



Rules Fest 2010

International Conference on Reasoning Technologies
October 11-14 • San Jose, CA USA

Building Mobil's Lube Knowledge Base and Knowledge Supply Chain™

Rolando Hernandez

Founder & CEO

BIZRULES

GVC Grindwork Corporation
Intelligent Automation

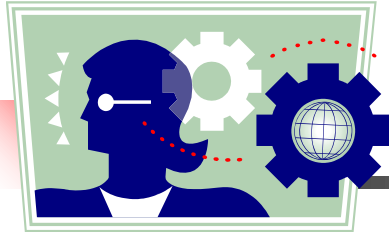
IBM

JBoss
by Red Hat

morris technical solutions
empowering knowledge for businesses

visionArts
communications
strategic thinking • creative action

Building Mobil's Lube Knowledge Base and *Knowledge Supply Chain*TM



Rolando Hernandez

Rules Architect

Knowledge Engineer

Founder & CEO

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BizRules  **com**

Mobil Oil Corporation

1988



- In 1988, Mobil is a \$40 billion/year business
 - Exploration Division – Finds oil
 - Marketing & Refining Division – Sells Lubes & Fuels
 - US Marketing
 - Int'l Marketing

- US Marketing begins AI/Expert Systems R&D
 - Starts building small proof-of-concept applications
 - Then builds suite of global expert advisors

Mobil Oil Corporation LKB Strategy



- **Strategy**

- Preserve and automate knowledge of top experts in the Mobil system
- *The Knowledge Supply Chain™*

- **Process**

- **Roadmap**

- **Methodology**

- For KA, KR, KM, KE
- Central team building shared rules and common code

- **Suite of Expert Systems**

Mobil's Lube Knowledge Base

Vision Before

Product Recommendations

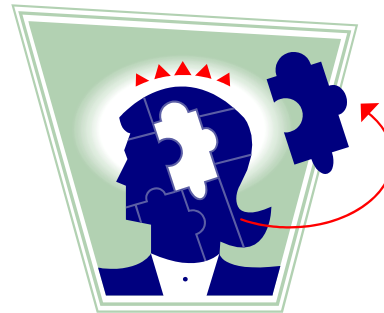
Expert Advice

Problem Diagnosis

Technical troubleshooting books
Troubleshooting manuals
Customer service reports
Industry manuals
Product recommendation charts

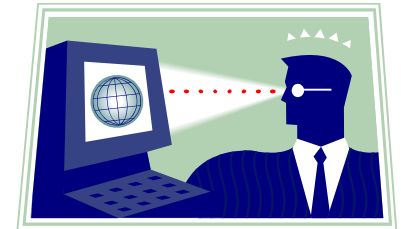
Product data sheets
Lab test reports
Technical files
Technical bulletins
Equipment builder books

Technical memos

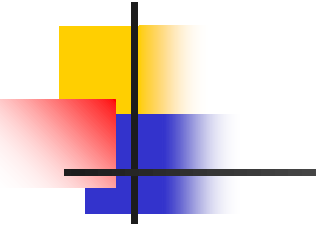


After

The Lube Knowledge Base



Mobil's Lube Knowledge Base



Rolling Oils

Expert System



Compressor

Expert System

Grease

Expert System

Environmental Health & Safety

Expert System

Hydraulics

Expert System

Diesel Engine

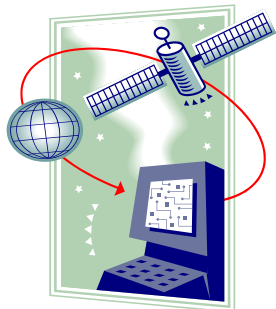
Expert System

Cutting Oils

Expert System

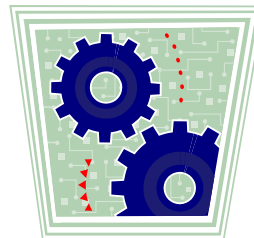


Worldwide Product Database



Shared Rules

(Rules about Gears, Bearings, Cylinders, Pistons, Seals, etc.)



