Managing Software Development for Global Health

Richard Anderson

Outline

- PATH
- The Cold Chain
- National Vaccine Forecasting
- CCEM 1.0: In house development
- CCEM 2.1: Out sourcing
- Managing a software product
- Lessons learned

Today's talk

- I'm spending my sabbatical working at a Global Health NGO in Seattle
- I've gotten sucked into a Microsoft Access software project
- The project made many of the classic software engineering mistakes and was in serious trouble
- Applying software industry best practices is leading to a positive outcome

Why this might be interesting

- Programming in the real world: much of the world's software is written by people who don't know what they are doing using tools like Microsoft Access
- ICT4D: improving the quality of software for global development could be Computer Sciences big contribution
- Software Engineering appears to be the key

PATH

- Seattle based NGO working in health technologies
- Founded 1977 – Now working in 70 countries
- Program for Appropriate Technology in Health

PATH focus

- Solutions for emerging and epidemic diseases, like AIDS, tuberculosis, and malaria.
- Health technologies designed for low-resource settings, by the people who will use them.
- Safer childbirth and healthy children.
- Health equity for women, among the world's most vulnerable—and influential—populations.
- The basic protection of vaccines for women and children around the world.
Technology Solutions
Primary areas of focus

- Immunization & vaccine technologies
- Diagnostic tests for diseases
- Reproductive health technologies
- Maternal & child health technologies
- Nutrition technologies
- Health Management Information Systems

Safe and Effective Immunization

- Safe Vaccine
- Safe Injection
- Safe disposal

Safe Vaccine
Safe and Effective Immunization
Safe Injection
Safe disposal

HEATmarker™
Vaccine vial monitors

Auto Disable Syringes

More than 5.4 billion distributed by 2005
Leads to medical waste problems

Removing the Danger of Contaminated Needles

Needle removal can ("popper")
• For luer-slip needles
• Reduces volume of "sharps" waste

Expanding contraceptive choice
Reducing Sexually Transmitted Infections
Safe Pregnancy and Childbirth
Early detection of Cancer
NPR Interview of Bill and Melinda Gates (10-28-09)

Q: I’m just curious - and this must be very hard as very practical, successful people to admit - but has there been an occasion where you’ve let some foundation money out the door and after a couple of years you would say, oh, that was pretty much a failure; that was wasted money; didn’t work?

Melinda Gates: And sometimes you make a mistake where it’s a fantastic investment but there’s a little piece of it you didn’t get right. So, a great example is rotavirus. We have, thank God, an amazing life-saving vaccine that’s coming for kids. And it’s actually being delivered now in Nicaragua; we’re going to get it out in lots of places. It’s a vaccine against diarrhea. … Well, unfortunately, the rotavirus packaging came out too large. We had these large boxes. Well, you can’t carry large boxes of vials of vaccinations out into villages. That requires too much refrigeration.

Vaccine Storage

<table>
<thead>
<tr>
<th>Vaccine Type</th>
<th>Storage Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral Polio Vaccine</td>
<td>2°C to 10°C</td>
</tr>
<tr>
<td>Inactivated Diphtheria</td>
<td>10°C to 25°C</td>
</tr>
<tr>
<td>Tetanus</td>
<td>10°C to 25°C</td>
</tr>
<tr>
<td>Measles, MR, MMR</td>
<td>10°C to 25°C</td>
</tr>
<tr>
<td>YF Vaccine</td>
<td>+2°C to +8°C</td>
</tr>
<tr>
<td>Hib Vaccine</td>
<td>Freeze-dried</td>
</tr>
<tr>
<td>Meningococcal A&amp;C</td>
<td>+2°C to +8°C</td>
</tr>
<tr>
<td>Hepatitis B</td>
<td>+2°C to +8°C</td>
</tr>
<tr>
<td>IPV</td>
<td>+2°C to +8°C</td>
</tr>
<tr>
<td>DT, DTP, DTP Hep B</td>
<td>+2°C to +8°C</td>
</tr>
<tr>
<td>Hib Liquid</td>
<td>+2°C to +8°C</td>
</tr>
<tr>
<td>Td, TT</td>
<td>+2°C to +8°C</td>
</tr>
</tbody>
</table>

Cold Chain in Nicaragua

- 1350 refrigerators, including 250 solar.
- Vaccine distributed monthly to Pacific, once every three months in Caribbean
- Electric refrigerators considered reliable
- Problems with solar refrigerators
  - Primarily with solar generation
    - Batteries
    - Theft of panels
Cold chain management

- Basic problems
  - Keep track of nation’s inventory of refrigerators and cold rooms
  - Answer the question: do we have refrigerator storage capacity for vaccine schedule
- Extra credit
  - Model cold chain capacity over multiple years with additions and removal of equipment
- Out of scope
  - Tracking inventory of vaccines
  - Transit time for vaccines

Cold chain expertise

- Knowledge of the following domains
  - Refrigeration, logistics, vaccines, packaging, regulatory environment, health practices, national politics
- Plan nation wide vaccine distribution
  - Distribution, storage, delivery
  - Work with donors and international organizations
- Formalization of idea of a National Cold Chain

New Vaccines

- Higher cost vaccines
- Vaccine packaging
- Packaged with preservatives
- Global vaccine initiatives
  - GAVI: Global Alliance for Vaccines and Immunization
  - Gates Foundation: $10 billion commitment

Increased cost, increased volume

Old vs. New Vaccines

- 4,100 doses Polio and Measles $635
- 625 doses Rotavirus $4,687

CCEM Vision

- Capture expertise of cold chain experts in software
- Provide basic tool for analyzing a nation’s cold chain
- Enable countries to do their own cold chain analysis
- Model
  - Initial cold chain inventory
  - Inventory updates
  - Cold chain analysis
CCEM Process

