

# Engineering Notebook

Best Practices for All

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ROBOTICS EDUCATION &  
COMPETITION FOUNDATION

**SUMMIT**

VEX ROBOTICS PROGRAMS



# 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.**

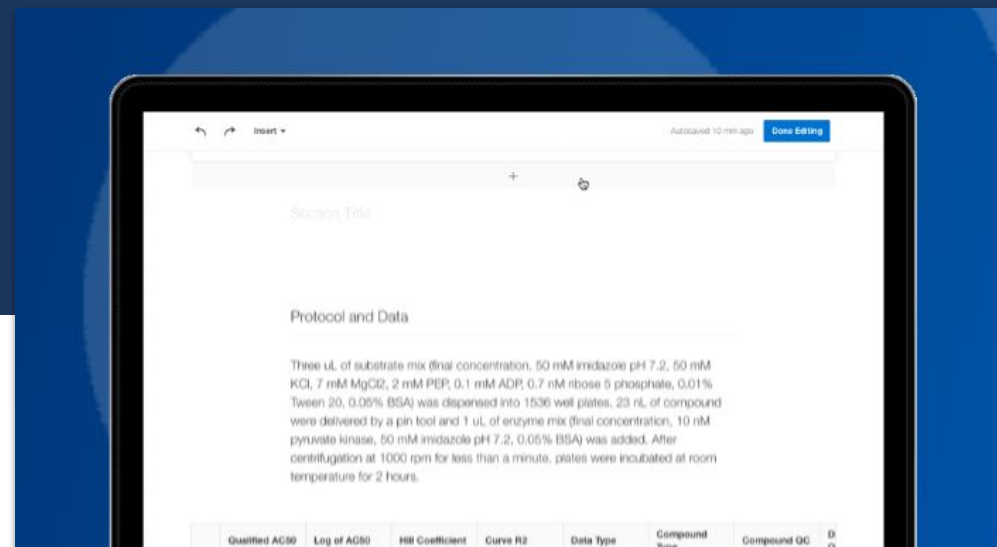


# Engineering Notebook History

*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



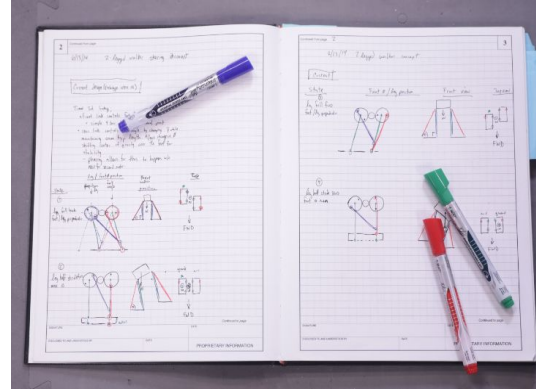
Opportunity to practice written communication skills



