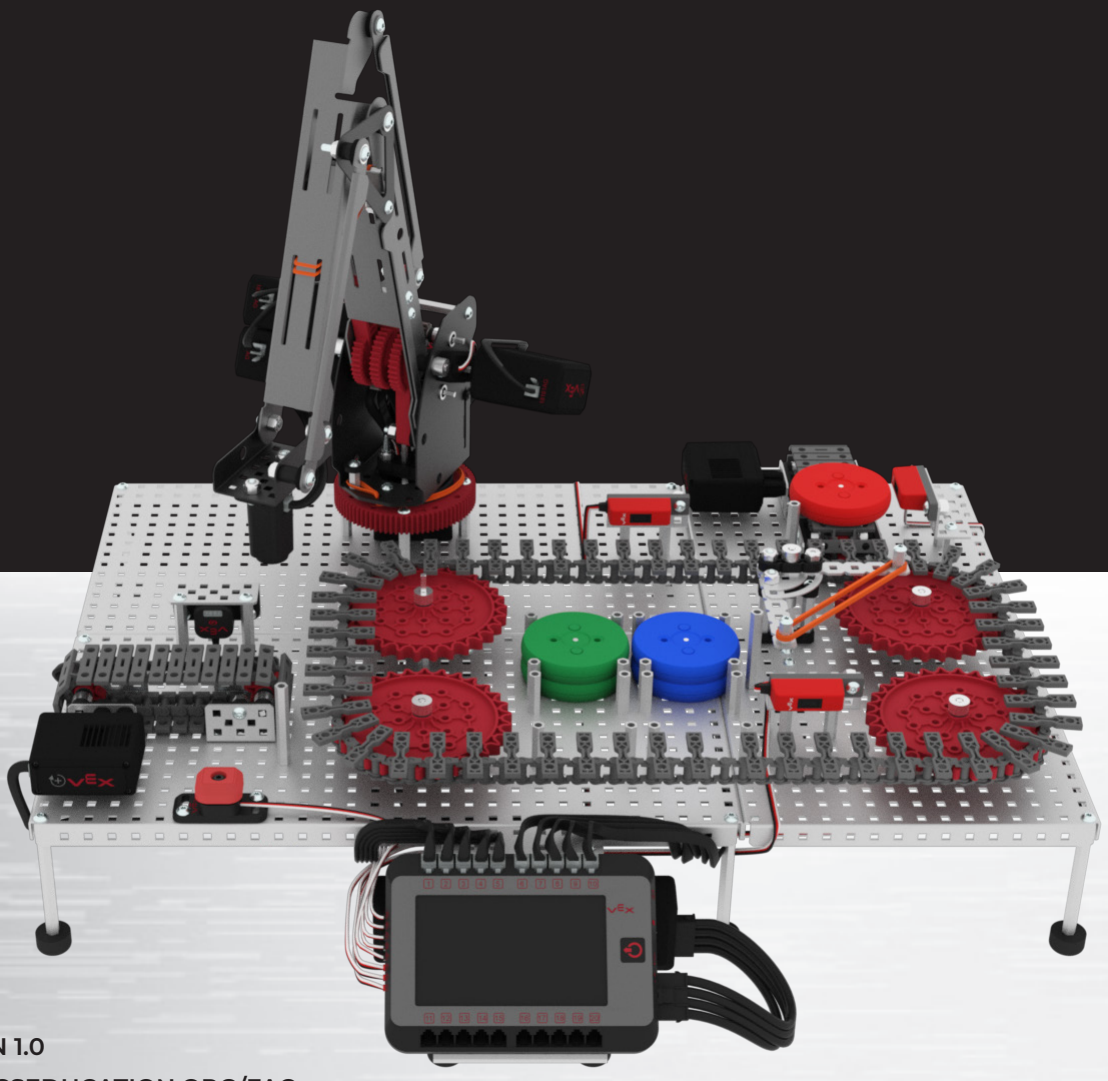
REC FOUNDATION

VEX FACTORY AUTOMATION COMPETITION

PACK AND SHIP

GAME MANUAL 2023 2024



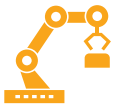
VERSION 1.0

ROBOTICSEDUCATION.ORG/FAC

INTRODUCTION

FACTORY AUTOMATION COMPETITION

There has never been a higher demand for advanced manufacturing and STEM-related jobs, with an estimated 2.5 million STEM jobs going unfilled today.



