Engineering Notebook

Best Practices for All

Presented by:

Pat Price
Regional Support Manager

Carol Kujawa
Director of Regional Operations

ROBOTICS EDUCATION & COMPETITION FOUNDATION
SUMMIT
| VEX ROBOTICS PROGRAMS |

REC FOUNDATION   VEX ROBOTICS

Mission and Vision

✔ **Mission**

The Robotics Education & Competition Foundation's global mission is to provide every educator with competition, education, and workforce readiness programs to increase student engagement in science, technology, engineering, math, and computer science.

✔ **Vision**

We see a future where every student designs and innovates as part of a team, overcomes failure, perseveres, and emerges confident in their ability to meet global challenges.

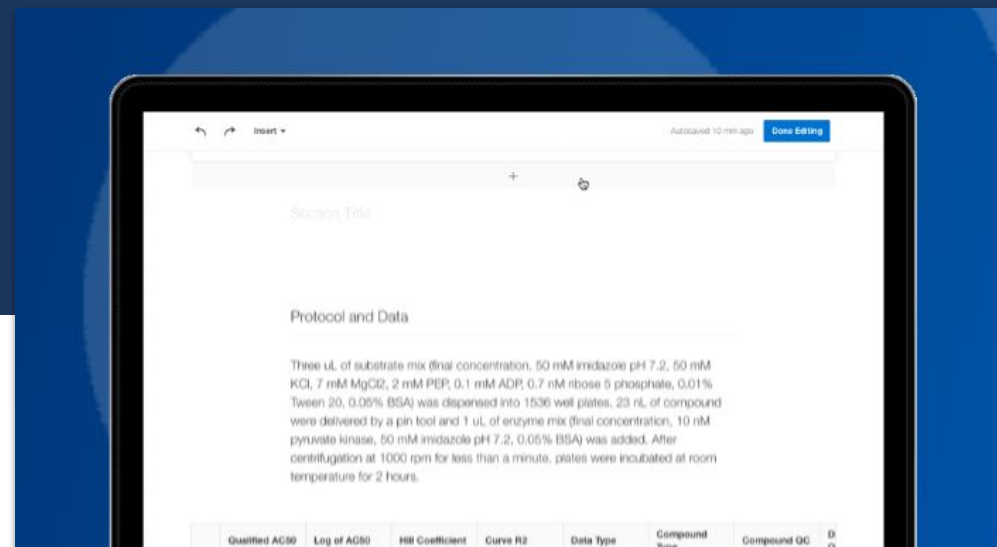**Inspiring students, one robot at a time.**

Engineering Notebook History

Codex Forster II , Leonardo da Vinci, late 15th – early 16th century, Italy

Electronic Lab Notebook, Online 2024

US Patent Law Prior to 2013

❏ An Inventor needed to prove that they were the first one to invent a product to earn a patent for an idea. Notebooks had each page signed, dated, and witnessed.

❏ Notebooks were chronologically documented.

❏ No editing of past notes.

US Patent Law Change 03/16/2013

❏ The US patent laws switched from a "first to invent" to a "first inventor to file" system.

❏ Witnesses are not necessary.

❏ Digital notebooks become a valid option.

Workforce Readiness

Documenting work in an Engineering Notebook is a widely used engineering and design industry practice

By following the Engineering Design Process and documenting that process in an Engineering Notebook, students practice:

- ❏ Project management

- ❏ Time management

- ❏ Brainstorming

- ❏ Effective interpersonal collaboration

- ❏ Written communication skills

Benefits

Benefits to the Team of Keeping an Engineering Notebook

- Keep track of ideas
- Record alternative solutions for later
- Reflect on how ideas are working
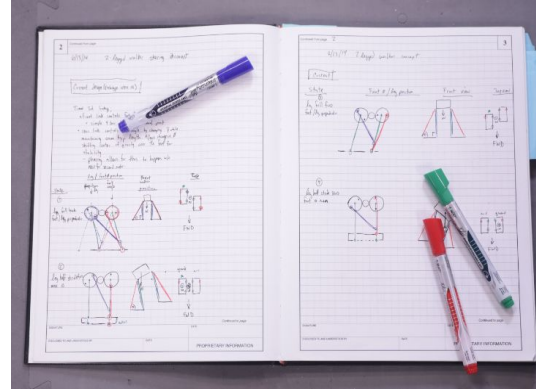- Provide reference for future seasons
- Opportunity to practice written communication skills
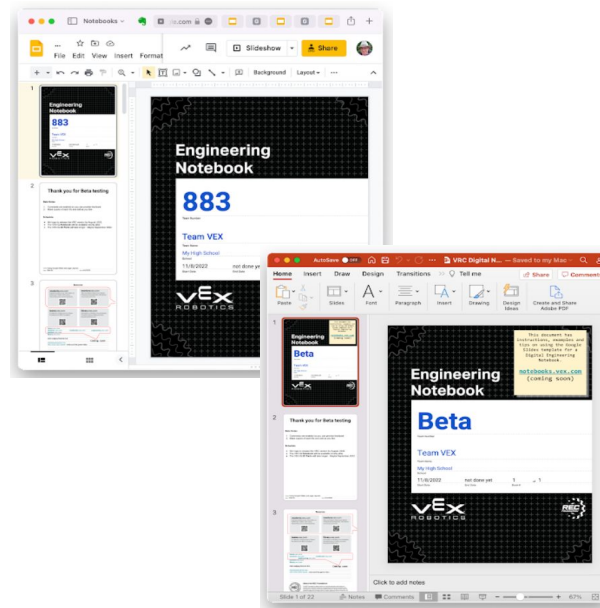- Learn how to properly credit outside sources

