatisfied
- three levels of participation
 - consultative, representative, consensus
- design groups including stakeholder representatives make design decisions
- job satisfaction is key to solution

Ethnography

very influential in CSCW

a form of anthropological study with special focus on social relationships

does *not* enter actively into situation

seeks to understand social culture

unbiased and open ended

contextual inquiry

- Approach developed by Holtzblatt
 - in ethnographic tradition but acknowledges and challenges investigator focus
 - model of investigator being apprenticed to user to learn about work
 - investigation takes place in workplace - detailed interviews, observation, analysis of communications, physical workplace, artefacts
 - number of models created:
 - sequence, physical, flow, cultural, artefact
 - models consolidated across users
 - output indicates task sequences, artefacts and communication channels needed and physical and cultural constraints



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Chapter 3

communication and
collaboration models

CSCW Issues and Theory

All computer systems have group impact
– not just groupware

Ignoring this leads to the failure of systems

Look at several levels – minutiae to large scale context:

- face-to-face communication
- conversation
- text based communication
- group working

Face-to-face communication

- Most primitive and most subtle form of communication
- Often seen as the paradigm for computer mediated communication?

Transfer effects

- carry expectations into electronic media ...
... sometimes with disastrous results
- may interpret failure as rudeness of colleague

e.g. personal space

- video may destroy mutual impression of distance
- happily the 'glass wall' effect helps

Eye contact

- to convey interest and establish social presence
- video may spoil direct eye contact (see video tunnel, chap 19)
- but poor quality video better than audio only

Gestures and body language

- much of our communication is through our bodies
- gesture (and eye gaze) used for deictic reference
- head and shoulders video loses this

So ... close focus for eye contact ...
... or wide focus for body language?

Back channels

Alison: Do you fancy that film ... *err*¹ ...
`The Green' *um*² ...
it starts at eight.
Brian: Great!

- Not just the words!
- Back channel responses from Brian at 1 and 2
 - quizzical at 1
 - affirmative at 2

Back channels (ctd)

- Back channels include:
 - nods and grimaces
 - shrugs of the shoulders
 - grunts and raised eyebrows
- Utterance begins vague ...
... then sharpens up *just* enough

Back channels -media effects

Restricting media restricts back channels

video – loss of body language

audio – loss of facial expression

half duplex – lose most voice back-channel
responses

text based – nothing left!

Back channels and turn-taking

in a meeting ...

- speaker *offers* the floor
(fraction of a second gap)
- listener *requests* the floor
(facial expression, small noise)

Grunts, 'um's and 'ah's, can be used by the:

- listener to *claim* the floor
- speaker to *hold* the floor

... but often too quiet for half-duplex channels

e.g. Trans-continental conferences – special problem

- lag can exceed the turn taking gap
... leads to a monologue!

Basic conversational structure

Alison: Do you fancy that film

Brian: the *uh* (500 ms) with the black cat
'The Green whatsit'

Alison: yeah, go at *uh* ...
(*looks at watch* – 1.2 s) ... 20 to?

Brian: sure

Smallest unit is the utterance

Turn taking \Rightarrow utterances usually alternate ...

Adjacency pairs

Simplest structure – adjacency pair

Adjacency pairs may nest:

Brian: Do you want some gateau?

Alison: is it very fattening?

Brian: yes, very

Alison: and lots of chocolate?

Brian: masses

Alison: I'll have a big slice then.

Structure is: B-x, A-y, B-y, A-z, B-z, A-x

– inner pairs often for clarification

... but, try analysing the first transcript in detail!

