A Distributed CBR Application for Engineering Sales Support

Ian Watson
ai-cbr
University of Salford
UK

Dan Gardingen
Western Air
Fremantle
Western Australia

contents

- background
  - the tyranny of distance
  - the old sales cycle
- solution #1 - a database
- solution #2 - case-based reasoning
  - implementation
  - architecture
    - XML, case retrieval

contents

- solution #2 - case-based reasoning
  - the new sales cycle
  - testing
  - roll out
  - re-implementation
  - results
- lessons learnt
- further information

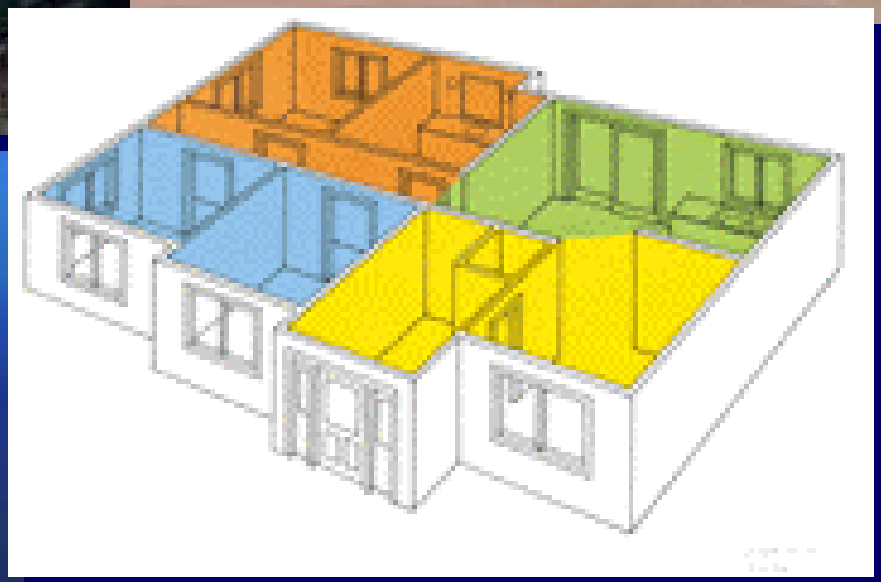
western air

- distributor and installer of HVAC equipment
- HVAC = heating, ventilation & air conditioning
- based in Fremantle operates in Western Australia
- over 2 million square miles
- annual turnover $25 million (US)

western air ltd.

- residential & commercial systems
- new build and retro-fit
- deal with boilers, heat pumps, ventilators, air conditioners, humidifiers, refrigerators, ducting & control systems
- 100 sales engineers in the field
- 5 HVAC engineers at head office

western air ltd.