Engineering Notebook Format

Physical Notebook

- Typically bound
- Official VEX Robotics notebooks or any other physical notebook
- Students can draw everything in notebook or glue pictures in

Digital Notebook

- Any format of choice, for example, Google Slides, Google Docs, Microsoft PowerPoint or Word
- Use VEX Robotics templates or your version
- Must be an unlocked / password-free URL to allow judge viewing for competitions

**There is no 'favored' native format.
Notebooks are judged consistently with the same rubric and criteria.**

Judged Awards

Students demonstrate their knowledge of the Engineering Design Process by documenting their design process in an Engineering Notebook.

Only Fully Developed engineering notebooks are considered for:

- **Excellence Award**
- **Design Award**
- **Innovate Award**

A team nominated for the following awards should have a notebook that contains content that supports the team interview and award criteria.
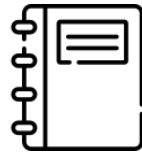
- **Think Award**
- **Build Award**
- **Amaze Award**
- **Create Award**

Developing vs. Fully Developed Notebooks

Developing Engineering Notebooks

- Contain minimal or vague detail
- Have few drawings
- Not a complete record of the design process

Fully Developed Engineering Notebooks

- Contain specific details with detailed drawings, tests, results, and solutions to problems
- A complete record of the design process
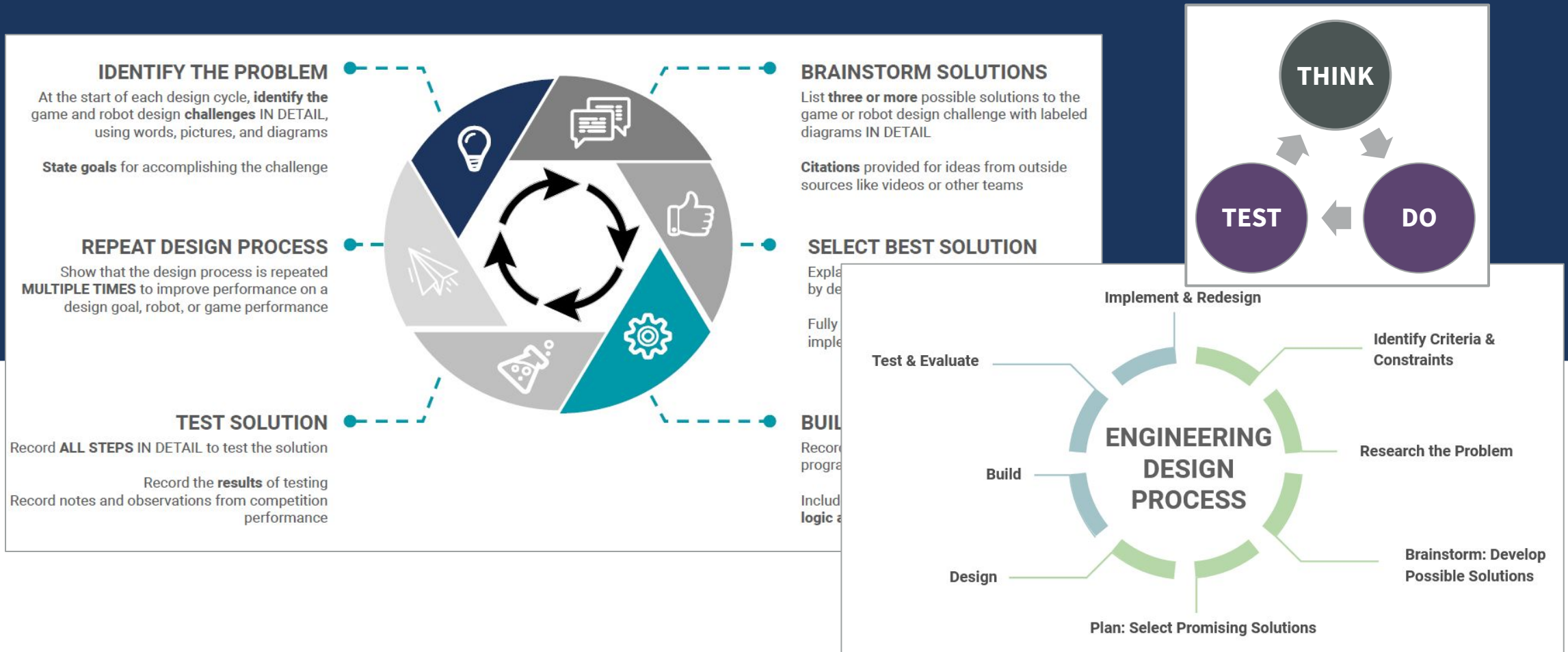- A score of two points or higher in the first four criteria of the Engineering Notebook Rubric, as this is one iteration of the Engineering Design Process

Notebook content should support the team interview, the rubrics, and the award criteria.