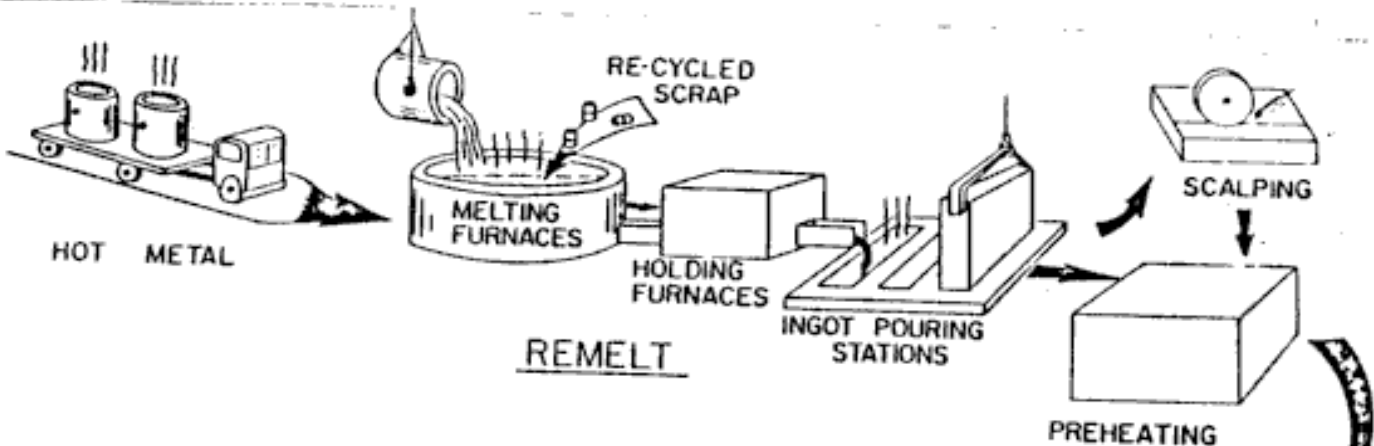
Equipment Builders Database



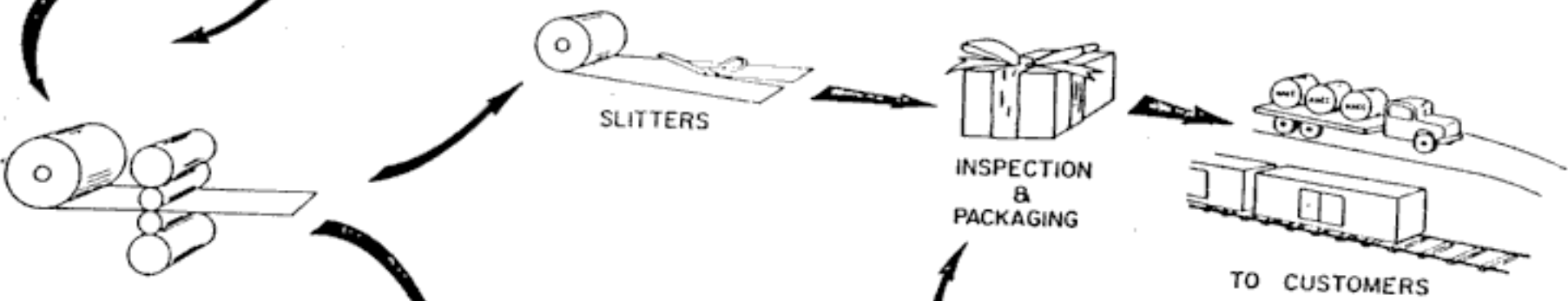
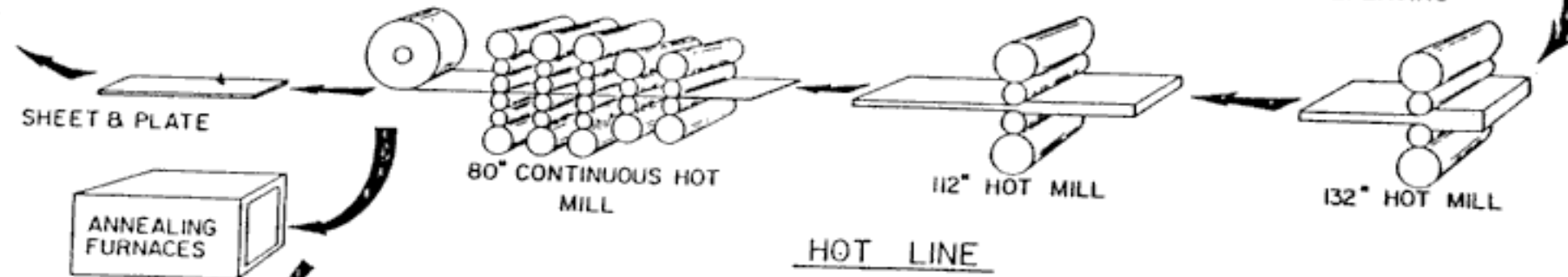
Security