Context in conversation

Utterances are highly ambiguous

We use context to disambiguate:

Brian: (*points*) that post is leaning a bit
Alison: that's the one you put in

Two types of context:

- external context – reference to the environment
e.g., Brian's '*that*' – the thing pointed to
- internal context – reference to previous conversation
e.g., Alison's '*that*' – the last thing spoken of

← *deictic reference*

Referring to things - deixis

Often contextual utterances involve indexicals:

that, this, he, she, it

these may be used for internal or external context

Also descriptive phrases may be used:

- external: *'the corner post is leaning a bit'*
- internal: *'the post you mentioned'*

In face-to-face conversation can point

Common Ground

Resolving context depends on meaning
⇒ participants must share meaning
so must have shared knowledge

Conversation constantly negotiates meaning
... a process called *grounding*:

Alison: So, you turn right beside the river.
Brian: past the pub.
Alison: yeah ...

Each utterance is assumed to be:
relevant – furthers the current topic
helpful – comprehensible to listener

Focus and topic

Context resolved relative to current *dialogue focus*

Alison: Oh, look at your roses : : :

Brian: mmm, but I've had trouble with greenfly.

Alison: they're the symbol of the English summer.

Brian: greenfly?

Alison: no roses silly!

Tracing topics is one way to analyse conversation.

- Alison begins – *topic* is roses
- Brian shifts topic to greenfly
- Alison misses shift in focus ... *breakdown*

Breakdown

Breakdown happens at all levels:
topic, indexicals, gesture

Breakdowns are frequent, but

- redundancy makes detection easy
(Brian cannot interpret *'they're ... summer'*)
- people very good at repair
(Brian and Alison quickly restore shared focus)

Electronic media may lose some redundancy
⇒ breakdown more severe

Speech act theory

A specific form of *conversational analysis*

Utterances characterised by what they *do* ...
... they are *acts*

e.g. '*I'm hungry*'

- propositional meaning – hunger
- intended effect – '*get me some food*'

Basic conversational act the illocutionary point:

- promises, requests, declarations, ...

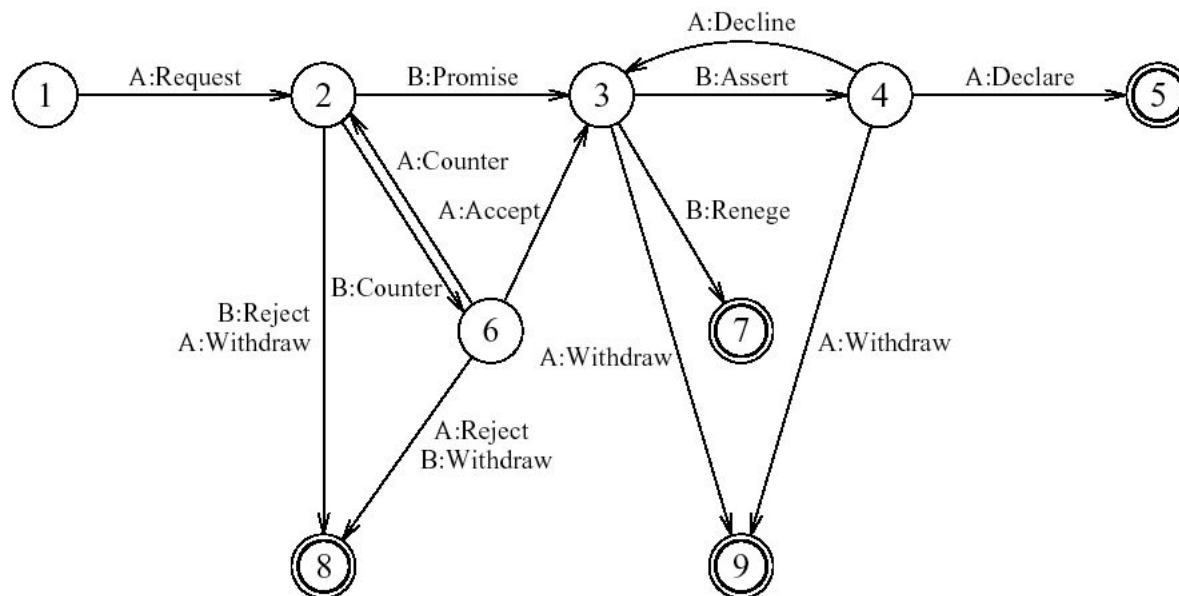
Speech acts need not be spoken

e.g. silence often interpreted as acceptance ...