What Is the Engineering Design Process?

There is no single universally accepted design process. Most engineers have their own twist for how the process works. However, it always starts with a 'problem' and ends with a solution!

IDENTIFY THE PROBLEM
At the start of each design cycle, **identify the** game and robot design **challenges** IN DETAIL, using words, pictures, and diagrams

State goals for accomplishing the challenge

REPEAT DESIGN PROCESS
Show that the design process is repeated **MULTIPLE TIMES** to improve performance on a design goal, robot, or game performance

TEST SOLUTION
Record **ALL STEPS** IN DETAIL to test the solution

Record the **results** of testing
Record notes and observations from competition performance

BRAINSTORM SOLUTIONS
List **three or more** possible solutions to the game or robot design challenge with labeled diagrams IN DETAIL

Citations provided for ideas from outside sources like videos or other teams

SELECT BEST SOLUTION
Expla
by de

Fully
imple

BUIL
Reco
progr

Inclu
logic a

THINK

TEST   DO

ENGINEERING DESIGN PROCESS

Implement & Redesign

Identify Criteria & Constraints

Test & Evaluate

Research the Problem

Build

Brainstorm: Develop Possible Solutions

Design

Plan: Select Promising Solutions

Using the Engineering Notebook Rubric

Use the Engineering Notebook Rubric to discuss with your team what the judges will be looking for in their notebook

Engineering Design Process

❏ Identify the Problem

❏ Brainstorm

❏ Select Best Solution

❏ Build and Program the Solution

❏ Original Testing of Solution

❏ Repeat Design Process

Additional Criteria

❏ Independent Inquiry

❏ Usability and Completeness

❏ Originality and Quality

❏ Organization/Readability

❏ Record of Team and Project Management

Rubric Criteria for the Engineering Design Process

Identify the Problem	Brainstorm Solutions	Select Best Solution	Build and Program the Solution	Original Testing of Solution	Repeat Design Process
• What is the game challenge? • What are the goals?	• List solutions • Provide citations if inspired by outside ideas	• Explains why solution is chosen in each step for all aspects of design	• Records the steps • Provides detailed information that reader can follow	• Records steps to test • Includes original test results done by the team	• Design Process is repeated multiple times

Additional Rubric Criteria

Independent Inquiry	Usability and Completeness	Originality and Quality	Organization / Readability	Record of Team and Project Management
• Where do the ideas originate?	• Well-recorded design and development process	• Cited content is kept to relevant information • Most or all content is original to the submitting team members	• Organization of the document makes it easy to reference • No extraneous content that does not further the engineering design process	• Documentation is in sequence within the design process • Team and project assignments

Engineering Notebook Content

The notebook provides a complete record of team and project assignments

Team Meeting Notes, Goals, Decisions, Building/Programming Accomplishments

- Resource constraints including time and materials

- Descriptions, sketches, and pictures of design concepts and the design process, from initial conception, and brainstorming to the planning and creation of the final design

- Observations and thoughts of team members about their design and their design process

- Records of original tests, original test results, and evaluations of specific designs or design concepts and how these have informed team decisions

- Project management practices including their use of time, personnel, and financial resources

- Notes and observations from competitions to consider in the next design iteration

- Descriptions of programming concepts, programming improvements, or significant programming modifications

- Enough detail that a person unfamiliar with the team's work would be able to follow the logic used by the team to develop their design, and recreate the robot design

Emerging	Proficient	Expert
(For Illustrative Purposes Only) Does not record steps to test the solution. Testing or results are borrowed from another team's work.	*(For Illustrative Purposes Only)* Records the key steps to test the solution. Testing methodology may be incomplete, or incomplete conclusions are recorded.	*(For Illustrative Purposes Only)* Records all the steps to test the solution, including test results. Testing methodology is clearly explained, and the testing is done by the team. Original testing results are explained and conclusions are drawn from that data.
(For Illustrative Purposes Only) *Testing* *We tested the robot and decided to swap it for the new intake.*	*(For Illustrative Purposes Only)* *Testing* *We tested the old and new intakes in 10 driver skills runs each to find their average scores. Sarah and Evan each drove 5 runs with each intake.* *The new intake scores better than the old one, so we're planning to switch.*	*(For Illustrative Purposes Only)* *Testing* *We tested the old and new intakes in 10 driver skills runs each to find their average scores. Sarah and Evan each drove 5 runs with each intake.* *Old intake scores: 60, 73, 80, 81, 56, 73, 69, 73, 70, 65; Average score with old intake: 70* *New intake scores: 74, 81, 85, 72, 71, 87, 85, 89, 91, 85; Average score with new intake: 82* *Because the new intake improves the average by 12 points, we plan to use it at the next competition.*