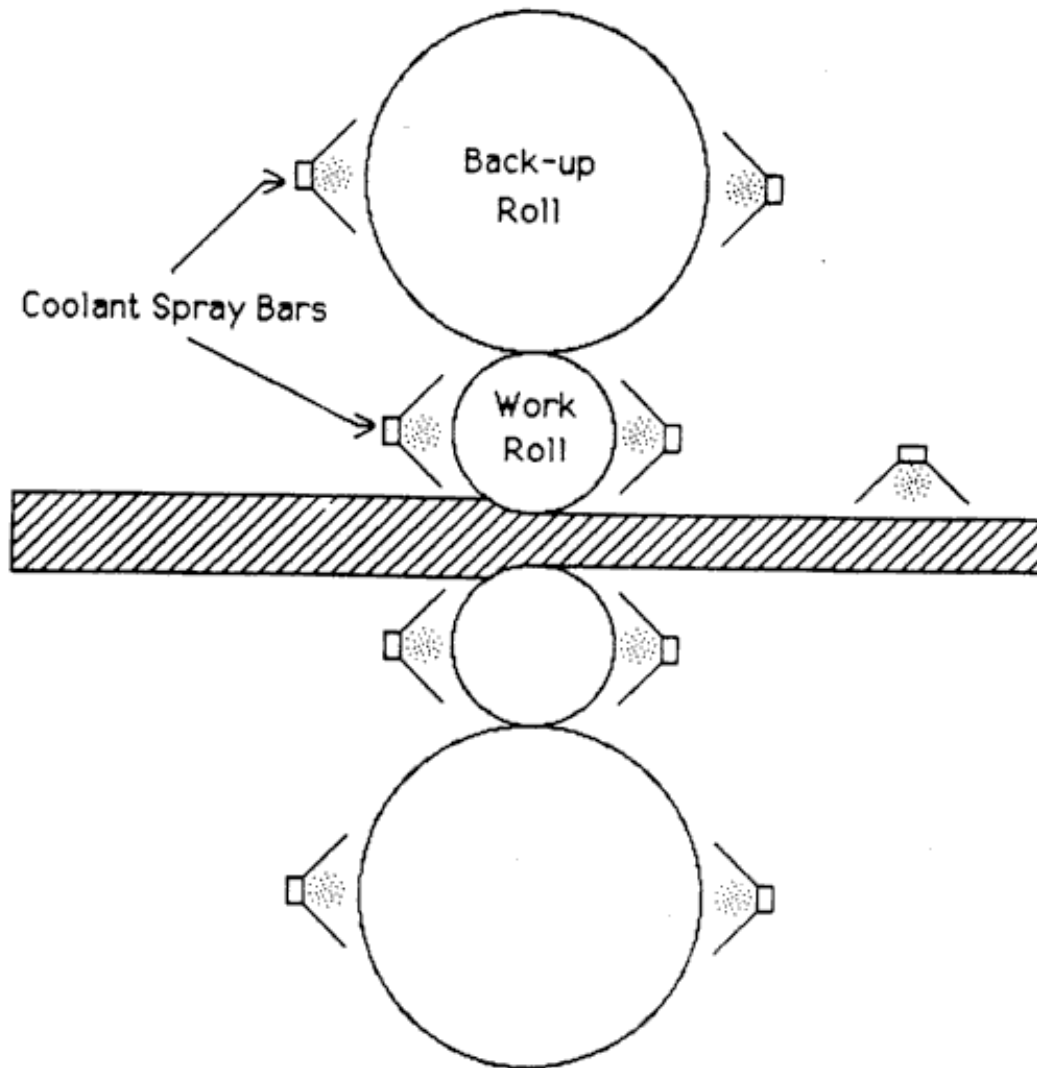
Library & Reference Manuals



TO CUSTOMERS



ALFRED: An Expert System



Do you remember...

August 1990

IBM PS/1
10-MHz 80286
640K RAM
30MB Hard disk
\$1,999

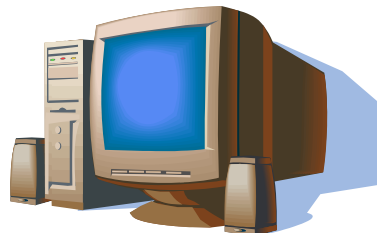
August 1990
PC Magazine



August 2000

Dell Dimension XPS B
800-MHz Pentium 3
128MB RAM
30GB Hard disk
\$2,068

www.dell.com



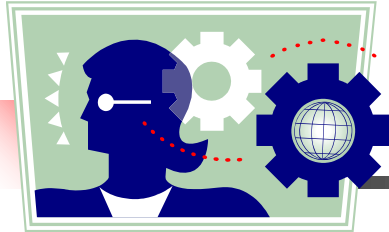
August 2010

Sony Vaio L Series All-In-One
Intel® Core™ 2 Quad Processor
2.66 GHz per core
8GB RAM
1TB Hard drive
\$1,999

www.bestbuy.com



Additional slides with more details



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Rules Architect

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Pilot Project: ALFRED

Rolling Oils Expert System

- Captures 50 years of Mobil's experience with rolling oils & metal rolling mills
- Scope
 - Problem diagnosis
 - Lab test analysis
 - Recommend corrective action
- 400 rule expert system developed using 1st Class Fusion



Lessons Learned: ALFRED

- One int'l expert: ALFRED
 - 30 years experience in Austria/Germany office
 - Didn't really know the market in England, France, Japan, etc.
- One US expert
 - Could not agree with many of Alfred's decisions/recommendations for US market



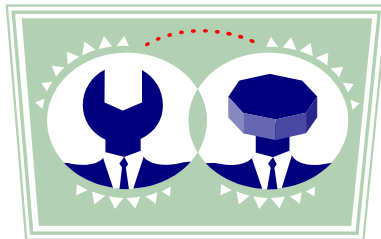
Lessons Learned: ALFRED

- So we decided to build a US version and an international version
- US expert was recognized and accepted by US colleagues
- But Alfred didn't really understand the different product variations and customer requirements in other countries
 - Turned out that the metal rolling process and industry was different in different countries
 - Because the int'l system did not meet their needs, other countries never really used it



Lessons Learned: ALFRED

- One expert is not enough for an international system
- You need a team of SME's representing major affiliates
- SME personality is key
- Must be accepted by other experts