Learn how to properly credit outside sources

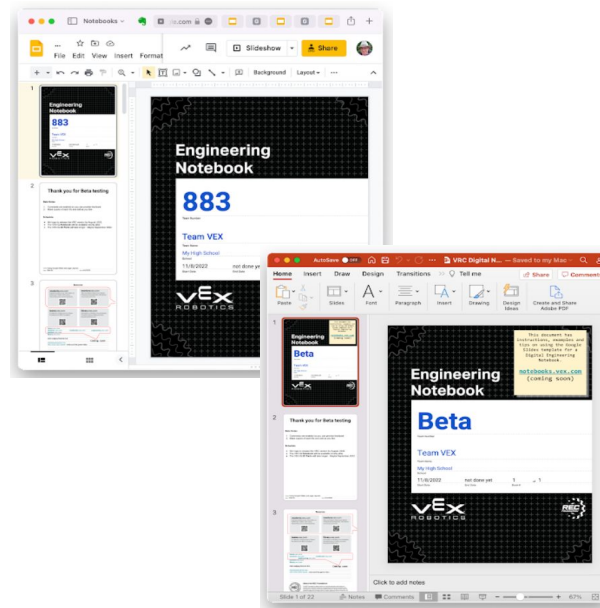


# Engineering Notebook Format



## 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**

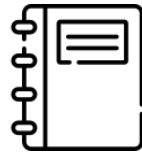
> **Amaze Award**

> **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

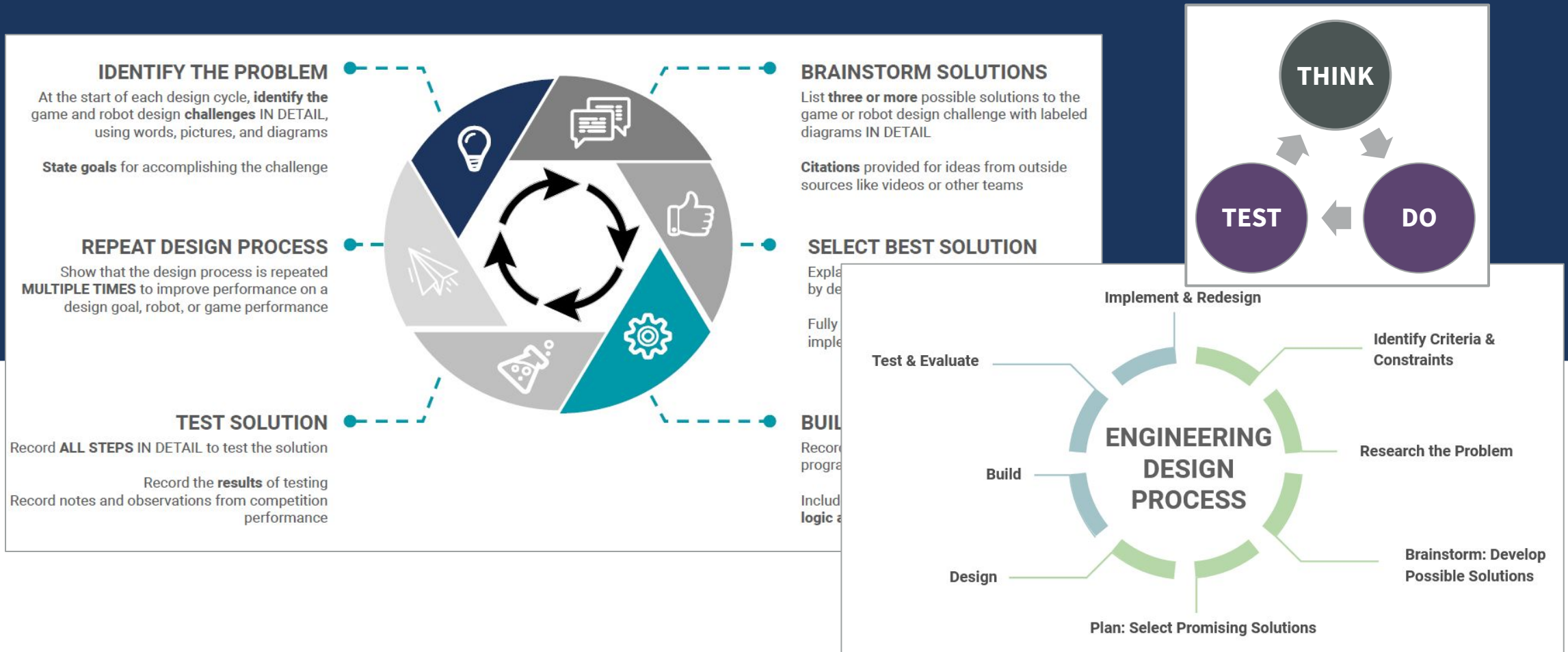


Notebook content should support the team interview, the rubrics, and the award criteria.



# 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!



# 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

Engineering Notebook Rubric (Page 1 of 2)

Team # \_\_\_\_\_ Grade Level □ ES □ MS □ HS □ University Judge Name \_\_\_\_\_

**Directions:** Determine the point value that best characterizes the content of the Engineering Notebook for that criterion. Write that value in the column to the right. This rubric is to be used for all Engineering Notebooks regardless of format (physical or digital). Please refer to Section 5 of the Guide to Judging for information on how to use this rubric.

**Note:** Any student-centered or academic honesty concerns, such as plagiarism, should be brought to the attention of the Judge Advisor and/or Event Partner.

CRITERIA	PROFICIENCY LEVEL			POINTS
	EXPERT (4-5 POINTS)	PROFICIENT (2-3 POINTS)	EMERGING (0-1 POINTS)	
<b>ENGINEERING DESIGN PROCESS</b>				
<b>IDENTIFY THE PROBLEM / DESIGN GOALS</b>	Clearly <u>identifies</u> the problem / design goal(s) <u>is</u> stated at the start of each design process cycle. This can include elements of game strategy, robot design, or programming, and should include a clear definition and justification of the design goals, criteria, and constraints.	Identifies the problem / design goal(s) at the start of each design cycle but is <u>lacking</u> details of justification.	<u>Does not identify</u> the problem / design goal(s) at the start of each design cycle.	
<b>BRAINSTORM SOLUTIONS</b>	Explores <u>several different solutions</u> , with explanation. Criteria are provided for ideas that came from outside sources such as online videos or other teams.	Explores <u>few solutions</u> . Criteria are provided for ideas that came from outside sources.	<u>Does not explore different solutions</u> or solutions are recorded with <u>little justification</u> .	
<b>SELECT BEST SOLUTION</b>	Fully <u>explains the "why"</u> behind design decisions in a clear state of design process for an <u>significant amount</u> of a team's design.	<u>Incompletely explains</u> the "why" behind design decisions.	<u>Minimally explains</u> the "why" behind design decisions.	
<b>BUILD AND PROGRAM THE SOLUTION</b>	Records the steps the team took to build and program the solution. Includes <u>specific details</u> that <u>describe</u> the solution, such as how the team <u>built</u> or <u>programmed</u> the solution, as well as <u>explanation</u> of the robot's design.	Records the key steps to build and program the solution but <u>lacks sufficient detail</u> to describe the solution.	<u>Does not record the key steps</u> to build and program the solution.	
<b>ORIGINAL TESTING OF SOLUTIONS</b>	<u>Records all the steps</u> to test the solution, including test results, testing methodology is clearly explained, and the testing is <u>documented</u> . Logical, complete conclusions are drawn from that data.	<u>Records the key steps</u> to test the solution. Testing methodology may be incomplete. Logical conclusions are recorded.	<u>Does not record steps</u> to test the solution. Testing or results are borrowed from another team's work.	
<b>REPEAT DESIGN PROCESS</b>	Shows that the <u>design process is repeated</u> . Includes steps to work towards a design goal. This includes a clear definition and justification of the design goals, the criteria, and constraints. The team's design process is <u>documented</u> .	Design process is <u>not fully repeated</u> for design goals or objectives. The team's design process is <u>not fully documented</u> .	<u>Does not show that the design process is repeated</u> .	
<b>NOTES:</b>				