Patterns of acts & Coordinator

- Generic patterns of acts can be identified
- Conversation for action (CfA) regarded as central
- Basis for groupware tool Coordinator
 - structured email system
 - users must fit within CfA structure
 - not liked by users!

Conversations for action (CfA)



Circles represent 'states' in the conversation
Arcs represent utterances (speech acts)

CfA in action

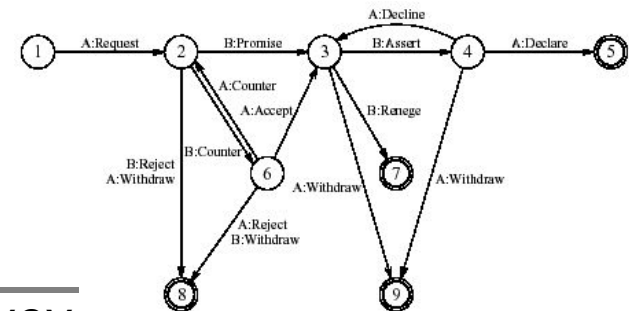
- Simplest route 1-5:

Alison: have you got the market survey
on chocolate mousse? *request*

Brian: sure *promise*

Brian: there you are *assert*

Alison: thanks *declare*



- More complex routes possible, e.g., 1-2-6-3 ...

Alison: have you got ... *request*

Brian: I've only got the summary figures *counter*

Alison: that'll do *accept*

Text-based communication

Most common media for asynchronous groupware
exceptions: voice mail, answer-phones

Familiar medium, similar to paper letters
but, electronic text may act as speech substitute!

Types of electronic text:


- discrete directed messages, no structure
- linear messages added (in temporal order)
- non-linear hypertext linkages
- spatial two dimensional arrangement

In addition, linkages may exist to other artefacts

Problems with text

No facial expression or body language
⇒ weak *back channels*

So, difficult to convey:
affective state – happy, sad, ...
illocutionary force – urgent, important, ...

Participants compensate:
'flaming' and smilies
;-) :-( :-)

example - 'Conferencer'

The interface is divided into two main sections: a linear conversation area on the left and a spatial simulated pinboard on the right.

Linear Conversation Area (LHS):

- PARTICIPANT LIST:** A list of participants: TOM, DICK, and HARRY.
- LETTER:** A large text area containing a conversation transcript:
 - TOM: HAS STARTED A NEW PRIVATE CONFERENCE
 - DICK: HAS JOINED THE CONFERENCE
 - HARRY: HAS JOINED THE CONFERENCE
 - DICK: I really think we ought to agree on a letter format
 - TOM: Yes, it's important that we make the right impression
 - HARRY: okay well let's start with the address
 - DICK: whose?
 - HARRY: ours in the top right, theirs on the left below
 - TOM: okay I'll write that in the pinboard
 - HARRY: How amny paragraphs should a letter have?
 - DICK: A minimum of two
 - HARRY: We've forgotten the Dear Sir bit
 - TOM: I'll put that in
 - HARRY: Now all we need is the Sign off
- SEND:** A button to send the letter.
- COMPOSITION BOX:** A text area for composing the letter, with the text "I'll just put a name areas in".

Spatial Simulated Pinboard (RHS):

- PIN BOARD:** A large area for pinning and editing the letter content.
- Q:** A small box in the top right corner.
- TM:** A box containing the text "Our Address, Some Street, Anytown".
- TM:** A box containing the text "Their Address, Some Street, Anytown".
- TM:** A box containing the text "Dear Sir/Madam".
- HARRY:** A box containing the text "first paragraph".
- HARRY:** A box containing the text "second paragraph".
- EDIT:** A button to edit the text.
- DELETE:** A button to delete the text.
- DICK:** A box containing the text "Yours faithfully,".
- DN:** A box containing the text "Mr. A Name".