Lessons Learned: ALFRED

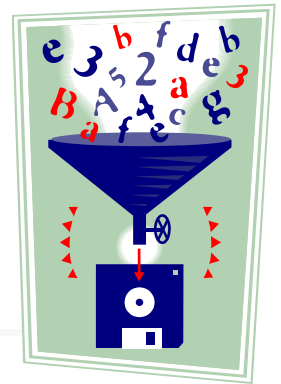
- System was not marketed correctly to all the affiliate offices
- Commercial directors & IT directors in each country knew about ALFRED, but Sales did not
 - This was seen as a technical MIS R&D project, instead of a practical business system
 - Sales depts. Didn't know this was a sales system for the sales staff
- Raised awareness across Mobil
 - US Mkting business execs saw the value of capturing knowledge and business rules as corporate assets
 - This got int'l Mkting interested, and people started talking



Mobil 1989

- Mobil Lube Strategy
 - Provide value added services to customers
 - Identifies a future need: a “Lube Knowledge Base”
- The Business starts talking about the need to manage knowledge & “Intellectual Capital”
 - Radical idea back then, mainstream today
- Business rules is the new thing

Mobil 1990



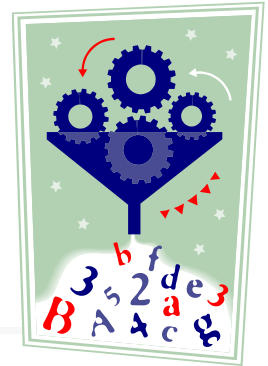
- IT starts envisioning the “Lube Knowledge Base” as a laptop sales tool to support every field marketer worldwide
 - Suite of integrated Expert Advisor Systems for product recommendation, equipment troubleshooting, and training
 - CD-ROM for Mobil & Competitor Product DB & Equipment Builders DB
 - Paperless - All paper files, such as product specs, MSDS, customer case studies, technical diagrams, charts, photos, etc. converted to electronic form
 - Customer database



LKB Goals

- Capture expertise from top marketers & engineers and make it available worldwide
- Train field reps
- Improve customer service & service quality
- Provide consistent solutions
- Minimize paperwork/looking through thick manuals

LKB Methodology



- We used the NIKE methodology: Just Do It
- Used an iterative JAD-RAD process
- We Listened, Designed, and Built prototypes quickly in order to refine the scope, specs, and functionality
- Once clients agreed to scope, specs, and functionality, we re-designed and rebuilt the final release

Mobil's Lube Knowledge Base

Vision Before

Product Recommendations

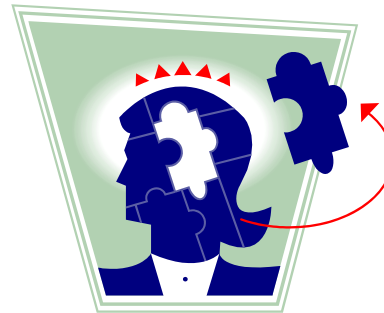
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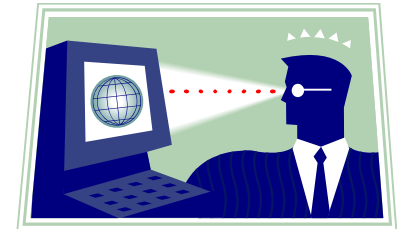
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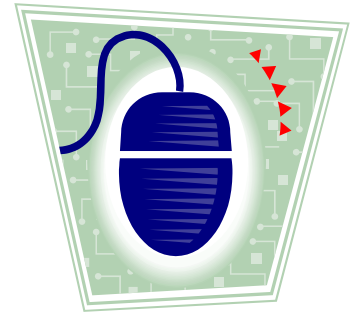


After

The Lube Knowledge Base



Mobil 1990



- All data/documents are linked via **hypertext** links so users can click on a “hot button” and “jump” to a related page
- Related link could be another document, a glossary definition, a picture, expert tips, etc.
 - Put cursor on keyword and press F2 to “jump”
 - This was BI – before the Internet and the Web
 - Radical idea back then, mainstream today
- This was before Windows
 - We didn’t have JPEGs or GIFs, but we did have PCXs



Mobil

May 1990

- Selects AIONDS as standard ES tool
- Looked at AICorp. KBMS, Neuron Data Nexpert, Information Builders Level 5, and IBM's ESE (TIRS)