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Engineering Notebook Rubric (Page 2 of 2)

ENGINEERING NOTEBOOK FORMAT AND CONTENT	EXPERT (4-5 POINTS)	PROFICIENT (2-3 POINTS)	EMERGING (0-1 POINTS)	POINTS
<b>INDEPENDENT INQUIRY</b>	Team shows evidence of independent inquiry <u>into the topic</u> of their design. Includes <u>documentation</u> of the team's process, ideas and information from outside the team are documented.	Team shows evidence of independent inquiry for <u>some</u> of their design process. Ideas and information from outside the team are documented.	Team shows <u>little to no evidence</u> of independent inquiry in their design process. Ideas and information from outside the team are not properly credited. Ideas or designs appear with no evidence of process.	
<b>USABILITY &amp; COMPLETENESS</b>	<u>Records the entire design and development process</u> with enough clarity and detail that the reader could recreate the project's history. Notebook has recent entries that align with the robot the team has brought to the event.	Records the design and development process <u>completing but lacks sufficient detail</u> . Documentation is inconsistent with possible gaps.	<u>Lacks sufficient detail</u> to understand the design process. Notebook has large gaps in time, or does not align with the robot the team has brought to the event.	
<b>ORIGINALITY &amp; QUALITY</b>	Content is kept to relevant information and is <u>not</u> content longer than a paragraph in length. Information originating from outside sources is <u>appropriately</u> documented with the source and date accounted. <u>Most</u> of all, Engineering Notebook content is <u>relevant</u> to the team's design process.	Content is <u>mostly</u> <u>relevant</u> to the team's design process. Information originating from outside sources is <u>partially</u> documented with the source and date accounted. Content is <u>partially</u> relevant to the team's design process.	Content is <u>mostly</u> <u>irrelevant</u> to the team's design process. Information originating from outside sources is <u>not</u> documented. Content is <u>not</u> relevant to the team's design process.	
<b>ORGANIZATION / READABILITY</b>	Entries are <u>logged</u> in a table of contents. There is an overall organization to the document that makes it easy to reference, such as color coded entries, tabs for key sections, or other markers. <u>Most</u> of all, Engineering Notebook content is <u>relevant</u> to the team's design process.	Entries are <u>logged</u> in a table of contents. There is some organization to the document to enhance readability. <u>Most</u> of all, Engineering Notebook content is <u>relevant</u> to the team's design process.	Entries are <u>not</u> logged in a table of contents, and there is little adherence to a system of organization. <u>Most</u> of all, Engineering Notebook content is <u>not</u> relevant to the team's design process.	
<b>RECORD OF TEAM AND PROJECT MANAGEMENT</b>	Provides a <u>clear record</u> of team and project management, including time and materials are noted throughout. Notebook has evidence that documentation was done in sequence with the design process. Entries include dates and names of contributing students.	Provides a <u>partial record</u> of team and project management, including time and materials are noted throughout. Notebook has evidence that documentation was done in sequence with the design process. Entries include dates and names of contributing students.	<u>Does not record the design process</u> or team and project management. Entries are <u>not</u> relevant to the team's design process.	
<b>INNOVATE AWARD NOTES (optional):</b>				

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# Rubric Criteria for the Engineering Design Process

## Identify the Problem

- What is the game challenge?
- What are the goals?

## Brainstorm Solutions

- List solutions
- Provide citations if inspired by outside ideas

## Select Best Solution

- Explains why solution is chosen in each step for all aspects of design

## Build and Program the Solution

- Records the steps
- Provides detailed information that reader can follow

## Original Testing of Solution

- Records steps to test
- Includes original test results done by the team

## Repeat Design Process

- Design Process is repeated multiple times

## Additional Rubric Criteria

### Independent Inquiry

- Where do the ideas originate?