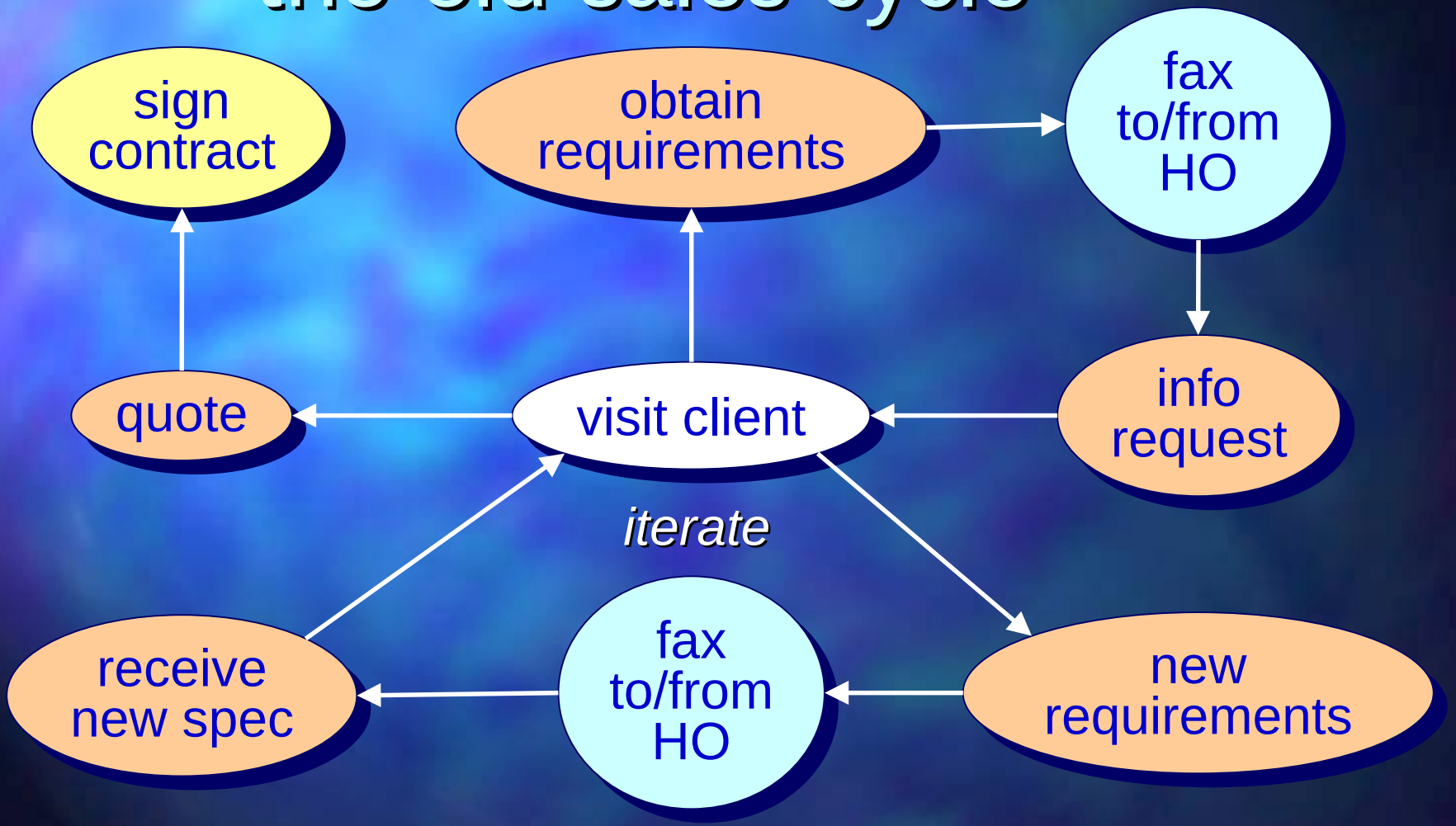


the tyranny of distance

by Geoffrey Blainey

- Australia is a long way from the rest of the world
- and...
- Australians are a long way from each other

the old sales cycle



problems

- sales cycle could take several weeks (av. = 5 days)
- sales people detained in remote places
- HO engineers were “blind”
  - busy with high value commercial projects
- unable to reuse best practice
- tenders included large margins of error
- ….a very inefficient process

the route from A to B

- is not always a straight one
- solution #1
  - they needed a database of installations
  - HO could match new jobs against old
  - base new specifications on old ones
  - provide repeatability
  - reuse best practice
  - reduce time & error margins
  - increase profitability

solution #1 - a database

- implemented in MS Access
- database of 10,000 past installations
- 30 to 60 fields per record
- plus file locations of project details
  - AutoCAD
  - HevaCOMP
  - Excel
  - Word

solution #1 - a database

- honeymoon period
  - initially HO engineers liked it
- then disillusionment
  - too hard to query
  - simple queries = too many matches
  - complex queries were too difficult
  - they browsed the database
  - relied on a *favourite* few dozen projects

solution #2 - a CBR system

- a case-based reasoner solves new problems by using or adapting solutions that were used to solve old problems

- use and adapt old HVAC installations to create new ones
- base cost estimates on price of similar projects

solution #2 - a CBR system

- put the system on the web for sales engineers to use
- let them produce good specifications
- reduce burden on HO engineers
- reduce sales cycle time (5 to 2 days)
- reduce travel costs & pricing errors
- increase profit margin
- increase efficiency

real cool air - implementation

- project budget $32,000
- October 97 to March 98
- development team:
  - project champion
  - domain expert - Dan
  - CBR consultant - me :-)
  - Java & HTML programmer
  - data entry clerk (part-time)
  - 5 sales engineers (for testing)