linear conversation area – LHS RHS – spatial simulated pinboard

PARTICIPANT LIST

TOM

DICK

HARRY

LEAVE

LETTER

TOM : HAS STARTED A NEW PRIVATE CONFERENCE
 DICK : HAS JOINED THE CONFERENCE
 HARRY : HAS JOINED THE CONFERENCE
 DICK : I really think we ought to agree on a letter format
 TOM : Yes, it's important that we make the right impression
 HARRY : okay well let's start with the address
 DICK : whose?
 HARRY : ours in the top right, theirs on the left below
 TOM : okay I'll write that in the pinboard
 HARRY : How many paragraphs should a letter have?
 DICK : A minimum of two
 HARRY : We've forgotten the Dear Sir bit
 TOM : I'll put that in
 HARRY : Now all we need is the Sign off

Note separate 'composition box'
 – transcript only updated
 when contribution 'sent'
 – granularity is the contribution

SEND

COMPOSITION BOX

I'll just put a name areas in

PIN BOARD

TM

Our Address,
 Some Street,
 Anytown

Pin board has similar granularity
 'cards' only appear on other
 participants' screens when
 edit/creation is confirmed

first paragraph

HARRY

EDIT

DELETE

second paragraph

DICK

Yours faithfully,

HN

Mr. A Name

Grounding constraints

Establishing common ground depends on
grounding constraints

- cotemporality – instant feedthrough
- simultaneity – speaking together
- sequence – utterances ordered

Often weaker in text based communication
e.g., loss of sequence in linear text

loss of sequence

Network delays or coarse granularity \Rightarrow *overlap*

1. **Bethan:** how many should be in the group?
2. **Rowena:** maybe this could be one of the 4 strongest reasons
3. **Rowena:** please clarify what you mean
4. **Bethan:** I agree
5. **Rowena:** hang on
6. **Rowena:** Bethan what did you mean?