### Usability and Completeness

- Well-recorded design and development process

### Originality and Quality

- Cited content is kept to relevant information
- Most or all content is original to the submitting team members

### Organization / Readability

- Organization of the document makes it easy to reference
- No extraneous content that does not further the engineering design process

### Record of Team and Project Management

- 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

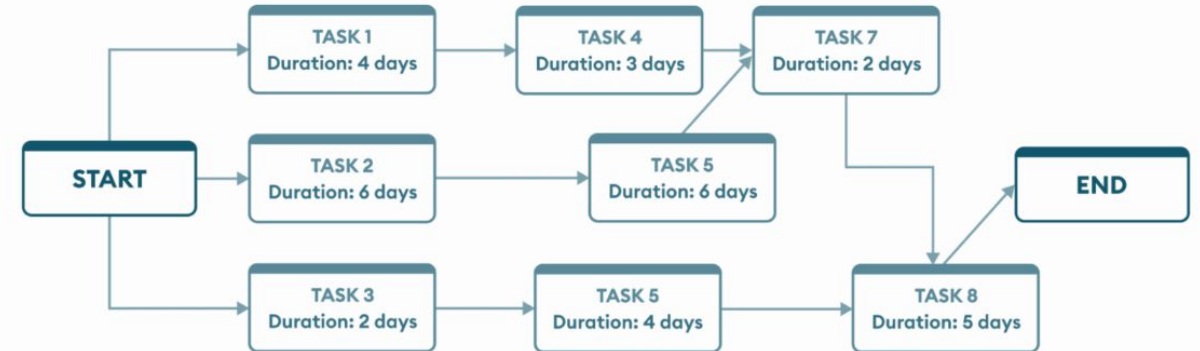
Timelines and planning can be in the style of Gantt or PERT charts, but teams can choose other ways to show their project timeline

## 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.





# 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:

Page	Project	Date
pg. 1-3	The Game: Change Up (rules, scoring, field diagram)	4/27-28/20
pg. 4-5	Analyzing Change Up (game and robot design challenges and strategy)	4/28-29/20
pg. 6	Design Checklist: Constraints, Requirements, Preferences	4/30/20
pg. 7	Goals for Change Up	4/30/20
pg. 8-10	Drivetrain Options / Possible solutions	5/4-5/20
pg. 11	Selected Drivetrain / Decision Matrix	5/4-5/20
pg. 12-13	Brainstorming and Research	5/6-8/20
pg. 14-16	Intake Design Options / Possible solutions	5/11-15/20
pg. 17	Selected Intake Design / Decision Matrix	5/11-15/20
pg. 18-25	Lift and Handling Design Options / Possible solutions	5/18 - 6/3/20
pg. 26	Selected Lift and Handling Design / Decision Matrix	6/4/20
pg. 27-32	Prototyping: Base layout, flippers, trapdoor/hoarding, bat / scoring	6/8-6/25/20
pg. 33	Design Plan: Implementing my solutions to Change Up	6/26/20
pg. 34	Updated Skills field layout and goals	6/27/20
pg. 35	Timeline: until the first competition	6/27/20
pg. 36-37	Building the Base Structure	6/28-29/20
pg. 38-39	Building the Drivetrain	6/29-30/20
pg. 40-41	Building and Testing the Conveyor	7/1-2/20
pg. 42	Building: Adding Polycarbonate	7/3-5/20
pg. 43-45	Building the Flippers	7/6-8/20
pg. 46-48	Design Cycle: Problem and Solutions for mounting the Flipper	7/8-9/20
pg. 49	Building: Adding Bumpers	7/11/20
pg. 50	Building the Conveyor Backing Supports	7/12-14/20
pg. 51-54	Design Cycle: Bat Spacing Problem	7/20-23/20
pg. 55	Improving the Hood and Dunker	7/29-31/20
pg. 56	Improving the Conveyor Backing	8/3-5/20
pg. 57	Improving the Visor and Zippers	8/8-10/20
pg. 58-60	Design Cycle: Visor Jolting Problem	8/8-17/20
pg. 61-62	Minor Hood and Visor Improvements	8/19-22/20
pg. 62-63	Timeline: New schedule and deadlines	8/23/20
pg. 64	Flipper Add-ons and Problems	8/29-30/20
pg. 65-66	Prototyping Intake Rollers	9/5-19/20
pg. 67-70	Intake Rollers: Building, Testing, Improving	9/19-20/20
pg. 70-74	Sensors and other Improvements: Limit switch, license plates, ball guides, support bars, optical sensor	9/26 - 10/3/20

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
- **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
- **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
- **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