Mobil

January 1991

- Business & IT agree there is a need to develop a worldwide lube expert systems strategy
 - Prioritized list of candidate expert systems
 - Architecture designed to allow concurrent development, and “thunking”
 - We could build one system at a time, in any order, and they would all work separately or integrated together
 - IT strategy was aligned with Mobil’s longstanding lube marketing strategy to provide value added services to customers

Mobil



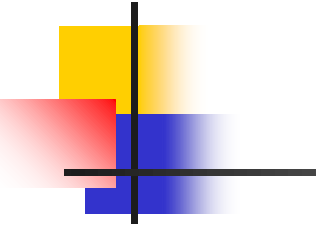
- IT and the US / Intl'l business units start planning a strategic Knowledge Management Program with these goals
 - Maintain Mobil's competitive edge in the worldwide lube market
 - Provide current product and customer data to the field sales force
 - Capture individual expertise and share that knowledge throughout the Mobil system
 - Enable marketers to increase face to face selling time

Mobil



- The “Lube Knowledge Base” is born
 - A suite of expert systems and databases
 - Mobil Office instead of Microsoft Office!
 - I think this was before MS Office was released. If so, this was also a radical idea that is mainstream today
 - Approach is to build LKB modules that can be justified individually, and can stand alone
 - Consistent design and interfaces so they can be linked together to share common data
 - Reusable objects (components) such as rules about bearings, gears, and cylinders that can be reused in many modules

Mobil's Lube Knowledge Base



Rolling Oils

Expert System



Compressor

Expert System

Grease

Expert System

Environmental Health & Safety

Expert System

Hydraulics

Expert System

Diesel Engine

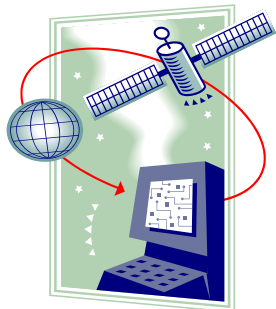
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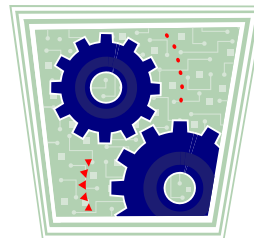


Worldwide Product Database



Shared Rules

(Rules about Gears, Bearings, Cylinders, Pistons, Seals, etc.)



Equipment Builders Database



Security



Library & Reference Manuals

Mobil



- Affiliates could either buy individual modules or the whole “suite”
 - Per copy charge would fund development of future LKB modules
- Similar to the approach Microsoft used to build the MS Office suite
 - Central group builds common code, designs infrastructure, and defines interfaces
 - Distributed groups build modules that plug into the suite



Mobil Lube Knowledge Base

Jan 1991 - Compressor Expert System-CES

- Selected as first system
 - Because less complex, smaller, usable by all business units worldwide, and used many components that could be reused later
- Scope
 - Diagnosing and solving customers' compressor oil related problems
 - Providing expert advice and reference material
 - Improving the professionalism and efficiency of the field sales force
 - Just taking a PC into the customer's office was impressive back then

Mobil Lube Knowledge Base Compressor Expert System-CES



- Expert meetings were held in the US, England, and Japan
 - Experts were from England, France, The Netherlands, and Japan



- Development cost hundreds of thousands of dollars
 - Released Summer 1992; Over budget by 5 %



- That was great, given the facts that
 - This was the first of many expert systems that were envisioned for the Lube Knowledge Base
 - We were using new technology & new tools
 - We were using multiple experts, which was our new approach after ALFRED





Mobil Lube Knowledge Base Compressor Expert System-CES

- CES Hardware Requirements (1991-92)
 - 80386 processor
 - 20MHz
 - 80MB hard disk
 - 3 MB RAM
 - CD-ROM drive for Product & EB databases