Cold Chain Equipment Management
CCEM
- Microsoft Access Application
  - 66 Tables
  - 204 Forms

Catalogs

Administrative Levels

Vaccine Schedules
- Target population (chosen from list: adult, child, male, female, teen, senior)
- Age group
- Program
- Total population
- Child, female, age, sex
- Usage on target population (%): This field by default is 70%, as the software assumes 70% of the total population is the target population for the vaccine. For example, if the target population for Hepatitis B vaccine is 1.2% of the total population in some countries.
- Vaccine size (%): This field sets the automatically observed usage rate for specific vaccine and the minimum value can be 0%

Facility and Refrigerator Records
Report Generation

Defining Removal Criteria

Defining Allocation Criteria

Vaccine Schedules

Forecasting

Forecasting Results
Result Reporting

CCEM 1.0

- Initial development phase: Cold chain expert with software developer
  - Work began October 2006
- Microsoft Access 2003
- Informal development process
  - “Can you add . . . “, “Yes”
  - “We need to determine what types of refrigerators to allocate”, “I can do that”
- Emphasis on increasing functionality of application

Results of CCEM 1.0

- Encapsulation of Cold Chain Analysis process in software
- In country tests and demonstrations
  - Uganda cold chain evaluation, 2007
  - Workshops
    - Seattle, May 2008
    - Panama City, October 2008
- Difficult to use software with defects
- Independent consultant did not consider the tool to be usable

CCEM 2.1

- Software firm hired to “fix” CCEM
  - Scope of work: deliver a working version of the code from a reference version
  - Seattle – India consulting firm working in the health domain
    - Agile methodology: Sprints, Use cases, Task estimation
  - Three month contract
  - Limited number of firms responded to the RFP
    - Project scale,
    - Lack of interest in Access applications

Outside development

- Initial focus
  - Development of comprehensive use case catalog
  - Port from Access 2003 to Access 2007
    - Integration of Ribbon UI
    - Addressing usability and workflow issues

Delivery difficulties

- After two months, sense of frustration on all sides
- Process not converging towards usable software
- Forecasting had not been evaluated
- Substantial finger pointing and blame assessment
Rapid Development
Steve McConnell

- Customers pose risk:
  - Don’t understand what they want
  - Won’t commit to written requirements
  - Insist on new requirements
  - Communication is slow
  - Incapable of participating in reviews
  - Technically unsophisticated
  - Don’t understand the software development process

What was going wrong

- Lack of documentation / understanding of the application
  - PATH did not have a specification
  - Developer accepted the original code as the specification
  - “We did not include correctness of the algorithms in the scope of the work.”
- No possibility of testing forecasting component
  - Subject matter expert not involved at this stage
  - Developer had no understanding of what they were building
- Contractor did not consider lack of domain expertise in their risk assessment

What was going wrong

- Focus on the easy stuff
  - Fixing reports and adjusting the workflow
- Unclear process for bounding the scope and identifying completion criteria
- Some things took longer than expected
  - Integrating the ribbon
- No plan for scaled testing or understanding of results

Involvement of subject matter expert

- Initial reaction
  - “This doesn’t work”
  - Focus on advanced features such as vaccine campaigns
- Planned to lead application walk through
  - Began by describing computations and processes
    - First time this had been described
    - Documentation of computations facilitated bug discovery
Getting project back on track

- Extended the contract by one month
  - Made it clear that no further extensions were available
- Reduced delivery target to “beta quality”
  - Identified resources to hire consultant for future bug fixes
- Took on domain specific testing as PATH task
  - Provided detailed directions for some specific fixes

PATH management of CCEM

- Code delivered to PATH December 2009
- Field validation test (February) postponed due to lack of available field data.
- Product management plan developed with internal rebudgetting
  - Project manager
  - Technical product manager
  - Contract programmer (original developer)

Defining a software process for PATH

- How can PATH effectively manage and deliver software products?
  - Software is critical for supporting global health
  - It is critical that public health expertise is incorporated into the software
  - PATH has had great success in engineering and testing products

Managing CCEM code development

- Software configuration management
  - Access application is basically a single database
  - Data and application are integrated
  - Challenges
    - Separation and tracking of data sets
    - Import and export of data sets
    - Versioning
  - Shouldn’t be hard to do . . .
  - Can trace many of our challenges to this

Issue management

- Bug tracking and feature suggestions
- Manage task list with prioritization
- Information Services setting up Bugzilla for project use
External Development

- Development phases
  - Triage task list
  - Assign work items to contract developer
  - Test and check in work items

Testing

- Develop simplified test cases
  - CCEM Data sets
    - Refrigerators
    - Vaccines
    - Geography
    - Facilities
    - Equipment
    - Forecast parameters
  - Important result: significant testing can be done on very small data sets
- Documentation of algorithms, process, computations
- Structured walk through

Management

- Schedule with objectives
- Working with budget limitations
- Critical to manage scope
  - “CCEM is code complete”
  - Avoid adding functionality
- Needs to be judged as usable by subject matter expert
  - Deliver an in-country analysis of a cold chain

Key lessons

- Challenges and experiences from CCEM are not unique
- Lessons from CCEM 2.1
  - Need for specifications
  - Communication with developers
  - In house software testing
  - Management of data sets
  - Issue tracking

Software Development at PATH

- Existing PATH employees have picked up key skills in software product management
- Opportunity for working with Information Services Department
- Tool and process support necessary
  - Configuration management
  - Bug tracking
- Area for skill development and training
  - Software testing