What a cool-looking airplane! This is first flight of the Premier I business jet, December 22, 1998.
Motivation (1):
Premier Development Program

- Ambitious
  - First “clean sheet” design in 15 years
  - New technology infusion (composites)
  - New processes and tools (stage-gate, IPT, ERP, CAD/CAM)
  - New team recruited industry-wide (the “New Guard”)
  - 36 month schedule (48-60 mo. was industry average)
  - $85 M budget (approx.) (not unreasonable for 36 mo.)
  - Entering new market segment
    - Certification requirements being re-defined
    - Premier is beta test subject

The Premier I development program was an ambitious undertaking for Raytheon Aircraft Company. It was the first airplane designed from scratch by the company in over 15 years (the Starship 2000 being the last “clean sheet” program), major components were to be built from composite materials (including the entire fuselage shell), many processes and tools were introduced to the company (including a new stage-gate design process, integrated product teams, elements of an enterprise resource planning system, and extensive use of personal computers for the first time), and the team had never before worked together. The original bid for schedule was barely half the industry average at the time, and the certification requirements for the targeted market segment (entry-level jet aircraft; Federal Airworthiness Requirement Part 23) were to be re-defined by the FAA for this type of aircraft.
Motivation (2):
Premier Development Program

- A qualified failure…?
  - More than 100% over budget
  - Completed in 72 months (100% over original bid)
  - Program publicly blamed for parent company’s troubles
  - Legacy products suffered; team member burnout

- However…
  - More than 300 announced orders before certification
  - Customers love the aircraft
  - Price/performance unmatched by competition
  - Can serve as a platform for decades of derivatives

Company feelings are mixed toward this program. It cost more than twice as much as budgeted and took twice as long. The parent Raytheon Company has publicly blamed Raytheon Aircraft, and specifically the Premier I program, for poor earnings for a number of years. Legacy aircraft products have not been updated as the company focused on Premier (hurting their performance in the market). However, the market has responded positively to the new product, with tremendous sales and positive reviews in the media. No other aircraft on the market today can match the Premier's price/performance niche, and Raytheon Aircraft now has a platform on which to base derivative products for 3-4 decades to come.
Approach

What were the key milestones; what information was available to the public regarding the program?

• Literature survey
  – Financial reports for Raytheon, 1997 - 2001

How the program was planned; team dynamics…

• Personal interviews
  – Engineering
  – Manufacturing
  – Program Management

A two-pronged approach: 1) search the publicly-available literature for program updates – milestones, key events, financial performance, customer acceptance, industry reaction; 2) conduct personal interviews (telecon & face-to-face) of current and former Premier team members – probe into key factors causing delays and cost overruns, lessons learned.
The feeling within Raytheon Aircraft Company was that the Premier program was crucial to the future of the company. The legacy product line was still competitive in the market place, but it was clear that the company could not expect future growth (market share or revenues) based on these products alone. The parent Raytheon Company would need to fund the development program so there was pressure on the Raytheon Aircraft division to present an attractive bid in terms of schedule and budget. All those interviewed felt that this initial bid was overly optimistic and presented too low an estimate of both time and money required. A major outside consulting firm was brought in to help in reorganizing the company along a matrix structure (project teams & functional departments) – this was the first use of integrated product teams in the company. New processes and tools were brought in such as those mentioned previously. The new team, largely hired from outside the company, was put in charge of the Premier program (the “New Guard”) with many long-time company employees (“Beechcrafters” or the “Old Guard”) relegated to secondary roles or placed in charge of the legacy product lines (soon to be neglected due to Premier’s cost and schedule overruns). The Premier I program was green-lighted by Raytheon in March of 1995.
A number of significant changes were required to the design relatively late in the program, including a major wing redesign, control cable re-routing and a redesign of the landing gear bays. The gear bay and control cable re-designs were necessitated by poorly understood (or late changing) certification requirements. The Raytheon team, under schedule pressure and believing they clearly understood the FAA requirements, made assumptions regarding the certification requirements and pressed on with the aircraft design. Meanwhile the FAA was still struggling with how to modify the Part 23 requirements and was characterized by conflicting opinions (internally) and frequently changing stances on the regulations. Communication between the FAA and Raytheon was poor and the relationship was perhaps not entirely congenial. In addition, the Premier team found that the learning curve for their new tools and processes was proving to be steep, with larger amounts of time and budget being used up in learning or refining the tools. Initially Premier and Raytheon management fully supported the new tools and processes and condoned the additional effort for implementation. As pressure increased due to delays and additional requests for budget (refused by the parent company; eventually taken out of the aircraft division’s legacy lines), management focused only on getting the design and certification of the aircraft complete. There was strong incentive to circumvent the new tools and processes. Premier was also becoming a company within the company as the “old guard” continuously derided the program and it’s staff, refused to adopt the new tools and processes company-wide, and in many cases refused to contribute to the program as additional resources (knowledge and manpower) were required. Premier was forced to turn inward, conducting their own hiring and now using tools and processes unique to their program. In at least one case the “old guard” gained the clout in manufacturing to refuse to build the Premier wing as designed by the Premier IPT manufacturing group. The wing was instead redesigned and built in a less efficient manner (more parts, more tools, more man-hours required).
Consistent Themes:  
Three Key Failure Factors