Manufacturing

STEM Principles

Communication

Teamwork

The focus of this program is to offer a comprehensive and scalable competition that helps change attitudes toward advanced manufacturing careers, bestow critical workforce skills, reduce the growing skills gap, and ultimately create a stable pipeline of industry 4.0 employees.

The Robotics Education & Competition Foundation's 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. The Factory Automation Competition is a classroom-based competition that provides students from across the world the opportunity to integrate and recognize how STEM skills translate to the workforce. This unique manufacturing competition exposes students to robotics manufacturing careers while providing curriculum, training, and hands-on problem-solving skills. The REC Foundation aims to improve workforce education and interest by providing a clear path for students to prepare for advanced manufacturing careers, help close manufacturing skills gaps for many employers, and prepare the future manufacturing workforce for continual development.

TABLE OF CONTENTS

02 OVERVIEW

04 SECTION ONE

04 THE GAME

05 GAME DEFINITIONS

07 COMPETITION PHASES

08 SCORING

09 RULES

10 SECTION TWO

10 THE WORKCELL

12 SECTION THREE

12 HOW TO COMPETE

12 GLOBAL COMPETITION

12 HOW TO REGISTER

12 GLOBAL RANKINGS

13 VIDEO PARAMETERS

THE GAME

SECTION 1

PACK AND SHIP

OVERVIEW

This section describes the 2023-2024 Factory Automation Competition game, Pack and Ship. It also lists the game definitions and game rules.

GAME DESCRIPTION

The Factory Automation Competition game, Pack and Ship, is a classroom-based competition where teams will compete to achieve the best Throughput and Run Time at different Competition Phases. Students design, build, and program a manufacturing Workcell to complete the Competition Phase. Participants submit a video of a Production Run to Robotevents.com, and their scores are recorded on a global leaderboard.

Teams from across the world will compete from their classroom to achieve the highest global rank based on their scores at each Competition Phase.

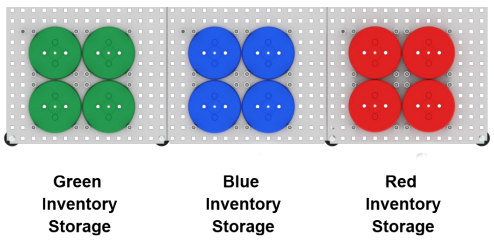
FAC PACK AND SHIP GAME CONSISTS OF THE FOLLOWING GAME OBJECTS:

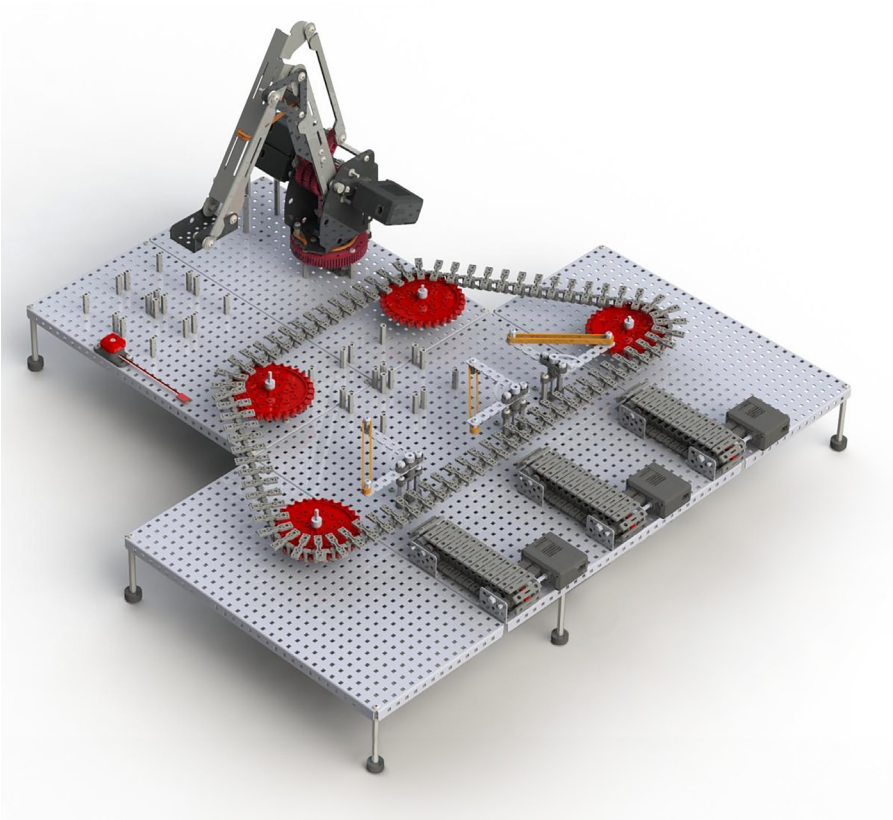
30 Products

- 10 Red Products
- 10 Green Products
- 10 Blue Products

3 Inventory Storage

- 1 Red Inventory Storage
- 1 Green Inventory Storage
- 1 Blue Inventory Storage





GAME DEFINITIONS

Adult - Anyone who is not a Student.

Auto Shipped - An Order is Auto Shipped if it is moved from the Packing Zone off of the Workcell without the assistance from any team members.

Builder - The Student(s) on the Team who assemble(s) the Workcell. An Adult cannot be the Builder on a Team. Adults can teach the Builder-associated concepts but may never work on the Workcell without the student Builder present and actively participating.

Competition Phase - Specific goals or tasks required to be completed in order to advance to the next Competition Phase.

Completed Order - An Order is considered completed once all four products within the order are compiled together within the Packing Zone.

Designer - The Student(s) on the Team who design(s) the Workcell to be built for competition. An Adult cannot be the Designer on a Team. Adults are permitted to teach the Designer associated concepts, but may never be working on the design of the Workcell without the student Designer present and actively participating.

Emergency Stop (E-Stop) - A simple, highly visible button designed to shut down the entire Workcell once pressed. This must be done using a V5 Bumper switch and accessible at all times. Teams must demonstrate that the Emergency Stop Button works in a Production Run submission.

Home Baseplate - The V5 Brain and the team's ID plate are required to be mounted to a VEX Robotics 15 x 30 Base Plate (276-1341).

Inventory Storage - One of three initial starting locations for Products. Inventory Storage should be sorted by color to start; one (1) Red, one (1) Green, and one (1) Blue.

Mishandled Product - Any dropped Product.

Products may be dropped from the robot, by humans, or while moving through a Production Run.

Order - A collection of four (4) specific Products that need to be gathered and placed in the Packing Zone.

Contents of each Order will be listed on the selected Order Card.

Order Card - A card listing the four (4) Products required for the selected Order.

Order Cards can be found here.

Order Card(s) will be randomly selected by the team prior to the Production Run.

GAME DEFINITIONS (CONTINUED)

Packing Zone - The area on the Workcell where each Order must be compiled and prepared to be Shipped.

Product - Thin and cylindrical shaped game objects with a diameter of 63.2mm x 12.45mm tall and in three (3) different colors: Red, Green, and Blue.

Production Run - A Production Run consists of an attempt to complete a Competition Phase in a maximum time of three minutes and thirty seconds (3:30).

Programmer - The Student(s) on the Team who write(s) the computer code that is downloaded onto the Workcell. An Adult cannot be the Programmer on a Team. Adults are permitted to teach the Programmer associated concepts, but may never be working on the code that goes on the Workcell without the student Programmer present and actively participating.

Run Time - The amount of time it takes to complete a Competition Phase.

Shipped - An Order is Shipped if it is moved from the Packing Zone off of the Workcell.

Team - One or more Students make up a Team. A Team is classified as a high school Team if any of its members are High School Students or made up of Middle School Students who declare themselves "playing up" as High School Students by registering their team as a High School Team. A Team is classified as a College Team if any of the members are College Students. Teams may be associated with schools, community/youth organizations, or a group of neighborhood Students.