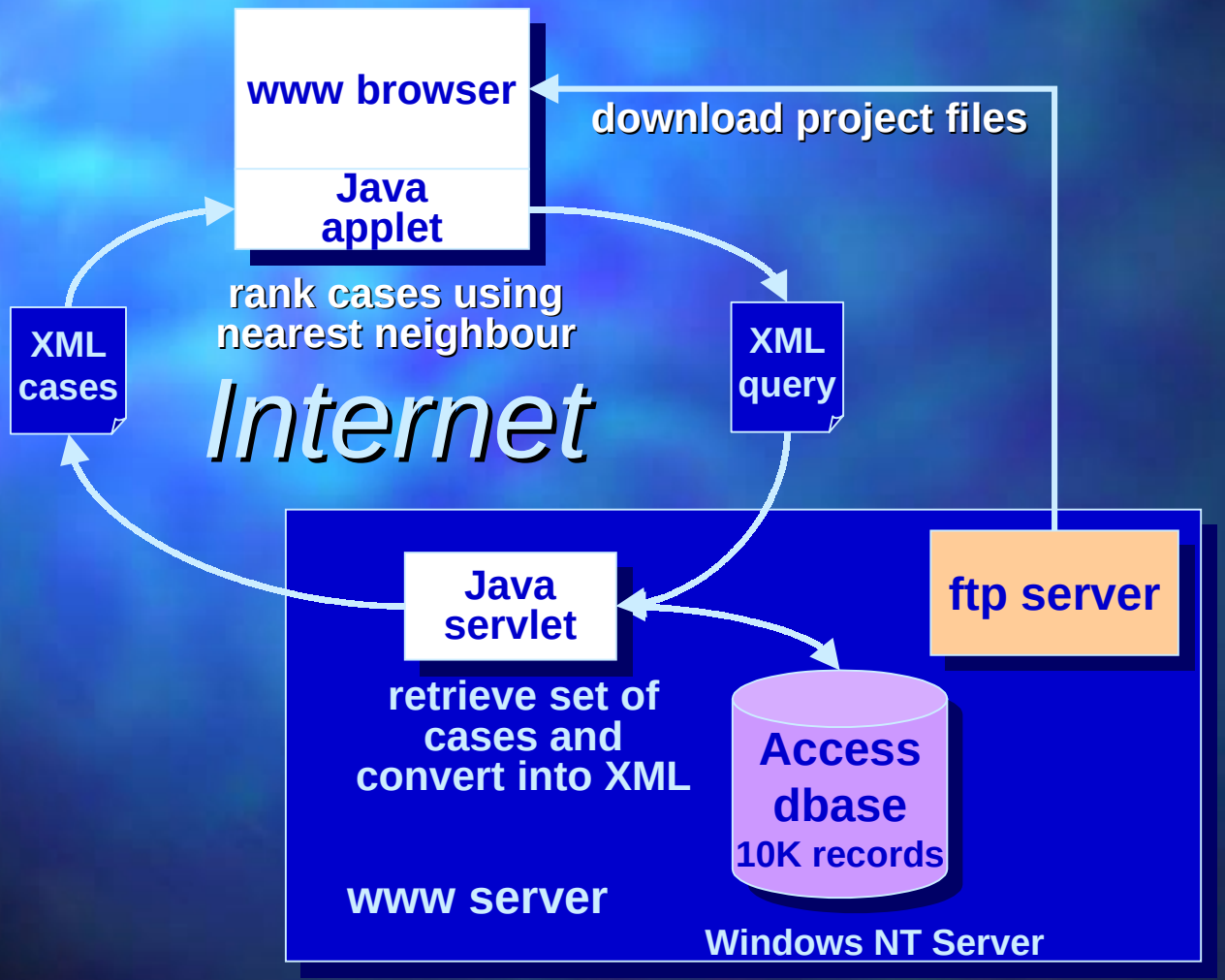
real cool air - implementation

- project goals
  - build a fully functional system
  - complex residential AC installations
    - low commercial risk
    - but realistic
  - well planned controlled system trial
    - essential to justify any future investment