Mobil Lube Knowledge Base Compressor Expert System-CES

- CES benefits
 - Improved quality and quantity of selling time
 - Reduced time looking up paper-based files
 - Paid for itself after one year



Lessons Learned: Compressor Expert System

- Building a rule-based system is a business project, not an IT project
- Business management must want this more than you do for it to succeed
- Sell the business on the idea, and IT will follow
- The business rules sharpen your competitive edge



Lessons Learned: Compressor Expert System

- Clients need to be involved with the Knowledge Acquisition process, especially the initial expert meetings, in order to provide their vision, and leadership
- Get experts together first. Let them decide how to work together and divide up the work
- Train and enable the experts to document their own business rules



Lessons Learned: Compressor Expert System

- SME interview schedule (how many trips, who, when, where) needs to be finalized up front
 - To get commitment/availability
 - To estimate travel costs
- SME interviewing is a critical success factor



Lessons Learned: Compressor Expert System

- Check the Holiday schedules in the other countries
 - We proposed a two-week SME meeting in Japan in August, and they accepted
 - When we arrived, we learned that both Mondays were holidays and the Tokyo office was closed
 - Our Japanese colleagues were too polite to ask us to reschedule



Tim Berners-Lee

August 1991

- *Releases the code for his new programs "World Wide Web", HTTP, HTML, URI via the Internet*
- *Posts a note on alt.hypertext*
- *info.cern.ch gets 100 hits/day*



Tim Berners-Lee

December 1991

- *Submits proposal to demonstrate his new program "World Wide Web" at the Hypertext '91 Conference*
- *Rejected, because it "violated the architectural principles that hypertext systems had worked on up till then."*



Tim Berners-Lee
August 1992

- *info.cern.ch gets 1,000 hits/day*



Mobil Lube Knowledge Base

1993 – Grease Expert System – GES

- GES was the 2nd system built as part of the Lube Knowledge Base
 - Designed to help lube marketers increase sales and profitability by providing expert advice
- Scope
 - Produce selection and recommendation
 - Problem troubleshooting
- Built to support Int'l Marketing's Worldwide Grease Sales Campaign, launched Q1 1993
 - This marked the first time Mobil released an IT system to support a major marketing campaign at the same time the marketing program was launched!

Mobil Lube Knowledge Base Grease Expert System – GES

- Expert meetings were held in the US, France, and Japan



- Experts were from France, England, Germany, Japan, and New Zealand

- Development cost hundreds of thousands of dollars



- Under budget by 9 %

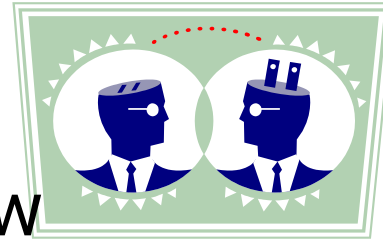
- Even though scope was larger than CES, we cut development costs by 50 % by reusing code



- Reused CES code for equipment problem diagnosis, expert advice, help, reports, and hypertext glossary

Mobil Lube Knowledge Base Grease Expert System – GES

- This was a big success and a big deal
 - IT & Marketing worked together to develop a business strategy and computer systems to support it
- Previously, IT would learn about new business strategy after it was in effect
- GES was released March 1, 1993, the same day the global marketing campaign began
 - The Internet was still not on our radar screens





Lessons Learned: Grease Expert System

- Reusing OO code really works
 - To reuse is smarter than to reinvent
 - We achieved significant cost/time savings by reusing components from GES
 - New GES components for product selection were now available for future reuse too
 - You need someone to manage the reusable code library
 - We worked with management to add time after each new app was built to take out reusable code and add it to the code library before we began building the next app. This was a critical success factor
- Demo system to users before field testing
 - Got good feedback on GUI, functionality, reporting
 - This got us user buy in before the final product was even released!