Team ID Plates - The Team ID Plate is included in the VEX V5 Workcell Kit. This allows team to display their team number in video submissions.

Throughput - The number of Orders successfully completed in a Production Run.

V5 Robot Arm - Type of programmable mechanical arm used in the Factory Automation Competition(276-7151).

Workcell - A collection of VEX Robotics 15 x 30 Base Plates (276-1341) with the V5 Brain, Products, Robotic Arm(s), and any supporting material attached.

COMPETITION PHASES

Competition Phase 1

- Enter one (1) Order into the Workcell
  - Contents of Order will be randomized for the Production Run
- Order will consist of four (4) Products
  - Assemble all contents of the Order in the Packing Zone

Competition Phase 2

- Enter two (2) Orders into the Workcell
  - Contents of Orders will be randomized for the Production Run
  - Order will consist of four (4) Products
  - Assemble all contents of the Order in the Packing Zone
- All Orders must be Shipped
  - First Order must be Shipped before second Order can be fulfilled
  - Second Order must be Shipped before Production Run can be completed

Competition Phase 3

- Enter three (3) Orders into the Workcell
  - Contents of Orders will be randomized for the Production Run
  - Order will consist of four (4) Products
  - Assemble all contents of the Order in the Packing Zone
- All Shipping must be automated
  - First Order must be Auto Shipped before second Order can be fulfilled
  - Second Order must be Auto Shipped before third Order can be fulfilled
  - Third Order must be Auto Shipped before Production Run can be completed

SCORING

COMPETITION PHASES

THROUGHPUT

1. Teams receive ten (10) points per Product properly placed in an order.

2. Teams receive five (5) points for each Completed Order.

3. Teams are penalized one (1) point for each mishandled Product.

4. Teams receive five (5) points for one (1) properly shipped order.

5. **Teams receive ten (10) bonus points for automated shipping.**

RUN TIME

1. Teams receive ten (10) points for completing a production run in under five (5) minutes.

2. Teams receive twenty (20) points for completing a production run in under three (3) minutes.

3. Teams receive thirty (30) points for completing a production run in under two (2) minutes.

* All times are rounded up to the closest second.

Competition Phase 1

Compile and pack an order

- Each Product that is correctly placed in an order is worth ten (10) points.
- Each completed order that moves through the packing zone is worth five (5) points.
- Each mishandled product will negate one (1) point.

Competition Phase 2

Compile, pack, and ship two orders

- Each Product that is correctly placed in an order is worth ten (10) points.
- Each completed order that moves through the packing zone is worth five (5) points.
- Each shipped order is worth five (5) points.
- Bonus points are given for automated shipping.
- Each mishandled product will negate one (1) point.

Competition Phase 3

Compile, pack, and ship three orders

- Each Product that is correctly placed in an order is worth ten (10) points.
- Each completed order that moves through the packing zone is worth five (5) points.
- Each shipped order is worth five (5) points.
- Each mishandled product will negate one (1) point.

SAFETY RULES

S1: Each Workcell must contain a functioning Emergency Stop Button.

S2: Students must keep their hands outside the Workcell while the Workcell is running.

S3: It is highly recommended that all Team members wear safety glasses while working on the Workcell.

S4: Before attempting a Production Run, do a visual safety inspection to prevent damage to operators and equipment.

S5: Always power off the Workcell before making any adjustments.

GAME RULES

G1: At the start of a Production Run, all Products must start in the correct Inventory Storage area.

G2: Any Mishandled Product must remain where it is dropped until the end of the Production Run unless an error occurs and the E-stop is enabled.

G3: If an error occurs during a Production Run, students may use the E-stop to disable the Workcell and fix the error. Once the error is fixed, the Workcell may start up again. Any Product that students interact with must go back into Inventory Storage before starting the Workcell again.

WORKCELL RULES

SECTION 2

<W1> Workcells are built from the VEX V5 system - Workcells may be built ONLY using official VEX V5 components, unless otherwise specifically noted within these rules.