Goal Setting

Developing and working toward shared goals is a growth experience for the team and for the robot

Motivation	Focus Team's Attention
Define Criteria for Success	Highlight Needed Changes

For each goal, specify how progress will be measured, which tasks will lead to successful completion, and how those tasks fit into the team's season timeline

One method might be to start with SMART goals - goals that lead directly to a step-by-step project plan that can be documented in the team's engineering notebook. SMART goals are:

- Specific - the goal targets a specific problem or need
- Measurable - progress on the goal can be accurately gauged
- Achievable - the goal should be realistic based on available resources and constraints
- Relevant - the goal must fit within the overall plan
- Time-Bound - the goal has a specific deadline or endpoint

Project Management

Timelines and planning can be in the style of Gantt or PERT charts, but teams can choose other ways to show their project timeline

Gantt Chart

Task Name	Q1 2019			Q2 2019		Q3 2019
	Jan 19	Feb 19	Mar 19	Apr 19	Jun 19	Jul 19
Planning						
Research						
Design						
Implementation						
Follow up						

PERT Chart Example

PERT charts are flowcharts that display project tasks in separate boxes. Dependencies are connected with arrows between the boxes.

START

TASK 1
Duration: 4 days

TASK 4
Duration: 3 days

TASK 7
Duration: 2 days

TASK 2
Duration: 6 days

TASK 5
Duration: 6 days

TASK 3
Duration: 2 days

TASK 5
Duration: 4 days

TASK 8
Duration: 5 days

END
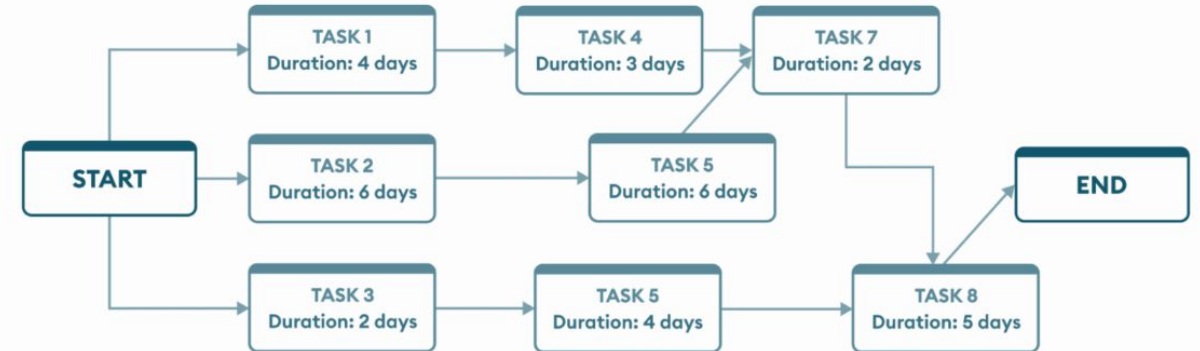
Organization and Readability

Details that help your team organize thoughts, document workflow and help competition judges find important information about the team's design history

> Use CAD models and/or detailed engineering drawings.

> Ensure all illustrations and figures include labels and keys.

> Include code snippets and rationale in chronological order alongside the build.

> The Engineering Design Process steps and criteria of Engineering Notebook rubric criteria can be used as an organizational tool.

Engineering Notebook Organization

There is no "correct" way to organize an engineering notebook, but there are best practices:

01 Front Cover

➢ team name
➢ team number

02 Title Page

➢ team name
➢ team number
➢ organization
➢ team members

03 Table of Contents

➢ page number
➢ entry titles
➢ entry dates

05 Each Page

➢ page number
➢ descriptive title
➢ date of entry
➢ list of team members participating that day
➢ detailed descriptions
➢ evidence of sequence with the engineering design process

06 Other Pages

➢ sections
➢ color coding
➢ template (created by students)
➢ entries intact - errors crossed out using a single line
➢ permanently affixed drawings or relevant material

Engineering Notebook Quality

A longer notebook is not necessarily a sign of quality

Judges have limited time to assess a team's notebook – make the most of that time!

- **Keep it Student-Centered**
  - content should not be generated nor filtered by generative AI
  - no content by anyone not a current student on the team
  - notebook content is original to the students who created it

- **Quantity does not Equal Quality**
  - no extraneous or repetitive content not meaningful to the team's Engineering Design Process
  - no content from other teams' or previous seasons' Engineering Notebooks

- **Citations and Appendices**
  - content from outside sources is properly cited/credited
  - move cited content longer than one paragraph to Appendices as reference material
  - extraneous content in Appendices

- **Youth Protection**
  - limit personal details about the students

Academic Honesty

The **Guide to Judging Section 5** explains the purpose of the Engineering Notebook, Academic Honesty, and the use of Artificial Intelligence (AI).