- Poor risk management
  - Aggressive initial bid
  - No contingency planning for failure
    - feedback loops kick in
  - Endemic at Raytheon
- Poor coordination with certification authorities
  - Raytheon & FAA: uncultivated relationship
  - Lack of communication; assumptions & hubris
- Poor tools and processes adoption
  - Design new processes and a new product simultaneously
  - Erratic executive management support

At least three key failure factors consistently emerged during the literature survey and personal interviews conducted for this research. There was little risk management in terms of a management reserve or any similar contingency for failure, especially in light of the initial aggressive schedule and budget (this reportedly still goes on at the company today). Coordination with the certification authority was poor and characterized by a generally bad relationship on both ends. The aggressive adoption of new tools at the same time a new product was being designed exacerbated delays and overruns.
Poor Risk Management

- Initial bid unrealistically low (budget & schedule)
  - Heroic initial efforts to hold schedule (run up budget)
    - Mandatory overtime (not necessarily paid)
    - Morale sags
    - Undiscovered rework builds until found later in program
    - Turnover (among contractors) is high
    - Program consumes resources from all corners of the company
  - Results in ballooning budget & inevitable schedule slips

"I know up to 80 percent of the tasks at any one time [leaving 20% unknown]… If you under-fund your intended tasks, there's no way to handle the additional tasks [10% on top of the 20% unknown], because now you'll be 30% under-funded." - Former senior Premier I manager

As mentioned before, it was felt that the initial bid was over-optimistic, resulting in unrealistically low estimates of budget and schedule for the program. Initially heroic efforts were made to hold the schedule by spending more (performance of the product was always held and never allowed to slip). The well-known (to this class) system dynamic feedback loops were triggered at this point – low morale, a build-up in undiscovered rework as no-one has time to check their work before releasing it, high staff turnover rates (mostly limited to the contract workers), etc. As costs balloon and the schedule continues to be in danger the program starts consuming resources (money, manpower, facilities, management focus) from all parts of the company. Inevitably the schedule is allowed to slip. A former senior Premier program manager indicated in our interview with him that only 80% of required tasks are really known and defined (and funded) at any one time. Another 20% are unknown/undefined but should be anticipated (and funded by a reserve). If the initial 80% of tasks are under-funded to start with, then when an additional 10% of tasks “pop-up” (rework, failed tests, etc.) you'll now be 30% under-funded and hopelessly unable to cope with the tasks.
Risk Management