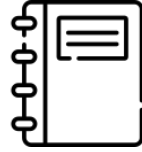
The Engineering Notebook is an original work written and organized by the team, describing the Engineering Design Process over the course of the season



## 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

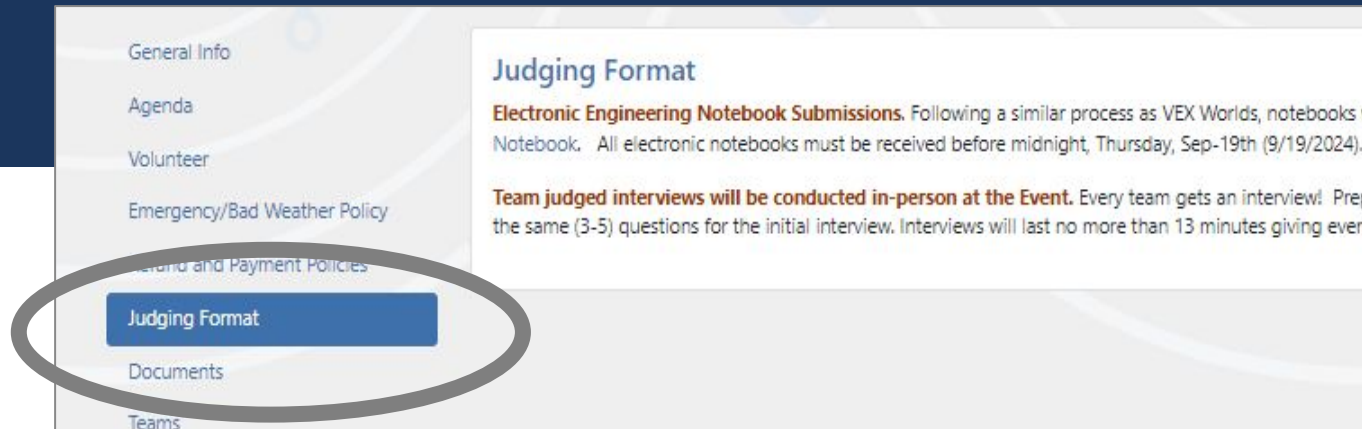


# Engineering Notebook Submission

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.

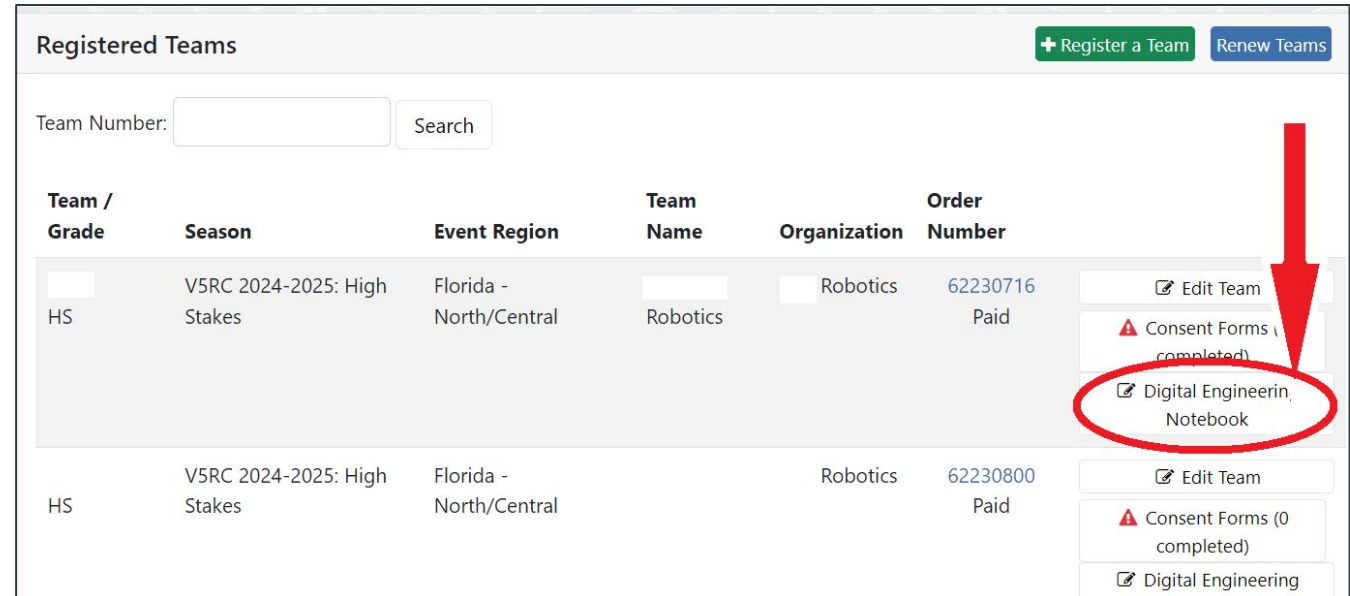


Digital notebooks must be printed for events requesting physical notebooks. Physical notebooks must be digitized for events requesting digital notebooks.