Message pairs 1&2 and 3&4 composed simultaneously
– lack of *common experience*

Rowena: 2 1 3 4 5 6

Bethan: 1 2 4 3 5 6

N.B. breakdown of turn-taking due to poor back channels

Maintaining context

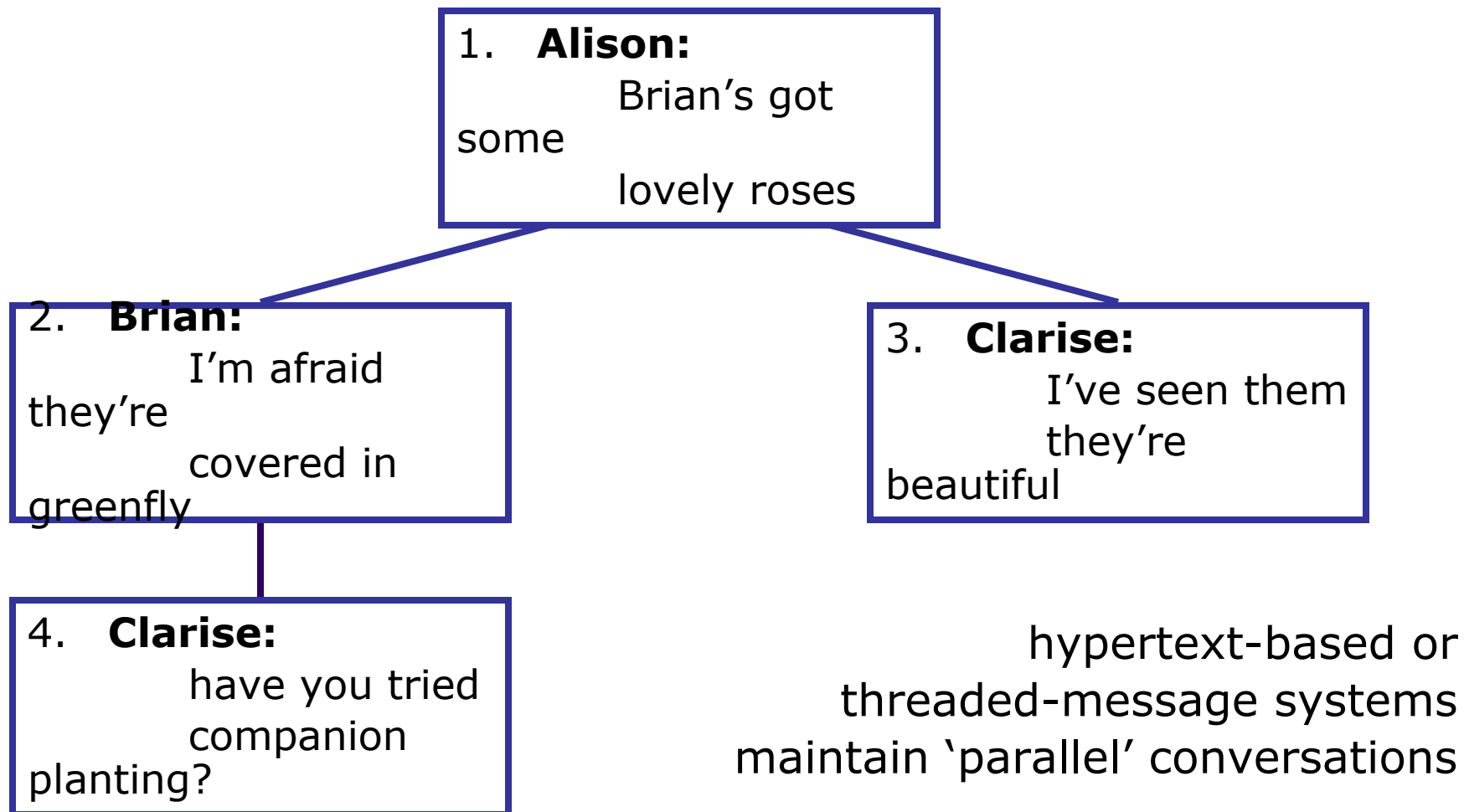
Recall *context* was essential for disambiguation

Text loses external context, hence deixis
(but, linking to shared objects can help)

1. **Alison:** Brian's got some lovely roses
2. **Brian:** I'm afraid they're covered in greenfly
3. **Clarise:** I've seen them, they're beautiful

Both (2) and (3) respond to (1)
... but *transcript* suggests greenfly are beautiful!

Non-linear conversation



Pace and granularity

Pace of conversation – the rate of turn taking

face-to-face – every few seconds

telephone – half a minute

email – hours or days

face-to-face conversation is highly interactive

- initial utterance is vague
- feedback gives cues for comprehension

lower pace \Rightarrow less feedback
 \Rightarrow less interactive

Coping strategies

People are very clever!

they create *coping strategies* when things are difficult

Coping strategies for slow communication
attempt to increase granularity:

eagerness – looking ahead in the conversation game

- **Brian:** Like a cup of tea? Milk or lemon?

multiplexing – several topics in one utterance

- **Alison:** No thanks. I love your roses.