Products from the VEXpro, VEX IQ, or VEX Robotics by HEXBUG* product line cannot be used for construction unless cross-listed as part of the VEX V5 system. VEX IQ and additional components found in V5 Workcell Kit (276-7900) are legal for competition use. For example, the Rubber Shaft Collar (228-3510) is a VEX IQ component that can be found on the VEX "Shafts & Hardware" page and is thus legal: www.vexrobotics.com/drive-shafts.html. Any parts which are identical to legal VEX parts are permitted. For the purposes of this rule, products which are identical in all ways except for color are permissible.

** The HEXBUG brand is a registered trademark belonging to Spin Master Corp.*

<W2> VEX products come from VEX Robotics or VEX Robotics Resellers - Official VEX products are ONLY available from VEX Robotics and official VEX Resellers. To determine whether a product is "official" or not, consult www.vexrobotics.com. A complete list of authorized VEX Resellers can be found at www.vexrobotics.com/how-to-order.

<W3> Custom Parts - Teams are allowed to fabricate their own custom components for their Workcell utilizing the following additional raw materials:

a. An unlimited amount of non-shattering plastic from the following list: polycarbonate, acetal homopolymer (Delrin), acetal copolymer (Acetron GP), POM (acetal), ABS, PEEK, PET, HDPE, LDPE, Nylon (all grades), Polypropylene, and FEP.

b. An unlimited amount of silicone, polyurethane, or other rubber.

c. An unlimited amount of composite materials, such as G10 (Garolite), FR-4, or carbon fiber.

d. An unlimited number of plastic 3D printed parts.

<W4> A limited amount of tape is allowed - Workcells may use a small amount of tape for the following purposes:

1. For labeling wires and motors.

2. For the purposes of preventing leaks on threaded portions of pneumatic fittings. This is the only acceptable use of Teflon tape.

<W5> Certain non-VEX screws, nuts, and washers are allowed - #4, #6, #8, M3, M3.5, or M4 screws up to 2” (50.8mm) long (nominal), and any commercially available nut, washer, and/or spacer (up to 2” / 50.8mm long) to fit these screws may be used. The intent of this rule is to allow teams to purchase their own commodity hardware without introducing additional functionality not found in standard VEX equipment.

WORKCELL RULES (continued)

<W6> New VEX parts are legal - Additional VEX components released during the competition season on www.vexrobotics.com are considered legal for use. Some "new" components may have certain restrictions placed on them upon their release.

<W7> Workcell Electronics - Workcells must use exactly one (1) VEX V5 Robot Brain (276-4810). Workcells can only use up to twenty (20) V5 Smart Motors (276-4840). V5 Smart Motors, connected to Smart Ports, are the only motors that may be used with a V5 Robot Brain. The 3-wire ports may not be used to control motors of any kind.

<W8> Workcells must use one (1) VEX V5 Battery Pack - There are no legal power expanders for the V5 Robot Battery (276-4811). V5 Robot Batteries may only be charged by the V5 Robot Battery Charger (276-4812).

<W9> Custom V5 Smart Cables are allowed - Teams must use official V5 Smart Cable Stock but may use commodity 4P4C connectors and 4P4C crimping tools. Teams who create custom cables acknowledge that incorrect wiring may have undesired results.

<W10> No modifications to electronic components are allowed - Motors (Smart Motor firmware), micro controllers (including V5 Robot Brain firmware), extension cords, sensors, controllers, battery packs, reservoirs, solenoids, pneumatic cylinders, and any other electrical component or pneumatics component of the VEX platform may NOT be altered from their original state in ANY way.

1. External wires on VEX electrical components may be repaired by soldering, using twist/crimp connectors, electrical tape, or shrink tubing such that the original functionality / length is not modified in any way. The wire used in repairs must be identical to VEX wire. Teams may make these repairs at their own risk; incorrect wiring may have undesired results.

2. Teams must use the latest official VEXos firmware updates, found at www.vexrobotics. com/firmware. Custom firmware modifications are not permitted.

3. Teams may change or replace the gear cartridge in the V5 Smart Motor with other official replacement gear cartridges.

<W11> Most modifications and repairs to non-electrical components are allowed - Physical modifications such as bending or cutting are permitted and may be done to legal metal structures or plastic components.