real cool air - implementation

- hardware
  - Windows NT server for web and FTP
  - 5 Pentium portable computers with modems
- software
  - MS Access (reuse existing database)
  - Java Visual Café
  - FrontPage 98, DreamWeaver
  - Cold Fusion

real cool air - architecture



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real cool air - XML

- XML = e**X**tendible **M**arkup **L**anguage
- intended as a successor to HTML
- finalised by W3 Commission in Dec 97
- XML users can define their own tags
- XML documents can contain
  - attribute:value pairs
  - commands for browsers & applets to interpret
- ideal for distributed AI

real cool air - case retrieval

- two stage case retrieval
- stage 1
  - retrieves a small set (<20) of *similar* records from MS Access
  - uses SQL
  - uses query relaxation
- stage 2
  - rank this set using nearest neighbour

real cool air - case retrieval

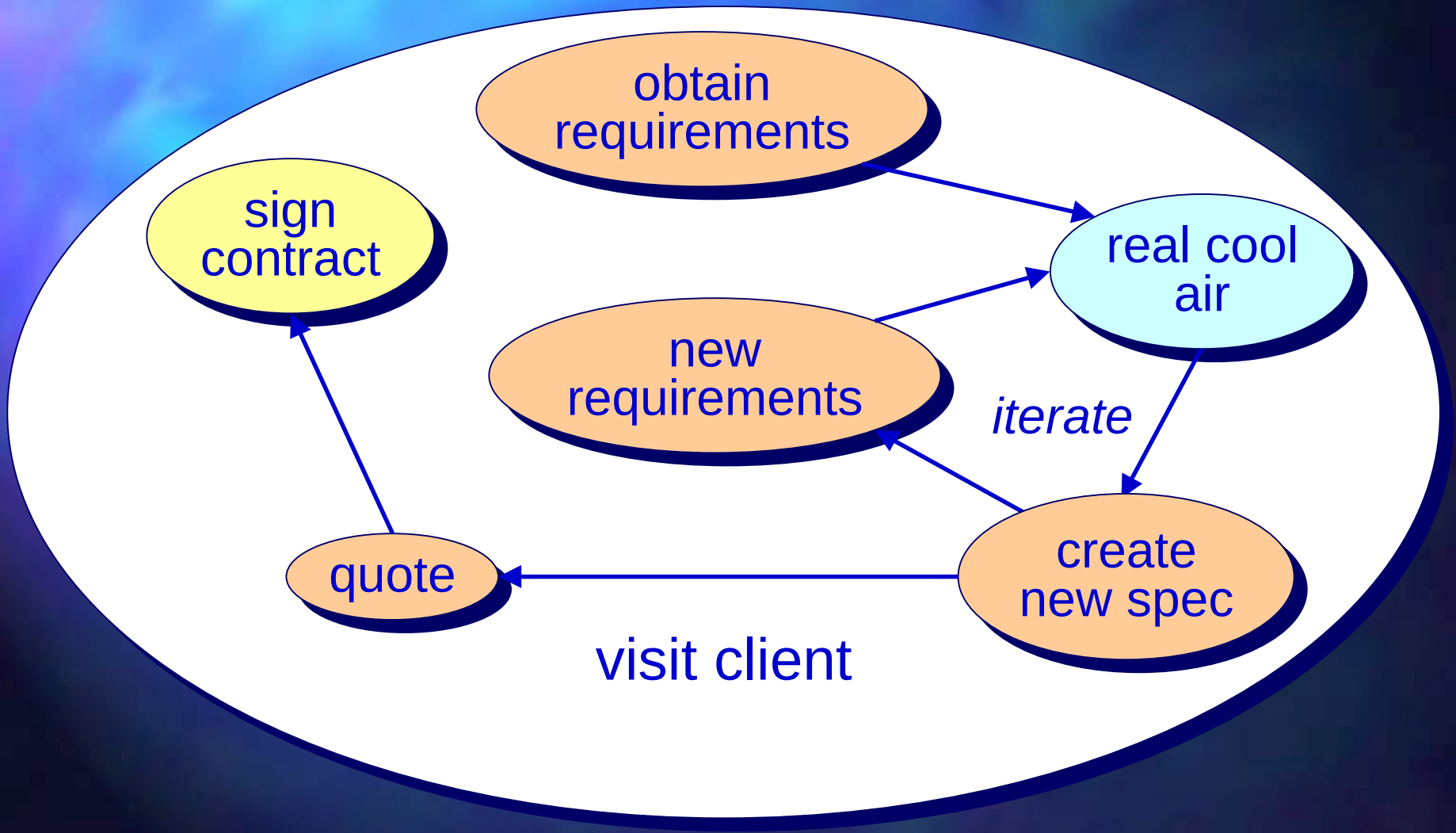
- stage 1 retrieval
  - SQL is efficient for a large database
  - query relaxation
    - used by Kitano et al at NEC in SQUAD
  - numeric values are relaxed within set limits
  - symbolic values use symbol hierarchies to generalise
  - required knowledge engineering
  - retrieval is an iterative process
  - increases the relaxation with each iteration