- ❏ The Engineering Notebook, as well as the processes students follow to create it, should be in alignment with the REC Foundation's Student-Centered Policy and Code of Conduct.

- ❏ Teams should properly cite sources and credit work that is not their own.

- ❏ Using common notebook content between teams in the same organization should be avoided.

- ❏ Students should avoid using programs or code that are beyond their ability to create and explain independently.

- ❏ The use of artificial intelligence (AI) programs or tools to generate or organize Engineering Notebook content or programming code is also contrary to the REC Foundation Student-Centered Policy and Code of Conduct.
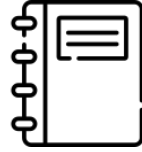
Educational Importance

The Engineering Notebook is an original work written and organized by the team, describing the Engineering Design Process over the course of the season

Prohibition of AI Tools

The use of generative AI in creating and/or organizing Engineering Notebook content is explicitly prohibited

Notes from Experienced Judge Advisors

Judge Advisor 1

- **Bullet points**: Distill a long narrative to the essence and organize thoughts; Outline the process and key points for decisions

- Data tables, labeled diagrams - anything to help the reader **visualize the process** without having to read every word on a page

- **Color-coded design cycles or rubric items** - commit to consistent use throughout the notebook!

- Put yourself **in the place of the reader** - how would you judge your notebook?

- **Hand-drawn** brainstorm diagrams point to **Student Centeredness**

- **Hyperlinking** Table of Contents items in digital notebooks makes finding key points easier; For physical notebooks, use **tabs** but in moderation

Judge Advisor 2

Authenticity of Content in every aspect of the design process:

- Game Analysis - what YOUR team thinks, not just generic highest score charts

- Actual build decisions - prototype mechanisms

- Reduce and 'file' non-team content - use appendices!

- Is a pic of the final build in the notebook?

- Develop tests for a reason with data showing something that mattered for the team

- Actual code that isn't pretty, but that does something useful, is cool

- Stating and solving a problem that you care about and documenting that… is engineering

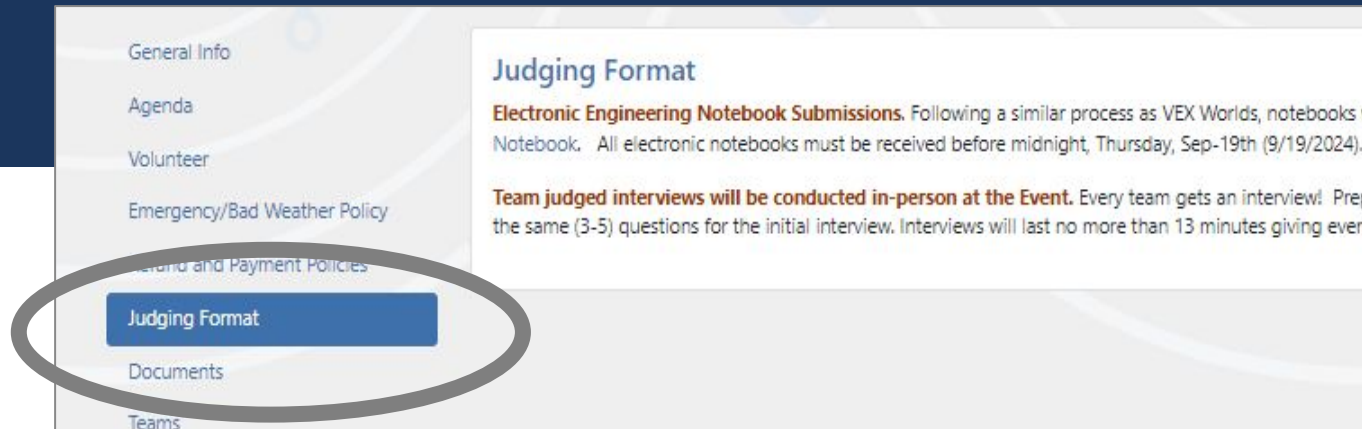- How much time spent making decisions vs. generic project timeline

Engineering Notebook Submission

The Event Partner decides which format (Physical or Digital) notebooks will be submitted for the event.

Find this information in the Judging Format tab for each event.

Pay close attention to submission deadlines.

General Info

Agenda

Volunteer

Emergency/Bad Weather Policy

~~Refund~~ and Payment Policies

Judging Format

Documents

Teams

Judging Format

Electronic Engineering Notebook Submissions. Following a similar process as VEX Worlds, notebooks w
Notebook.   All electronic notebooks must be received before midnight, Thursday, Sep-19th (9/19/2024).