• No contingency for failure…
  – Rework (changes to drawings, changing requirements)
  – Failed tests (some is “normal”)
  – Learning curve on new tools/”ramp up” time for new hires
  – Later in program: Hold to the schedule with fixed budget
    • More overtime
    • Morale sinks lower
    • Staff turnover continues
  – Voice of “old guard” becomes stronger
    • Premier doesn't know what they're doing; we can do it better
    • Step in to “help out”: dismantle/subvert new tools and processes just as they start showing benefits (manufacturing: wing design)

There was little or no contingency for failure on the Premier program. “Failure” is characterized here by undiscovered rework, failed tests (some of which should be expected), and learning curves and ramp up time for new hires. Later in the program efforts were being made to hold schedule as well as budget (product performance never slipped). Our “iron triangle” indicates that one of these elements MUST give. Meanwhile the “old guard” has become stronger as Premier loses credibility within the company. At one point the “old guard” is able to force a less efficient manufacturing process on the Premier IPT (see notes on slide 6).
FAA Coordination

- New certification requirements
  - High performance jet aircraft w/ single pilot operation
- Gap: perceived vs. actual knowledge
  - FAA: Internal struggle over new requirements
    - unsure of how to modify existing regulations
    - frequent changes; not all communicated in timely fashion
  - Raytheon: Assumptions made; proceed with design
- Poor communication
  - Initially: contact infrequent; limited to high mgmt. levels
  - Relationship is arms length (tense?); had been left uncultivated for years

As mentioned in the notes on slide 6, the certification requirements were being re-defined during this program. There was a gap between the perceived and actual knowledge of the certification requirements on the part of Raytheon as the FAA itself struggled internally to define the new regulations. This is exacerbated by poor communication between the two parties, perhaps due in part to the fact that the relationship has not been cultivated for many years while new products were not being designed by Raytheon.
The initial bid for the program assumed that all benefits (cost and schedule) from the new tools and processes would be available immediately to the program. But many of the major tools and processes were un- or under-developed at the start of the program. Two significant examples are the ERP element “Product Manager”; an electronic repository for documents and drawings and the new Integrated Product Development System – a stage-gate design process new to the company. In most cases it appears that time, money and knowledge for properly implementing these new tools and processes were not allocated.
Failed Program May Yield Long-term Company Success

• A fine aircraft
  – Unbeatable performance at value
  – Leads its segment
  – “Saved the company”

• Introduced processes to Raytheon
  – Internal adoption has been slowed by Premier’s reputation, but is entrenched nevertheless
  – IPTs are commonplace now

• New product line
  – Platform seen as vehicle to keep company viable for next 30-40 years

A failed development program, in this case, may equate to a long-term success for the company. The product itself appears to be a market success. The processes developed on the Premier program are now being embraced within Raytheon Aircraft company-wide. The Premier platform keeps Raytheon Aircraft’s product line viable for decades to come.
Conclusions

• Aggressive initial bid can backfire
  – Triggered feedback loops (quality, staff burnout, etc.)
  – Program exceeds industry average (cost, schedule)

• Leave room to fail
  – Management reserve is critical
  – Allow schedule slips

• Continuously coordinate with stakeholders
  – Don’t assume stakeholder buy-in (FAA, “old guard”)

• One big new thing at a time
  – Prove new processes on small programs first
  – Corporate support vital for radical process change

The initial aggressive bid appears to have backfired on the Premier program. The under-funded program triggered the well-known (in this class) system dynamics feedback loops, forcing quality of the work down (and rework up), causing staff burnout with overtime, etc.). In the end the program exceeded industry averages for cost and budget (by at least a factor of 2). Another lesson is to plan for some failures by creating a management reserve and allowing the schedule to slip when those failures occur (another lesson well-known in this class). All stakeholders must be engaged early and continuously throughout the program. In at least two cases (the FAA and the “old guard”) important stakeholders were held at arms length or were disenfranchised early, both of which would later hurt the program. And finally, our interview subjects uniformly said to do one big thing at a time – designing major new processes and tools at the same time as a major new product is a recipe for failure.