# Submit the Notebook

Upload a **Link** to your team's notebook in [RobotEvents.com](https://RobotEvents.com)

1. Log in to [RobotEvents.com](https://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

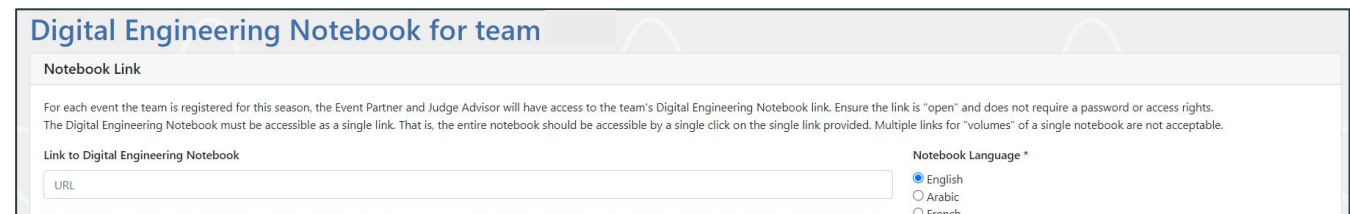


Registered Teams

[+ Register a Team](#) [Renew Teams](#)

Team Number:

Team / Grade	Season	Event Region	Team Name	Organization	Order Number	
HS	V5RC 2024-2025: High Stakes	Florida - North/Central	Robotics	Robotics	62230716 Paid	<a href="#">Edit Team</a> <a href="#">Consent Forms (0 completed)</a> <a href="#">Digital Engineering Notebook</a>
HS	V5RC 2024-2025: High Stakes	Florida - North/Central		Robotics	62230800 Paid	<a href="#">Edit Team</a> <a href="#">Consent Forms (0 completed)</a> <a href="#">Digital Engineering</a>



Digital Engineering Notebook for team

Notebook Link

For each event the team is registered for this season, the Event Partner and Judge Advisor will have access to the team's Digital Engineering Notebook link. Ensure the link is "open" and does not require a password or access rights. The Digital Engineering Notebook must be accessible as a single link. That is, the entire notebook should be accessible by a single click on the single link provided. Multiple links for "volumes" of a single notebook are not acceptable.