The Conversation Game

Conversation is like a game

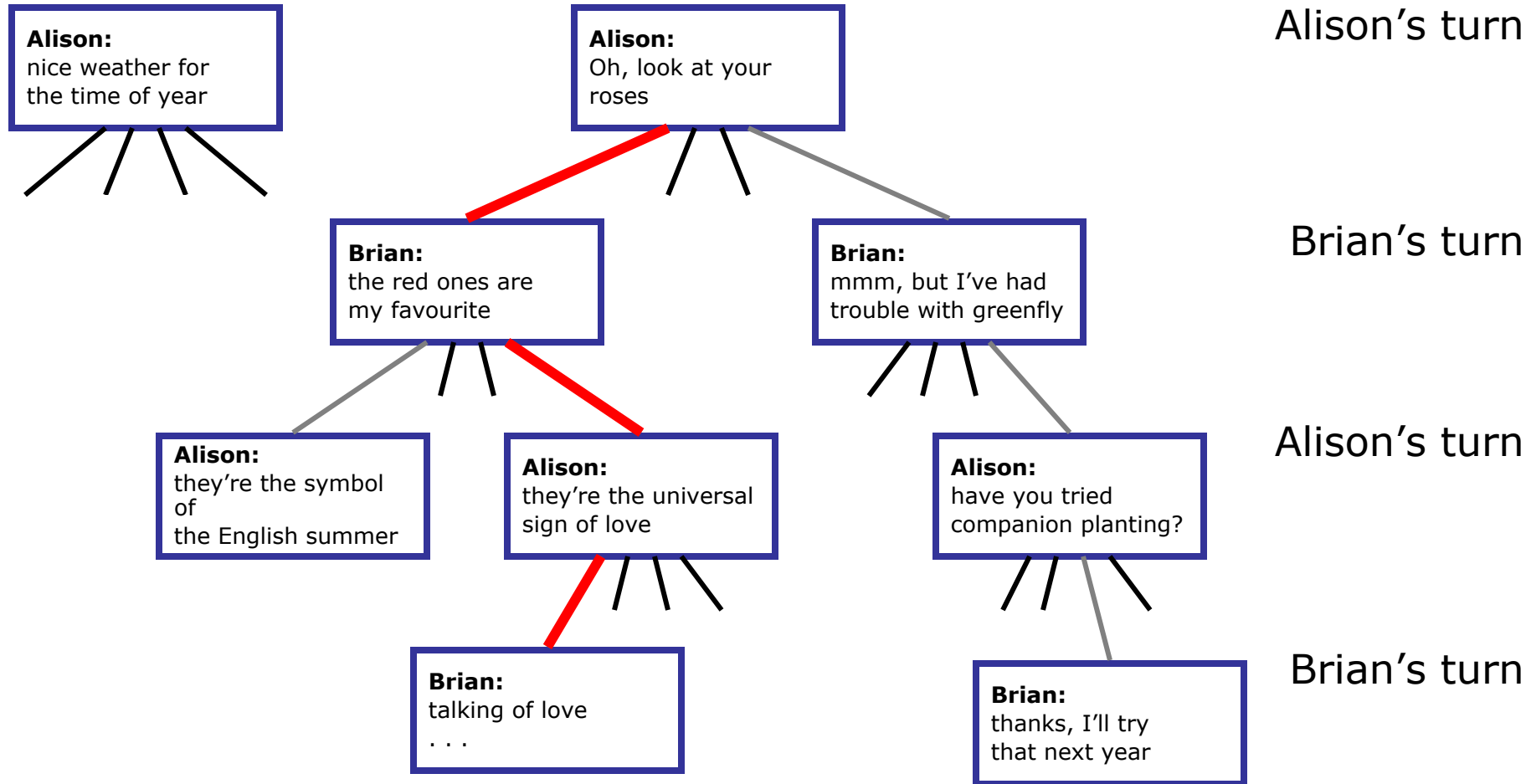
Linear text follows one path through it

Participants choose the path by their utterances

Hypertext can follow several paths at once

... like a game

participants
choose the path
by their utterances



Group dynamics

Work groups constantly change:

- in structure
- in size

Several groupware systems have explicit rôles

- But rôles depend on context and time
e.g., M.D. down mine under authority of foreman
- and may not reflect duties
e.g., subject of biography, author, but now writer

Social structure may change: democratic, autocratic, ...
and group may fragment into sub-groups

Groupware systems rarely achieve this flexibility

Groups also change in composition

⇒ new members must be able to 'catch up'