Team judged interviews will be conducted in-person at the Event. Every team gets an interview! Prepa
the same (3-5) questions for the initial interview. Interviews will last no more than 13 minutes giving every
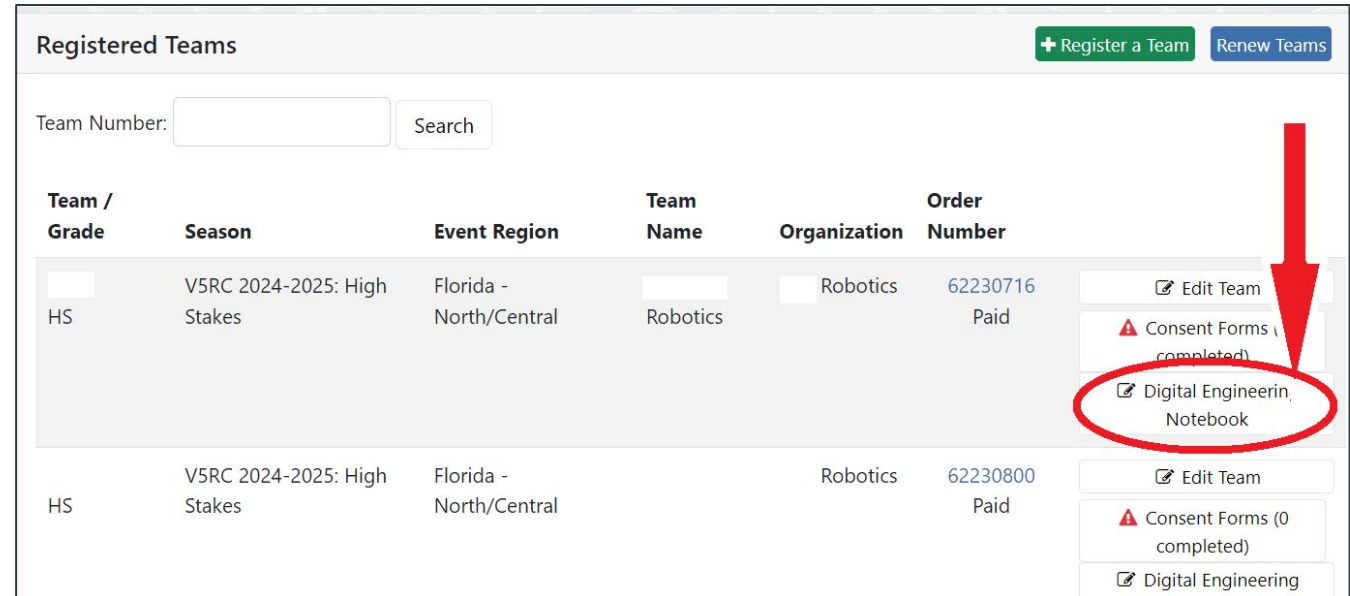

i Digital notebooks must be printed for events requesting physical notebooks.
Physical notebooks must be digitized for events requesting digital notebooks.

Submit the Notebook

Upload a **Link** to your team's notebook in RobotEvents.com

1. Log in to RobotEvents.com

2. Click on "My Account"

3. Under Registered Teams, next to each team, click Digital Engineering Notebook

4. Add link to Engineering Notebook

   a. Make sure that no password or download is needed and viewable in a web browser
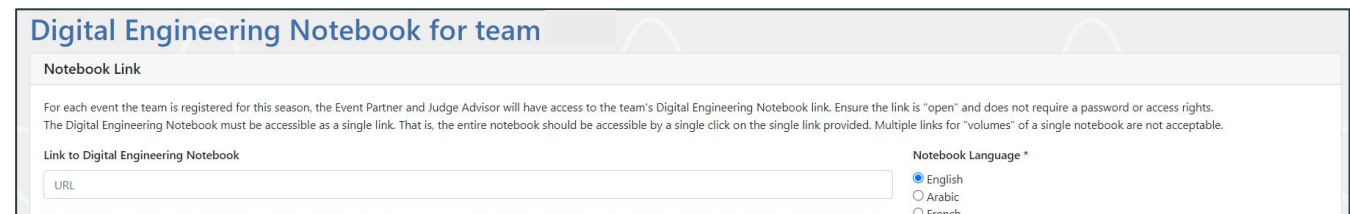
   b. .PDF file format under 500 MB is recommended

Innovate Award Submission

To be considered for the Innovate Award, teams must use the Innovate Award Submission Form

This form is required to be placed either directly behind the Engineering Notebook cover page or in a clearly marked section in the Engineering Notebook.