Link to Digital Engineering Notebook

URL

Notebook Language \*

☒ English  
☐ Arabic  
☐ French

# 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

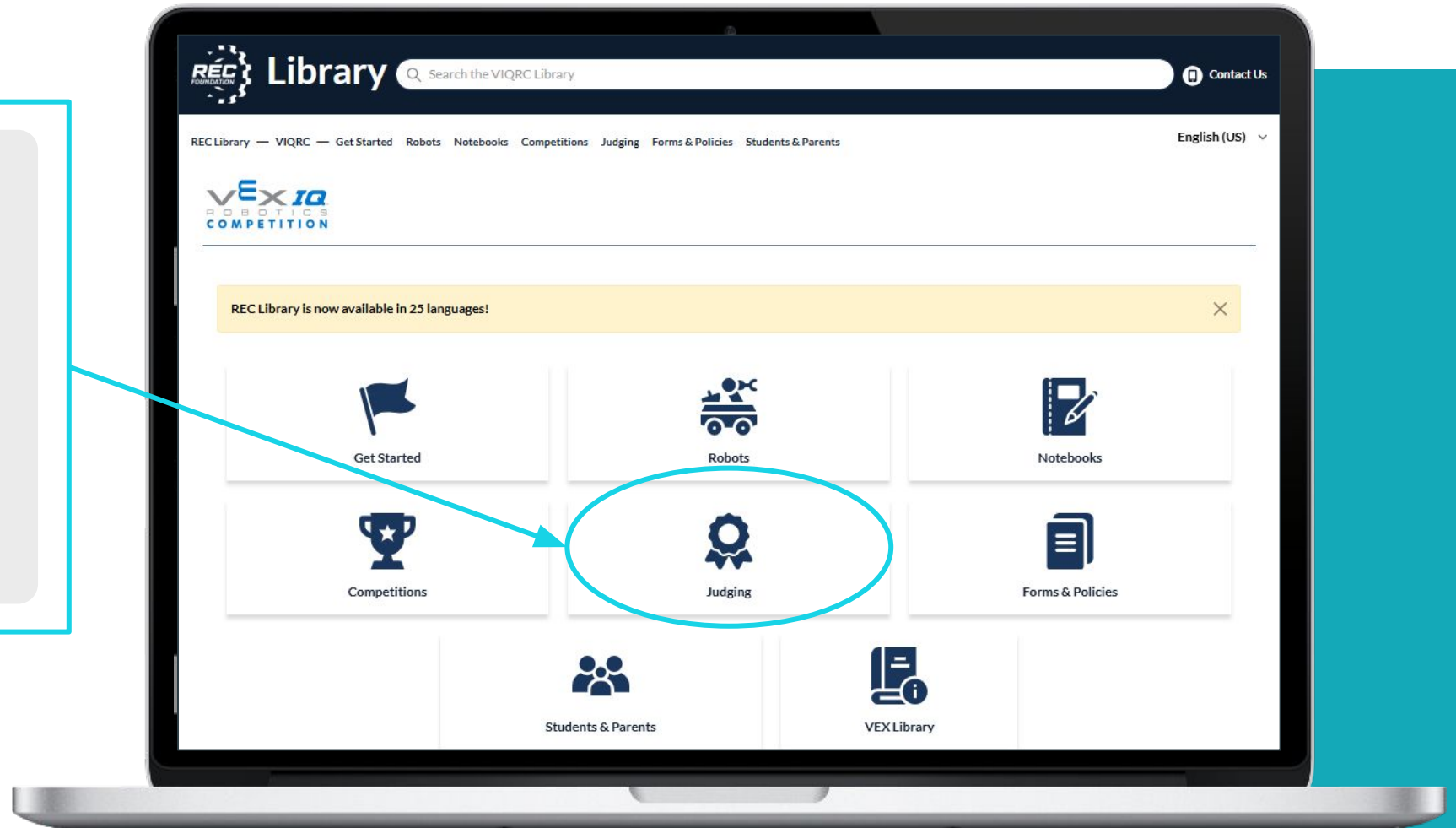


**SCAN ME!**

# Start Here: The Guide to Judging



**SCAN ME!**

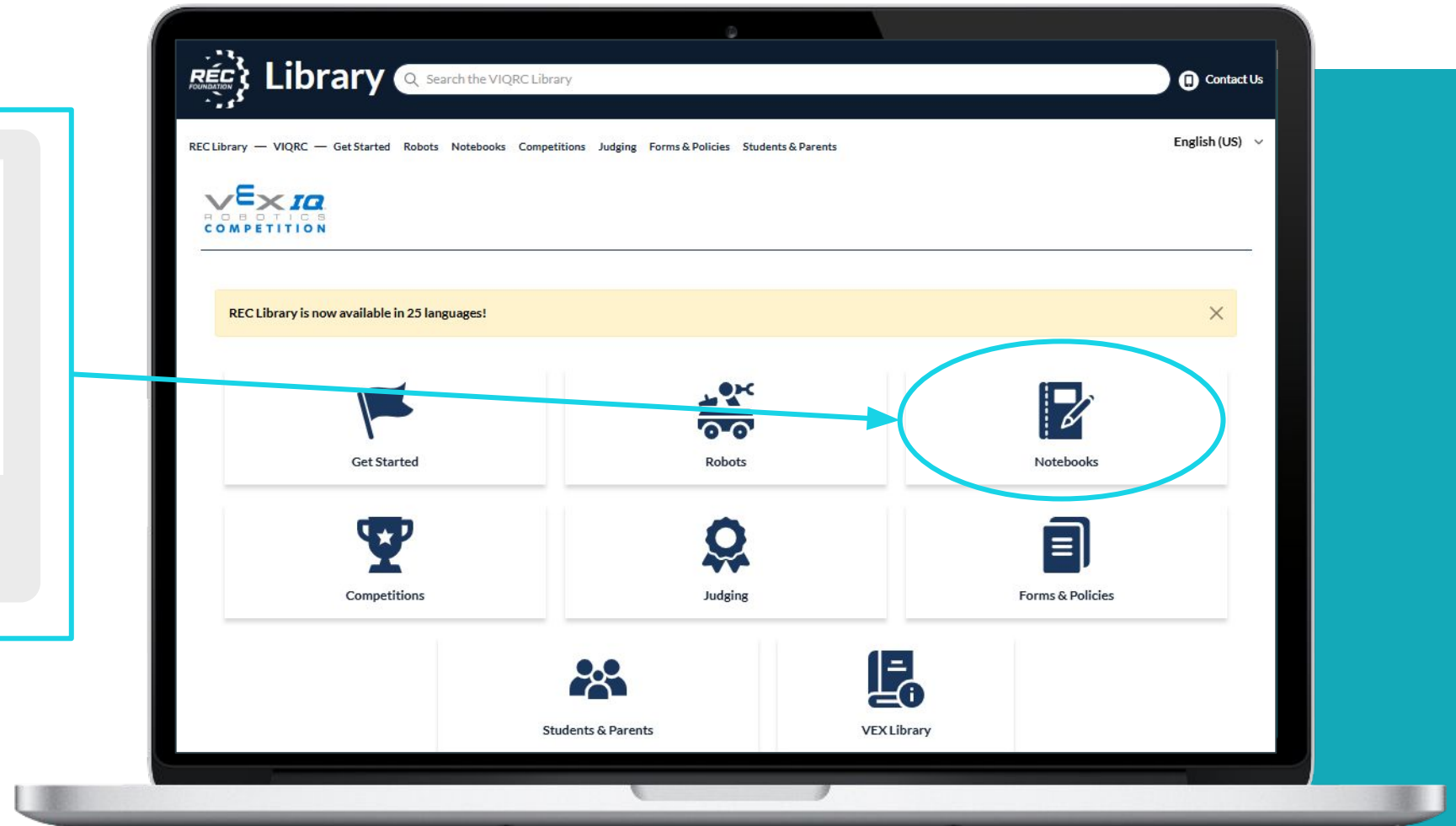




