

Project Management **Basic Principles for FIRST Teams**

The Project Management Institute (www.pmi.org) describes a project as an undertaking brought about to achieve a particular outcome.

A Project is undertaken to create change. It has a specific start date, and a specific end date.

A Program is comprised of multiple projects and may span several years. A Program may have no specific planned ending.

Based on these definitions, most *FIRST* teams are Programs that run for several years, and each year they start a new Project that begins with the announcement of the new game and ends with the final competition of the season.

This paper will identify some of the key activities that are part of a successful project and provide examples from both a business prospective and a *FIRST* team perspective. The business perspective is from that of a product development organization.

The focus will be on the act of “Managing the Project” and how that can help a team to be successful.

The intent is to provide some basic guidelines to help a *FIRST* team manage their project, and to also show the close proximity of how businesses manage projects to how *FIRST* teams can effectively manage their projects.

Key Role

Project Manager – One of the key roles for a successful project is a Project Manager. The Project Manager is responsible for understanding the requirements and managing the scope, schedule and cost of the program, while trying to minimize the project risk. The Project Manager does not do all of the work, but needs to make sure all of the work is being done.

In a business, the project manager is normally a mid-level or higher person who has a high level of experience in the field. The complexity and financial impact of the project will determine the experience level and expertise required of the manager. The project manager will be responsible for maintaining a project team, controlling the budget and making sure the final product is delivered to the company or sponsor.

In a *FIRST* team, the project manager may be the lead mentor, a teacher, an engineer, a student, or a small group. Some teams have a clearly designated person as the lead, while others do not make a formal designation. This person or group has the responsibility of meeting all of the *FIRST* requirements and completing the robot on time.

Although there is always debate and there are exceptions, most projects are best managed when there is a defined lead who can make the final decisions when needed and assume overall responsibility for the project success or failure.

Major Responsibilities of the Project Manager

The major responsibilities of the Project Manager and Project Team (and a FIRST team) include:

1. Capture the Requirements
2. Define the System / Solution
3. Create a Schedule and a Plan
4. Execute the Plan
5. Deliver the Product
6. Review and Close-Out

Each of these major responsibilities will be discussed below, with both a business example and a *FIRST* season example to support the definition. (The business example will be an engine development program, which normally starts with a customer requirement and ends with delivery of a qualified engine.)

1. Capture the Requirements

One of the keys to success is to understand the requirements. A great product that does not meet the customer requirements or expectations cannot be sold and was a poor use of resources.

The requirements may be obtained from documents, meetings, general conversations, or other means. Before any major work is started, it is important to understand the requirements so that they can be evaluated and balanced as the project plans are put together. Often, requirements documents are prepared, with a customer and supplier signature to formalize the agreement.

The requirements should be captured in a document or matrix and maintained for the entire project team to review when needed. If there are questions, those items should be identified and someone assigned to get the answers. If there are assumptions made, they should be identified as such until the final answers are known.

For FIRST teams, an effective way to create a requirements document and be sure the entire team understands what is required is through a brainstorming session where the rules of the robot and the game are written on a large marker board and discussed as a group. This first step assures that everyone is working to the same requirements and incorrect assumptions do not drive a bad decision.

Business Example

The requirements will be captured in a formal Project Requirements Document. For a product development program, sources of requirements include:

- The Customer and Customer Meetings
- A Customer Requirements Document
- FAA Rules, Federal, State or Other Laws
- Internal Company Standards and Requirements
- Company Strategies
- Lessons Learned, Best Practices

Sample requirements could include:

- Power Capability and Fuel Efficiency
- Life Requirements
- Weight and Size Limits
- Material Limitations or Requirements
- Schedule
- Costs
- Safety Requirements

FIRST Example

The requirements may be captured in a formal document or in team notes. For a FIRST program, sources of requirements include:

- FRC Rules and Documents
- FIRST Kick-Off
- Q & A Sessions at FIRST
- Referees at the Event
- Team Guidelines and Goals
- Brainstorming Discussions

Sample requirements (2008 Game) could include:

- Power (12 V battery, Back-Up Battery, Pneumatic Pump)
- 2 Minute, 15 Second Match
- Autonomous Mode / Hybrid Mode
- Height, Weight, Starting Size
- Motor Requirements and Availability
- Use of Previous Years Components
- Schedule Requirements
- Documentation and Submission Dates
- Cost Limits

- Safety Requirements

2. Define the System / Solution

The next step is to define the system and solution to meet the requirements. This is a critical part of the process, and decisions and trade-offs must be made to meet requirements that are often conflicting. There are several steps and processes used to define the final solution and take into account all of the requirements.

For FIRST teams, a good process is to start at a very high level and then work to a more detailed solution.

As an example, a team can begin with concepts of how the game might be played. These concepts may be high level (drive fast, hurdle the ball). The next step is to create a more defined definition (drive 12 feet per second, lift the ball and roll it across the tower to score). Next, more detailed drawings and prototypes may be built to determine how the solution will work as a system. At this point, motors could be assigned, the decision on use of pneumatics and specialized sensors is made, along with the “auto mode / no auto mode” decision.

