

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

- Goal
 - A compelling goal
 - A specific goal
 - A realistic goal
- Circumstances
 - A reason to act (in Apollo this was competition, but many types of reasons are possible)
 - A sense of urgency (which might come from a deadline or from external events)
 - A crisis can make some decisions possible that would not be possible at other times
- Support
 - Political support
 - Public support
- Expertise
 - A sufficient set of existing knowledge
 - Experience with work of 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)
 - An ability to predict likely outcomes
- Resources
 - Adequate resources (money, qualified workforce, ...)
 - Other interested parties who can bring resources you don't have (e.g., in Apollo, overseas locations for tracking stations)
 - Adequate existing technology to build on
 - Adequate infrastructure
- Organizing the effort
 - The ability to construct an effective bureaucracy to organize the effort
 - Ways of leveraging market forces (e.g., competition between contractors)
 - An ability to start some key work before making the big decision (e.g., Eisenhower started work on the F-1 engine long before Kennedy decided on Apollo)
 - An ability to try things out in pieces and learn as you go
 - Simultaneously pursuing multiple alternatives can sometimes be helpful,
- Leadership
 - Many types of leadership are important (decision makers, consensus builders, technical expertise, ...)
 - An inclination to face challenges head on and to act boldly
 - 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 to address to make something at the scale of Apollo successful:

- Goals and circumstances
 - Opposition to the goal itself
 - Many goals are constantly competing for attention
 - The circumstances very strongly influence the decisions that can be made
 - Some other societal goals may impose limits on what you can do (e.g., environmental impact may limit where you can build facilities)
 - Priorities and interests change over time
 - It is hard to maintain a sense of urgency over an extended period of time
 - Geography can impose limits (as it did with where the Soviet Union built the N1)
- Program Management
 - Controlling resource allocation to get the needed resources to the most critical tasks is essential
 - 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, ...)
 - Complex organizations are inherently hard to coordinate
 - Many kinds of communication are needed; a single hierarchy can not manage it all
 - The structure of the organization(s) working on the task has serious consequences
 - Coordination can beat direction when the tasks are easily separated
 - You will need resources to deal with “unknown unknowns” (unanticipated problems)
 - A flexible and responsive decision process is needed to respond to challenges and capitalize on opportunities
 - At the outset, you may not know what’s feasible, but you need to know what’s feasible to make good decisions
 - Things involving people are harder to predict than things involving systems or physics
- Decision Making
 - All decisions are technical, and all decisions are political
 - Someone needs to have the final say, and who that is matters
 - Access to trusted technical expertise is important
 - Power structures are important, but they are not the whole story; internal politics is important as well
 - Power struggles can get in the way of principled decisions that need to be made
 - The effects of self-interest need can’t be eliminated, but they need to be limited
 - Getting incentives right will help the right things to happen more naturally
 - 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.
 - Both the rational actor and the bureaucratic politics model have explanatory power.
 - Compromise is often necessary when different interests favor different outcomes
 - People might want to do the same thing for different reasons
 - Delegating decisions to the lowest possible level makes it possible to get more done
 - 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
 - Some information must be confidential, which limits participation in some decisions
 - Planning can help react to emergencies, even emergencies you did not plan for