INST 154
Apollo at 50
Consolidated Notes on Lessons from Apollo
November 7, 2019

These are based on class discussions on October 31 and November 5. Items are generally listed in no particular order.

Some things that can help to make something at the scale of Apollo successful:

- A reason to act (in Apollo this was competition, but many types of reasons are possible)
- A compelling goal
- A specific goal
- A realistic goal
- A sufficient set of existing knowledge and relevant experience
- Adequate existing technology to build on
- Adequate resources (money, qualified workforce, …)
- Political and public support (which has implications for a public relations strategy)
- The ability to construct an effective bureaucracy (the "technology" to organize the effort)
- Existing work practices for the type of work that needs to be done (e.g., the systems engineering for Apollo was first developed in the Air Force missile programs)
- The ability to leverage market forces (e.g., competition between contractors for business)
- A sense of urgency (which might come from a deadline or from external events)
- The ability to try things out in pieces and learn as you go rather than just trying once and hoping it works
- A consortium of interesting parties can bring resources no one party has (e.g., in Apollo, locations for tracking stations)
- Infrastructure
- You can do small but strategic things before you get a commitment to go all the way (e.g., they started work on the F-1 engine long before Kennedy decided on Apollo)
- Simultaneously pursuing multiple alternatives can sometimes be helpful, although for cost and schedule reasons that strategy needs to be pursued selectively
- A willingness to take risks in ways that balance risk and reward
- Perseverance in the face of adversity
- Clear accountability can help to maintain public and political support

Some challenges that need to be overcome to make something at the scale of Apollo successful:

- Opposition to the goal itself
- Many goals are constantly competing for attention
- When trading off between schedule, cost and capability, you can control only two
- Slowing things down (e.g., to accommodate technical challenges or limited resources) can increase overall costs
- Risks of many types need to be managed (safety, cost, schedule, …)
- The outcomes you decide among must all be feasible, so you need ways to know what's feasible
- A crisis can serve to make some decisions possible that would not be possible at other times
- Leadership makes a difference
- Geography can impose limits (as it did with where the Soviet Union built the N1)
- Other goals may be in tension with your goal (e.g., environmental sustainability may conflict with development of new facilities)
- Vested interests may limit what's possible
- Priorities and interests change over time.
- It is hard to maintain a sense of urgency over an extended period of time
- You will need resources to deal with "unknown unknowns" (problems you could not anticipate)
- An inclination to face challenges head on and to act boldly
- Complex organizations are inherently hard to coordinate
- Many kinds of communication are needed; a single hierarchy can not manage it all

How decisions get made

- All decisions are technical, and all decisions are political.
- Both the rational actor and the bureaucratic politics model have explanatory power.
- Power structures are important, but they are not the whole story; internal politics is important as well
- Getting incentives right will help the right things to happen more naturally
- Compromise is often necessary when different interests favor different outcomes
- People might want to do the same thing for different reasons
- A flexible and responsive decision is needed is needed to respond to challenges and capitalize on opportunities
- Someone needs to have the final say
- Checks and balances can help to minimize bad decisions, but they also slow down the process. So you want some of this, but you can have too much of a good thing.
- Delegating decisions to the lowest possible levels makes it possible to get much more done
- Planning can help you to reach to emergencies, even when you did not plan for that specific emergency
- Controlling resource allocation to get the needed resources to the most critical tasks is essential
- Coordination can beat direction when the tasks are well factored and the need for coordination can be limited.
- Power struggles can get in the way of principled decisions that need to be made.
- People at the working level know a lot, but it is hard to move all of that information to the people who are making decisions.
- Access to trusted technical expertise is important.
- Some information must be kept confidential, which limits participation in some decisions
- The effects of self-interest need can't be eliminated, but they need to be limited.