Once a solution is agreed, it should be documented and defined for the entire team, so that the team is then working to an agreed solution. Any changes after the solution is agreed need to be agreed and communicated to the entire team.

Business Example

There are several steps and processes that can be used to create the system and solution. Companies may use a combination of these or other internal, proprietary procedures in this phase.

- Brainstorming to Identify Solutions
- Making Sketches and Prototypes
- Identification of Likely Solutions
- Rubrics and Other Comparison Processes
- Rig Tests and Component Level Testing
- Independent Reviews
- Competitive Analysis

FIRST Example

For the most part, teams can use the same steps and processes that businesses use, with a few extra options.

- Talk With Other Teams (Mentoring Teams, Forums)
- Review of Past Robot Designs from Competitions

3. Create a Schedule and a Plan

Schedule

Although few teams make schedules and create formal build plans, most teams would benefit tremendously from this activity. Even a simple schedule with a few basic milestones provides a better guide than no schedule at all. It is common to hear someone say “we are way behind”, but without a defined schedule how can you know how much behind you are, and if it is critical or not.

For many teams, the development of a build schedule could be an iterative process, improved over several seasons.

One of the basics of creating a schedule is to identify milestones. For a FIRST team, the first two are easy – Kick-Off and Ship Day. The next step is to identify major milestones in between. These milestones could include:

- Sponsor Demo Day
- Community Open House
- Robot Design Decision Complete
- Design Complete
- Chassis Fabrication Complete
- Wiring Complete
- Programming Complete
- Chairman’s Award Submission Date
- Team Information Page Submission Date

More detail can be added to support these and other milestones. Critical decision dates and action dates should be included.

For example, if you have an outside company manufacture some components, and they only work on your team parts on Fridays, you might need to set a date that all designs and drawings for specific components must be completed by the Thursday before, so that you do not miss an entire week waiting for the next date they will work on your parts.

Some material may have long lead times, so you may need to set a date for decisions to be made so that the material can arrive in time for fabrication.

One of the keys to successful schedule management is to treat the milestone dates like they are the ship date, and be sure the work is done on time. Without this focus, the milestone dates will slip, and the group at the end of the process (usually wiring and programming and practice) do not get time to do their work.

Microsoft Project is a good tool for project planning and can be kept at a high level. Something as simple as a large calendar with dates circled and milestones written in can be very effective.

Plan

Concurrent with the schedule development, teams need to create a plan to get the work done. This plan might include decisions on when and where to work and the team organizational structure.

If there is a lot of activity in one area, there may be a need to assign more people to a sub-team than are currently on it. One business model is a work breakdown structure (WBS) that identifies the tasks to be completed at the subsystem and system level.

Business Example

Businesses may use different tools for schedule management. The level of information, reporting and tracking requirements will vary company to company and project to project. Military and government programs often have very strict guidelines on schedule management and progress reporting, called Earned Value Management (EVM). EVM is a process to track how you are performing against the required schedule, and how you are performing against the agreed budget.

For a business, the high level schedule might include:

- Key Customer Deliverables (Meetings, Prototypes, Finished Product)
- Key Internal Deliverables (Reviews, Test Dates, Project Releases)
- Major Tasks and Sub-Tasks
- Estimates of Task Times
- Identification of Task Dependencies (what has to happen in what order)
- Outside Events That Are Important (Trade Show, Symposium)

A Program Plan can be a formal document that describes the program scope and deliverables, the organization, sources of funding, budgets, key customers, internal and external regulations that must be followed, product plans and other data.

FIRST Example

For the most part, the information for a team to put into a schedule is similar, with different names for some of the requirements and organizations.

- FIRST dates (Kick-off, Ship Date, Competition Date)
- Key Internal Deliverables (Demo's, Open House)
- System Completion Dates (Design, Chassis, Arm, Wiring, Programming)
- Deliverable Dates (Awards, Team Info, Payments)

4. Execute the Plan

This is the fun time. The execution phase is where the work gets done. Designs are completed, parts are made, assemblies are completed and products are tested.

There is a balance required, but the more effort that is put into steps 1,2 and 3, the smoother and more successful this step is. With proper planning up front, everyone knows what is expected, when it needs to be done, and how it all fits together for the project.

One of the key roles for the project manager during this phase is managing the scope (what is going to be done), managing the schedule (is work getting done when needed) and managing risk (will things work as expected).

Managing Scope is the activity of keeping the team on the agreed plan and not trying to add features or capabilities late into the schedule. The impact of changes late in the process are significant, because even a simple change can impact several areas.

At times, changes are required to be able to meet the schedule or another critical requirement (weight). The key is to limit these changes and be sure they are managed and effectively communicated.

Managing Schedule is the activity of keeping everyone working to meet their agreed dates. This is a challenge because the people with activities early in the schedule (week 1) do not feel as much pressure for the deadline as people with activities late in the schedule (week 5).