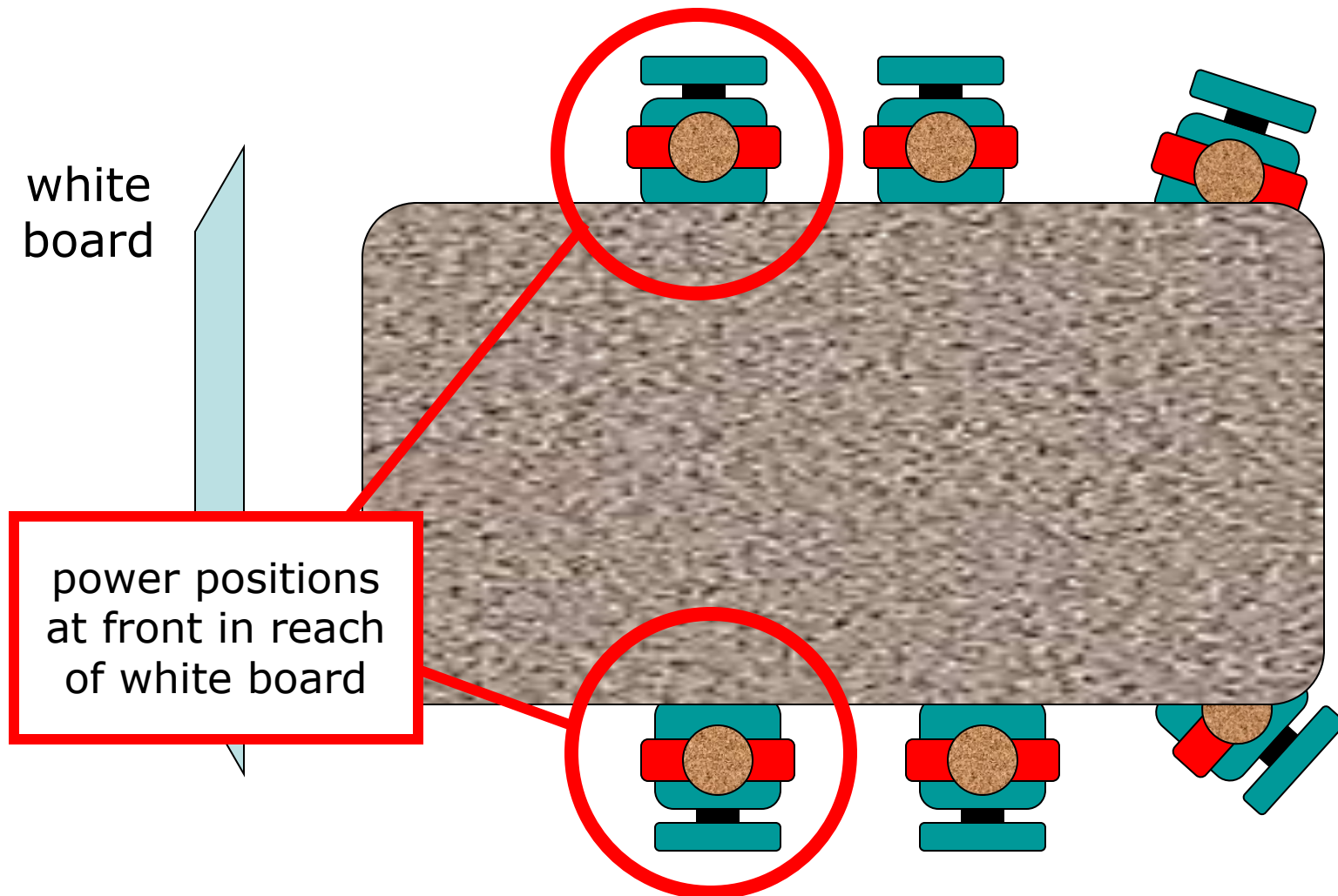
Physical environment

Face-to-face working radically affected by layout of workplace

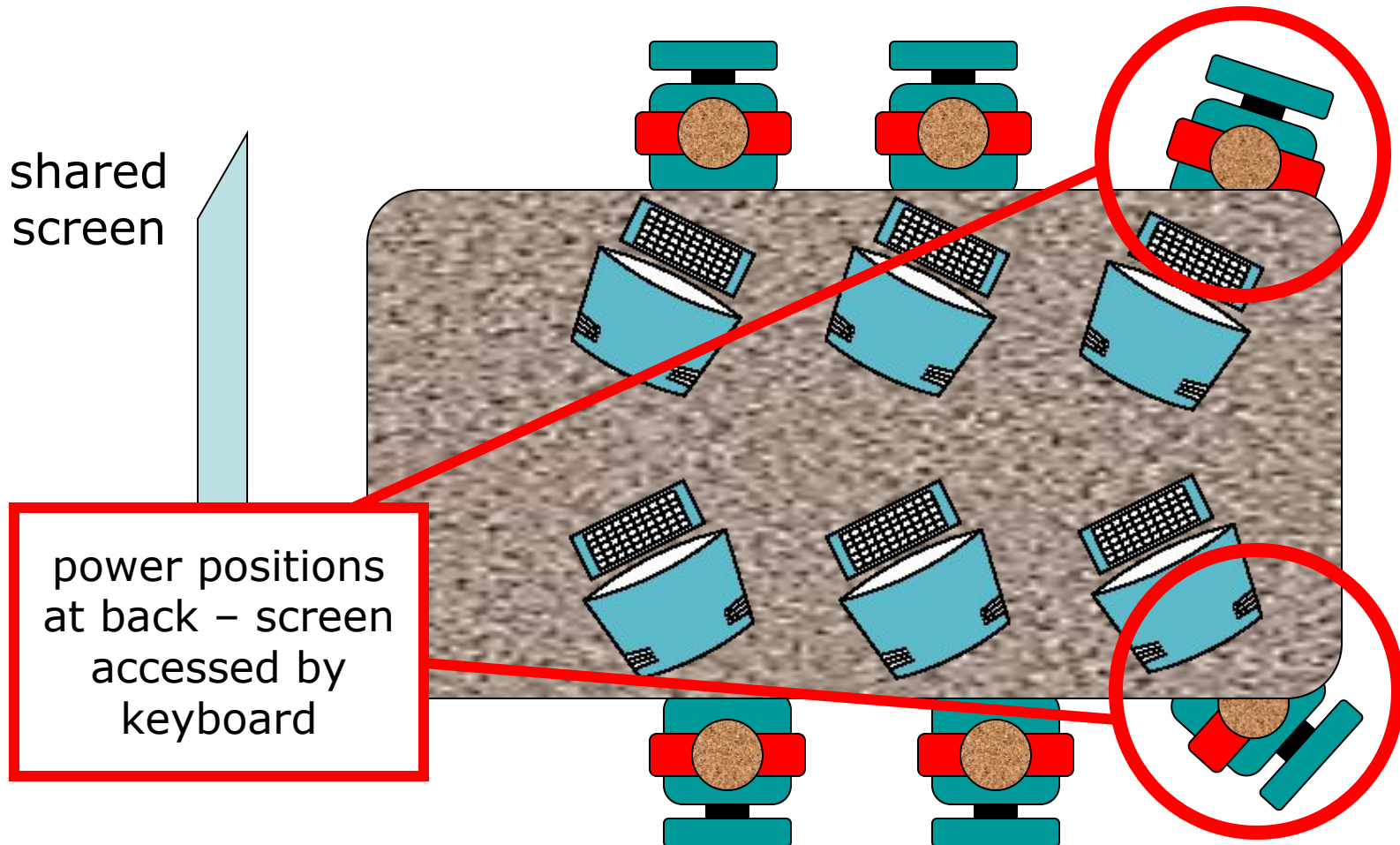
e.g. meeting rooms:

- recessed terminals reduce visual impact
- inward facing to encourage eye contact
- different power positions

power positions traditional meeting room



power positions augmented meeting room



Distributed cognition

Traditional cognitive psychology in *the head*

Distributed cognition suggests look to *the world*

Thinking takes place in interaction

- with other people
- with the physical environment

Implications for group work:

- importance of mediating representations
- group knowledge greater than sum of parts
- design focus on external representation