real cool air - case retrieval

- stage 2 retrieval
  - nearest neighbour inefficient on large database
  - OK for small data set
  - allows user to express preferences through feature weights

$$Similarity(T,S) = \sum_{i=1}^{n} f(T_i, S_i) \times w_i$$

the new sales cycle



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real cool air - theoretical benefits

- efficiency
  - can be done in the client's house or office
  - can be done in a hotel room or car
- empowers sales engineers
  - only complex jobs need checking by HO
- reliable
  - specs & quotes based on past work

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real cool air - testing

- phase 1 - in vitro
  - 5 test complex residential projects
  - given to 5 sales engineers to specify
- results
  - 22 correct results
  - but remaining 3 were not *wrong*

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real cool air - testing

- phase 2 - in vivo (March 98)
  - 5 engineers use system on live projects
  - champion monitors all projects
    - daily then weekly
- results
  - 63 residential AC projects in 4 weeks
  - all judged to be technically sound
  - each project specified in 1 day
  - profit margin increased by 2%

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real cool air - roll out

- tests judged a success
- $200,000 borrowed to equip staff with portable PCs, modems & ISP accounts
- rolled out in May 98

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real cool air - results

- initial problems
  - sales engineers were:
    - unfamiliar with the software
    - unfamiliar with their new role
- solution
  - all called in for training course
    - involved software training
    - and role playing
- still had problems... ☹

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re-implementation

- ported database to mySQL (www.mysql.org)
- Netscape LiveWire database connectivity
- changed query relaxation algorithm
  - relax query sufficiently to guarantee retrieving several hundred cases first time
  - then make the query more precise
  - much more efficient
- use an introspective learning algorithm to learn how much to relax query by
- reduced server-side processing time by 50%

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real cool air - update

- since May 1998
- sales volume increased by 10%
- profit margin increase by 1.75%
- investment $254,000 (h & s ware)
- profit $476,000
- return on investment $222,000 in first year!

lessons learnt

- solve process problems
  - improving the process is what made the money
- not technical ones
  - a CBR system for HO would not have made any profit

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lessons learnt

- without the web (old world)
  - install system on each PC
  - and update database monthly
  - plus bug fixes - time & money
- with the web (new world)
  - all data & software held on one server
  - no updates
  - applet bug fixes download automatically
- distributed AI on the web is good

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lessons learnt

- having a good case-base really helps
- having a good database for the cases really helps
  - easier to manage cases
- train users
  - not just *how* to use software but *why*
- charge a percentage not a fee :-(

further information

www.ai-cbr.org

the internet site for CBR

- people, projects, tools
- mailing list
- online bibliography
- conferences, workshops
- consultancy

Applying CBR: techniques for enterprise systems
by Ian Watson
Morgan Kaufmann Publishers Inc. 1997