In a business environment, some schedules can be revised and modified as programs progress and new information is received, but with a FIRST project the deadline is set and has rarely been adjusted.

Managing Risk is the activity of looking ahead to what might go wrong, and determining if there is action that can be taken to minimize the likelihood of the risk happening, or reducing the impact if it does happen. These actions are called “Mitigation Plans” and may involve activity that is only in place in case something goes wrong. Many companies utilize formal risk management processes and hold regular risk reviews.

Risks are often written in an “IF, THEN” format. An example of a risk might be “IF we get a heavy snowstorm Thursday night, THEN we cannot get into the school and finish the design”. If there is a high probability of a snowstorm, a mitigation plan might be for some students to take laptops with Inventor software home with them, and other students to take some documents that they could work on at home. If it does snow, the students act on the mitigation plan and do the work at home, if it does not snow, then they proceed with their regular plans.

Another risk could be “IF FIRST reduces the allowable weight by 10 pounds, THEN we will have to remove two of our drive wheels to make the new weight”. This is a risk that most teams would consider to be a low probability, so they would just accept that risk and not put any mitigation plans into place.

Business Example

For a Product Development Program, some of the activities in the execution period could include:

- Design and Analysis
- Manufacture Components
- Identify Suppliers and Place Orders
- Make and Test Sub-Systems
- Integrate Sub-Systems and Test
- Complete Audit and Reviews
- Complete Required Reporting
- Attend Customer Meetings and Trade Shows
- Manage Change and Monitor Progress
- Manage Risk
- Deliver the Product

FIRST Example

For FIRST Teams, the activities can be similar. Some actions that would be unique for teams include:

- Read and Interpret FIRST updates
- Check Chief Delphi for Info on Other Teams and Interpretations
- Verify the FIRST Q & A Responses
- Perform DEMOs for Sponsors
- Help Rookie and other New Teams With Activities

5. Review and Close-Out

The Review and Close-Out phase is a step that many businesses and FIRST teams omit or do on a very limited basis. This step is the process of documenting what was done. It is the process of evaluating performance and capturing lessons learned and good practice so that it can either be avoided or repeated for the next project.

For a business, this step could include writing formal reports, closing charge numbers and transferring people to other positions.

For both businesses and FIRST teams, this step is an opportunity to look back. Through brainstorming or other processes, teams can identify what things did not go well and could be improved for the next season. Some processes used in this phase can be Root Cause – Corrective Analysis, 5 Why and Ishikawa diagramming. Each of these is a process to understand the real reason why something happened, and then determining how to avoid it in the future.

Another key activity is to document what went well and what needs to be repeated. This could involve identifying “Keys to Success” or “Best Practices” that need to be written down for future reference.

When this work is completed, it should be collected into a common file or report so that it can be referred to later.

An example of a “Root Cause – Corrective Action” could be related to robot wiring. If the problem was that connectors came loose during matches, the root cause could be that the crimps were not tight enough to withstand the vibrations and also that connectors came loose from under the connection screws. After asking several questions about why, the cause could be that the crimps were not done properly because there was no crimping tool and that the students were using u connectors in all locations because they were quicker to install. The Corrective Actions for this could be the purchase of a new crimping tool and training on how to use it, and a team decision to only use closed side connectors for all wiring, even though it would take longer.

An example of a “Best Practice” could be related to nuts and bolts. A team might have determined that they did not have any loose nuts or bolts the entire season. After analysis, they determine that they had accidentally bought higher quality bolts and only used nylon lock nuts in every case. This could become a “Best Practice” and lead the team to only buy the higher quality materials and only use nylon lock nuts on their robot.

Teams (Business and FIRST) that complete these activities (Close-Out Reporting, Lessons Learned and Best Practices), their performance improves project after project as they avoid making the same mistakes each year.

Business Example

Some of the activities a business could undertake to close out a project include:

- Close Out Charge Numbers
- Re-Assign People
- Create Project Closure Reports
- Complete Final Reviews
- Determine Future Program Support Requirements
- Continuous Improvement Activities
 - Root Cause / Corrective Action
 - Lessons Learned Reviews
 - Best Practice

FIRST Example:

FIRST Teams could complete most of the same activities listed above, although on a smaller scale.

Many FIRST teams simply stop after the last competition and move on to other activities or do nothing else until the next build season. The process of closing out a project can take as little as a few hours, and can be ‘reported’ through a file with copies of someone’s notes from the discussions.

For teams that choose to close-out their project, the information can be gathered during a final all team meeting when the competitions are over for a season. The discussions can lead to actions that are needed to correct issues and copies of the notes can be made and filed. Ideally, this information will be reviewed during the fall so that it is fresh for the students who begin the next robot season.

Summary

Most teams undertake the project of building a FIRST competition robot with a goal of being successful during the season. By applying some basic Project Management principles – Capture Requirements, Define the Solution, Create a Schedule and a Plan, Execute the Project, Review and Close-Out – teams can increase their chances of achieving the level of success they desire, however they define that success for their particular situation.

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