- ❏ In the case of physical notebooks, this form can be printed out and placed in the notebook

- ❏ For digital notebooks, this form can be scanned in or an exact recreation included

- ❏ Teams may only submit one aspect of their design in use at the event to be considered at that event
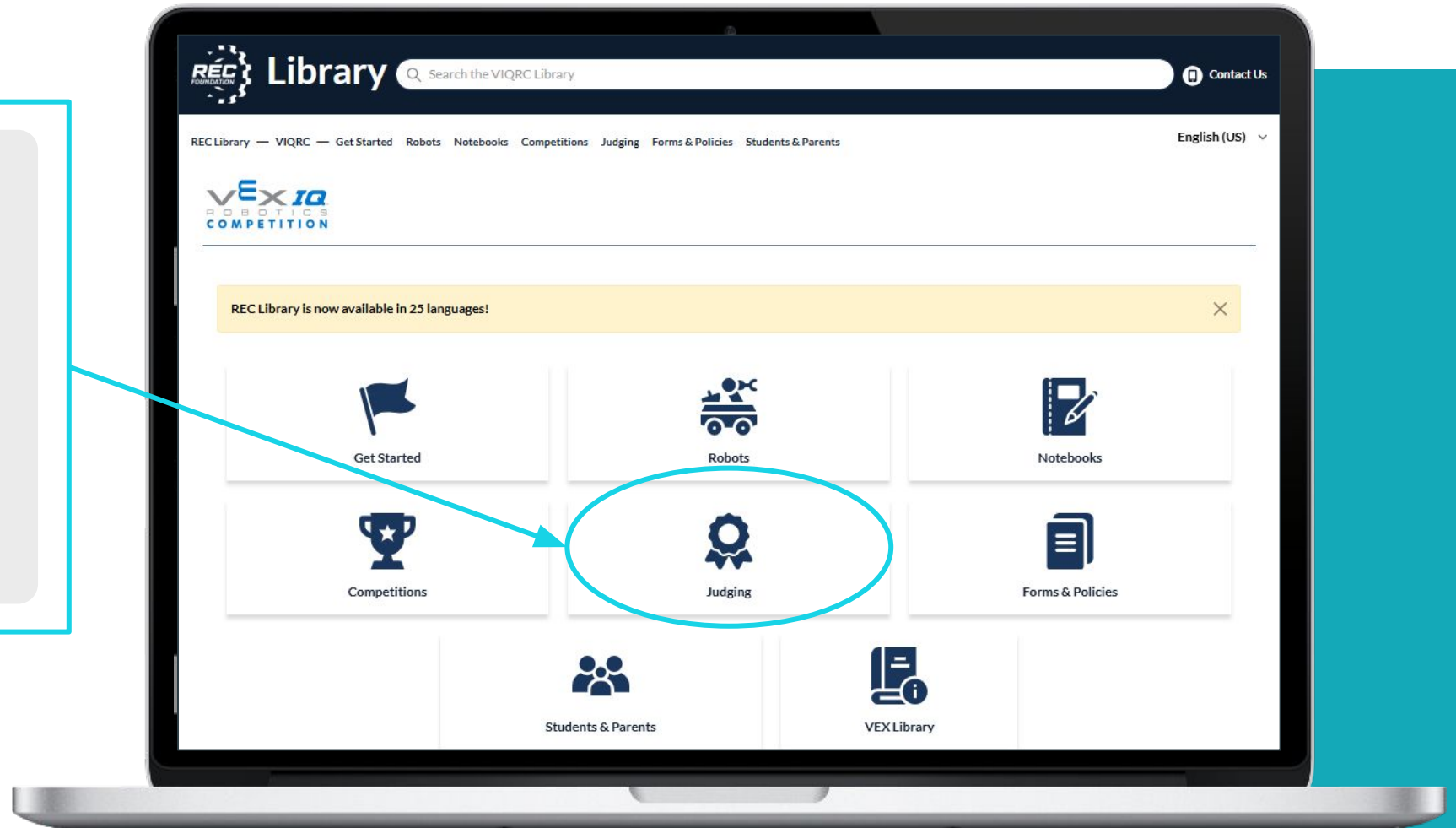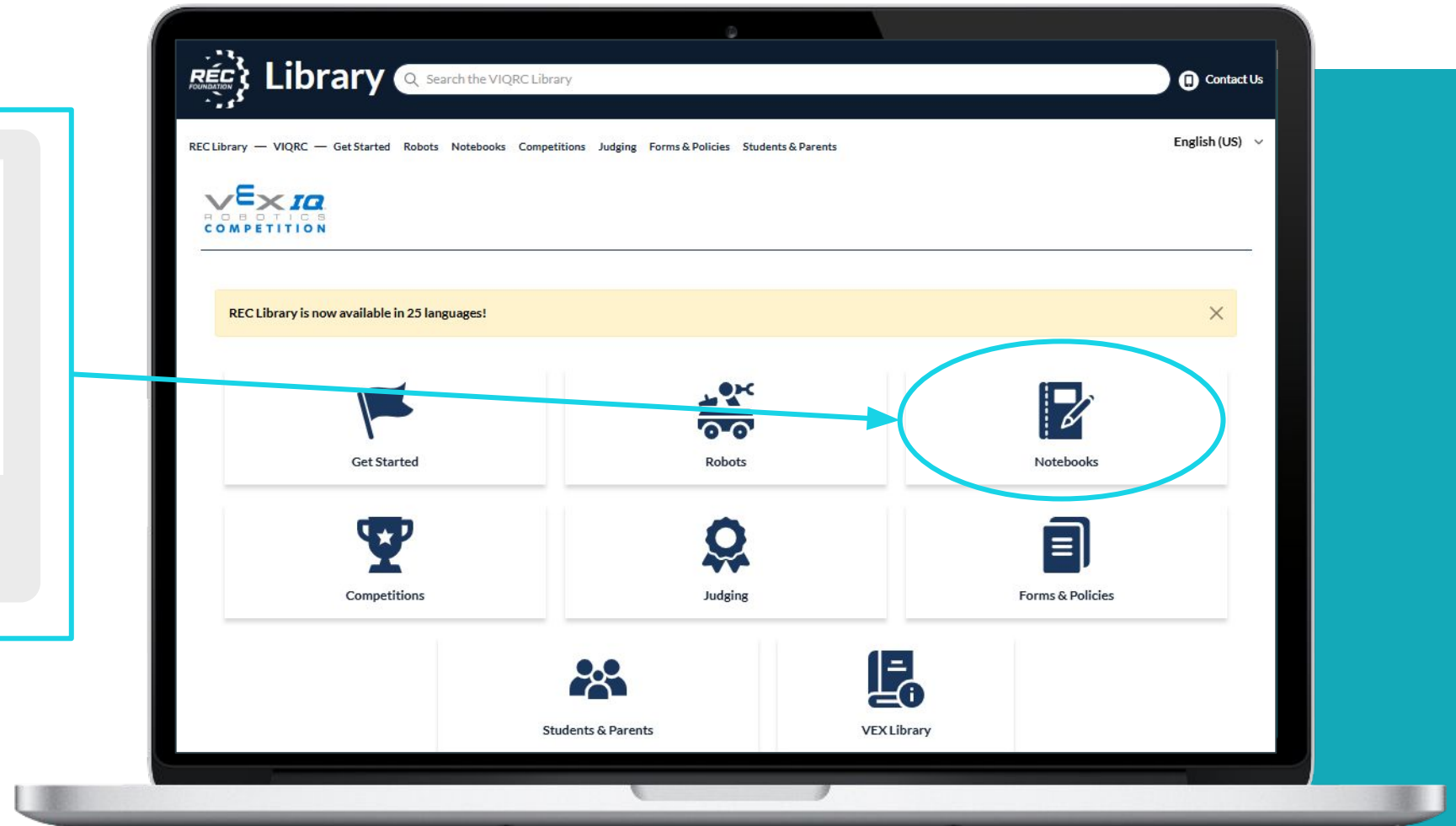
SCAN ME!