Lessons Learned: Mobil's Experience with AIONDS

- Rulebase must handle multiple developers
- Get training & consulting
- Develop a strategy, standards, & methodology for KA, KR, KM KE





Lessons Learned: Mobil's Experience with AIONDS

- RAD/iterative prototyping
 1. Build first system
 2. Build first common code library
 - You have to build it before you can reuse it
 3. Build next system by re-using code library
 4. Enhance library with new functionality
 - Repeat steps 3 & 4



Lessons Learned: Mobil's Experience with AIONDS

Actual Results with AIONDS

System	Compressor Equipment Troubleshooting Knowledgebase	Grease Product Recommendation Knowledgebase	EHS Safety Audit Knowledgebase
Scope	Full-size	Full-size	Prototype
Rules	300	300	100
Experts	8	9	1
Clients	2	1	1
Users	> 200	> 200	< 20

Lessons Learned: Mobil's Experience with AIONDS

Actual Results with AIONDS

System	Compressor Equipment Troubleshooting Knowledgebase	Grease Product Recommendation Knowledgebase	EHS Safety Audit Knowledgebase
Scope	Full-size	Full-size	Prototype
Rules	300	300	100
Experts	8	9	1
Clients	2	1	1
Users	> 200	> 200	< 20

IT Team	3	2	1
Dev Days	207	112	60
Budget	5% Over	9% Under	1% Over





Lessons Learned: Mobil's Experience with AIONDS

- Average Task Allocations for LKB Rule-Based Expert Systems
 - Programming 40%
 - Project Mgmt 17 %
 - Expert Interviews 14 %
 - Other 12 %
 - Contingency 10 %
 - Testing 7 %



Lessons Learned:

AIONDS Benefits & Disadvantages

- + Advanced development/debugging tools
- + Can interface external programs such as graphics & security
- + Can develop custom code for backup/save case/recall case
- + Easy to build reusable code library
- + User training not needed
- + HPO is essential



Lessons Learned:

AIONDS Benefits & Disadvantages

- - Initial learning curve, but high productivity payoff
- - High runtime costs limit # of users
 - *When will the rule vendors eliminate runtime per copy fees? That's one of the problems preventing this from getting in the mainstream*



Lessons Learned:

Building Rule-Based Systems at Mobil

- Use multiple experts for international systems
- Conduct design reviews with expert consultant
- Knowledge acquisition is critical task
- AIONDS enables reuse of objects, rules, and functions
- Development costs can be cut over 50% by reusing object-oriented AIONDS code



Lube Knowledge Base / ES Critical Success Factors

Critical Success Factors	Issues
■ Knowledge Acquisition (KA) involving multiple, geographically-dispersed experts	■ KA Methodology ■ KA technique selection ■ KA planning/coordination ■ KA analysis and synthesis
■ Structural and behavioral <i>Diagnostic Problem Solving Model</i> development	■ Diagnostic problem solving approaches ■ Representation of structural knowledge ■ Representation of behavioral knowledge



Lube Knowledge Base / ES Critical Success Factors

Critical Success Factors	Issues
■ Expert system software technical design	■ Expert system architecture ■ Knowledge base structure ■ Modular ES design strategies ■ Rule processing – forward-chaining, backward-chaining, bi-directional chaining, inference engine control ■ Object processing – class/instance data model, inheritance, demons, attached procedures, message passing ■ Procedure processing – processed, functions, control structures
■ Expert system and ADS ES shell programming	■ AI programming ■ Modular code development ■ Efficient data structures ■ Data encapsulation / Polymorphism ■ Test and evaluation



Tim Berners-Lee
August 1993

- *info.cern.ch gets 10,000 hits/day*



Tim Berners-Lee

December 1994

- *info.cern.ch gets 100,000 hits/day*
- *NetScape releases Navigator 1.0
WWW Browser*
- *Gives it away for free via Internet*

Tim Berners-Lee

1995

- *April – Compaq ships first PCs with pre-load browser, Navigator*
- *May – Sun introduces Java*
- *August – Microsoft releases Windows95, with Internet Explorer*
 - *The WWW is finally on everybody's radar screens*



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rolando@bizrules.info