A Distributed CBR Application for Engineering Sales Support

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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
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

© ai-cbr, 1999 www.ai-cbr.org the internet site for case-based reasoning
the old sales cycle

- sign contract
- obtain requirements
- fax to/from HO
- visit client
- info request
- quote
- new requirements
- receive new spec
- fax to/from HO

iterate
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

WWW browser

Java applet

XML cases

rank cases using nearest neighbour

Internet

download project files

Java servlet

Retrieve set of cases and convert into XML

Access dbase
10K records

WWW server

ftp server

Windows NT Server

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www.ai-cbr.org the internet site for case-based reasoning
real cool air - XML

- XML = eXtendible Markup Language
- 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

\[
\text{Similarity}(T, S) = \sum_{i=1}^{n} f(T_i, S_i) \times w_i
\]
the new sales cycle

- visit client
- obtain requirements
- iterate
- create new spec
- real cool air
- new requirements
- quote
- sign contract
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
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
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%
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
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... 😞
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%
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
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
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 :-(
Applying CBR: techniques for enterprise systems
by Ian Watson
Morgan Kaufmann Publishers Inc. 1997