Start Here: The Guide to Judging

More Notebooking Resources

SCAN ME!

Download a PDF of the Guide

SCAN ME!

Library   Search the REC Library   Contact Us

English (US) ⌄

Volunteers

REC Library / Volunteers

Get Started   Volunteer Coordinator   Check-in   Queuing & Practice Fields   Inspection   TM Operator   Emcee   **Judging**   Referee   Field Reset

- **Get Started**
  - Judge Advisor Certification / Judge Training Courses
  - Judge Advisor Role Overview
  - Judge Volunteer Role Overview

- **Judging Processes: The Guide to Judging**
  - Guide to Judging: Introduction and Terms
  - Guide to Judging: Judging Principles
  - Guide to Judging: Judging Roles
  - Guide to Judging: Event Preparation and Execution
  - Guide to Judging: Awards
  - Guide to Judging: Judging Engineering Notebooks
  - Guide to Judging: Team Interviews
  - Guide to Judging: Award Deliberations
  - Guide to Judging: Remote Judging
  - Guide to Judging: Judged Awards Appendix

- **Judging Resources**
  - Printable PDF version of the Guide to Judging
  - Code of Conduct
  - Student-Centered Policy
  - Judging Resource: Judge Volunteer Check-In Sheet

Table of Contents

- Get Started
- Judging Processes: The Guide to Judging
- Judging Resources

Key Takeaways

Help your students "buy into" why a notebook is important:

- ❏ History
- ❏ Workforce Skills
- ❏ Judged Awards
- ❏ Reference

Help your students choose the notebook format that is right for them:

- ❏ Physical Notebook
- ❏ Digital Notebook

Help your students analyze the Engineering Notebook Rubric to help in documentation:

- ❏ Engineering Design Process and Additional Criteria

Help your students understand Notebook Purpose and Academic Honesty:

- ❏ Student Centered Learning
- ❏ Innovation

Engineering Notebooking is a Process. Every Team Is Different. Ask Questions!

Contact

We are here for you

Event Partners, Coaches, and Volunteers are the core of our Programs here at the REC Foundation. Please reach out to us with any questions or concerns. Thank you for all of your support.

Address

1519 Interstate 30 West

Greenville, Texas 75402

Phone & Email

903 401 8088

support@recf.org

Resources

ROBOTICS EDUCATION & COMPETITION FOUNDATION

SUMMIT

VEX ROBOTICS PROGRAMS