1. Metallurgical modifications that change fundamental material properties, such as heat treating, are not permitted.

2. Teams may cut pneumatic tubing to the desired length.

3. Teams are permitted to fuse/melt the end of the 1/8" nylon rope to prevent fraying.

4. Welding, soldering, brazing, gluing, or attaching components in any way that is unsupported within the VEX platform is NOT permitted.

<W12> Workcells must have a team identification plate attached - The license plate with the team's FAC Team ID# must be clearly visible on the Home Base Plate.

GLOBAL COMPETITION

SECTION 3

OVERVIEW

Since the Factory Automation Competition is classroom-based, the REC Foundation has created a ranking system to allow teams to compete against themselves as well as other organizations. Teams will video record a Production Run with an explanation of the processes and how they function to achieve the Competition Phase Challenge. In order to be ranked globally, Teams must upload a video submission of their Production Run to Robotevents.com.

REGISTRATION

Learn how to register your Factory Automation Competition teams here. Registration is included for all teams.

GLOBAL RANKING

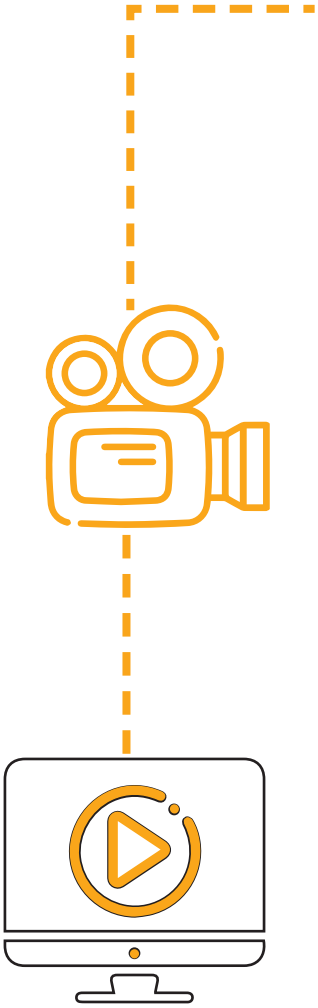
<T1> Teams must start at Competition Phase 1. Teams must successfully perform the specific tasks in the Competition Phase Challenges, outlined in Section 2, successfully submit a production run, and receive a score verification in order to become eligible to advance to the next Competition Phase.

<T2> Teams are ranked within each Competition Phase based on the number of points scored.

<T3> Team ranking tie breakers are determined as outlined below.

1. Total Points Scored
2. Total Throughput of Completed Orders
3. Run Time
4. Previous Competition Phase Score
5. Second highest submitted score
6. Random electronic draw

<T4> To participate in the Factory Automation Competition, a Team must first register on Robotevents.com. Upon registering they will receive their FAC Team Number to display on their Team ID plates.



VIDEO PARAMETERS

<V1> The Production Run video must be no longer than 5-minutes (5:00) in length, including credits. (Credits not required).

<V2> The video may be your team speaking, a voice-over storyboard, a voice-over PowerPoint, or any other video format of your choosing.

<V3> Students must be the ones who research, design, write, edit, film, and produce the video. Mentors should have a very limited role in giving direction except for teaching the concepts of how to do something specific. The students should be able to produce a similar result on their own in the future without the aid of a mentor.

<V4> The video must be posted or uploaded to YouTube, SchoolTube, Youku, or an equivalent free video posting service. The link provided must open directly to the video and not require a password, login, or present any other impediment. **Note: Links to Google Drive or Dropbox or any other "cloud drive" are not permitted.**

<V5> Teams must submit Production Run attempts via Robotevents.com.

<V6> Video submissions must clearly state which Competition Phase Challenge the team is attempting.

<V7> The video must have a stopwatch, clock timer on a smartphone, or another way of displaying time clearly visible to verify the Run Time. Any video without time verification will not be scored.

<V8> The video must clearly display the Team ID Plate and Team number.

Email FAC@recf.org with any FAC program or product questions

RECF.ORG/FAC

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