# More Notebooking Resources



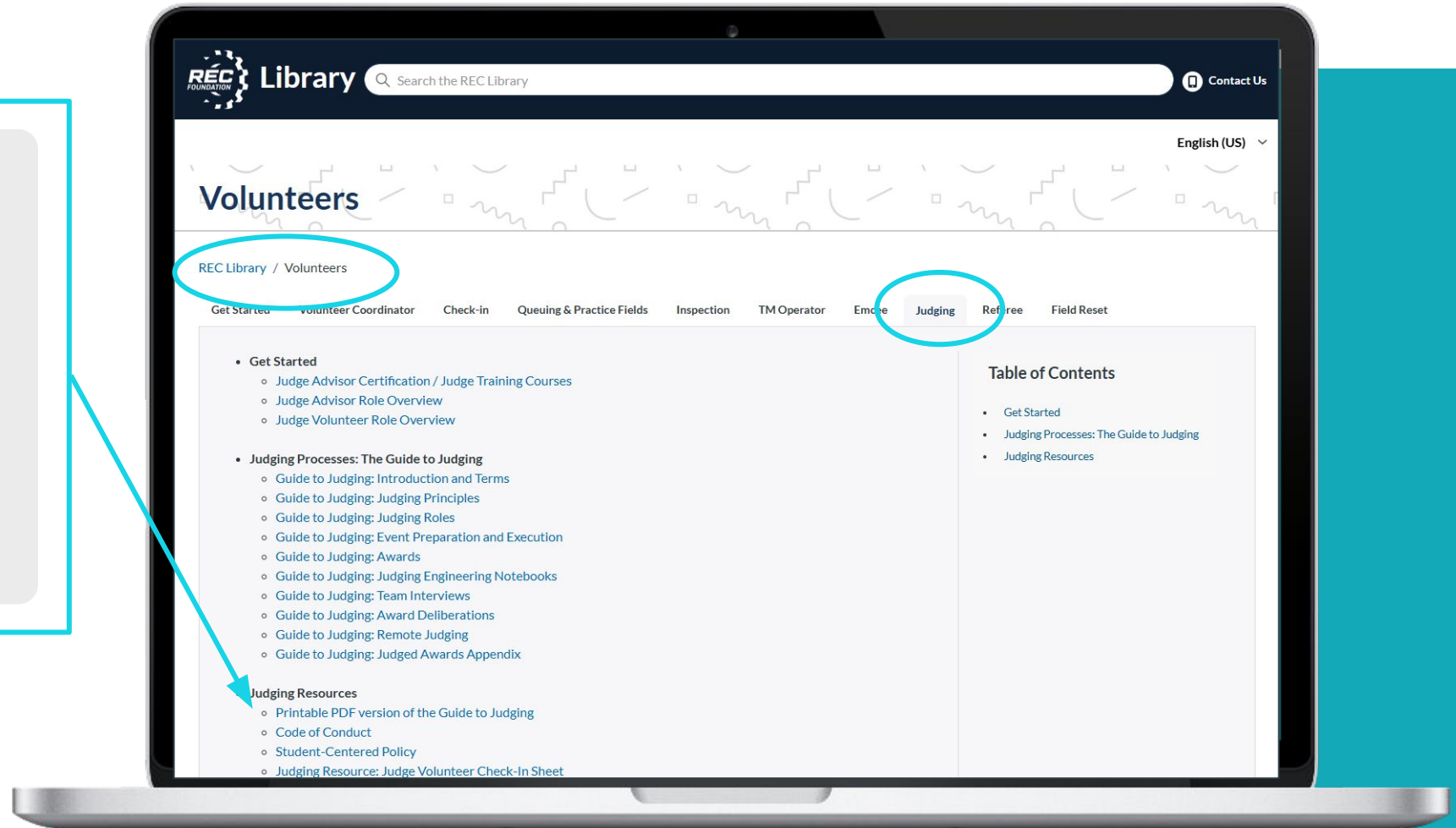
**SCAN ME!**



# Download a PDF of the Guide



**SCAN ME!**





# 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.

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[Resources](#)



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