To provide as much flexibility to teams as possible and to attempt to assist teams in this challenging time, the following rules will be edited or removed for the 2021 *FIRST* Robotics Competition season.

Teams should note that the changes below to R14 and R15 are for the 2021 season only. While INFINITE RECHARGE[SM] is being modified for 2021, all robots legal for the 2020 season will also be legal for the 2021 season. Any additional changes to the rules will ease robot restrictions, not tighten them.

The removal of the Bill of Materials requirement will be monitored closely for unintended consequences. This includes the rules R11, R13, and I6. We will reevaluate this removal after the 2021 season.

It is our intent to make the 2021 season as exciting as ever, knowing that INFINITE RECHARGE will be replayed. We also want to ease as many challenges that our teams may be facing as possible in this very difficult time.

If your team has feedback or a question, please send an email to frcteamadvocate@firstinspires.org.

9 ROBOT CONSTRUCTION RULES

R11. ~~The total cost of all items on the ROBOT (i.e. all items presented at Inspection per I3: MECHANISMS, configurations, and decorations that will be used on the ROBOT in MATCHES without re-inspection), including software, shall not exceed $5000 USD. All costs are to be determined as explained in Budget Constraints & Fabrication Schedule. Exceptions are as follows:~~

- ~~**A.** individual items that are less than $5 USD each, as purchasable from a VENDOR,~~
- ~~**B.** items from the team's current year's KOP (identical functional replacements may be used to meet this criteria), up to the KOP quantity (including the rookie KOP items), and~~
- ~~**C.** Specific exempt items:~~
  - ~~i. One (1) Inertial Measurement Unit (Note that R12 still applies)~~
  - ~~ii. Rockwell Automation sensors available through *FIRST* Choice in any season~~
  - ~~iii. tags used for location detection systems if provided by the event~~

~~An item is considered an IMU if it includes "IMU" or "Inertial Measurement Unit" in the VENDOR'S product description.~~

~~Teams should be prepared to disclose to Inspectors the cost of any non-KOP item and the total cost of the ROBOT. Teams should also be prepared to show that a particular item was received from *FIRST* Choice or a voucher in the current season if necessary.~~

~~Per 10, teams must be prepared to display a Bill of Material (BOM) to Inspectors during Inspection. The BOM may be displayed in either printed or electronic form.~~

~~Individual COMPONENTS or MECHANISMS, not excluded in 9, that are retrieved from previous ROBOTS and used on 2020 ROBOTS must have their un-depreciated cost included in the 2020 BOM and applied to the overall cost assessment.~~

~~Example 1: The Kickoff KOP checklist lists two (2) of motor controller XYZ in the Gray Tote distributed to rookie teams. Any team, including a veteran team that did not receive these items, can account for up to two (2) of them on the KOP checklist at a $0 cost.~~

~~Additional quantity of the same item would have to be accounted at the Fair Market Value.~~

~~Example 2: A team uses *FIRST* Choice credits, or a voucher, to acquire part ABC. This part, in the quantity obtained by the team via the KOP may be accounted at $0. Additional quantity of the same item would have to be accounted at the Fair Market Value.~~

~~Example 3: Part ABC is available in *FIRST* Choice, but a team decides they have enough already on hand and does not acquire any through *FIRST* Choice. All of these items used on the ROBOT need to be accounted for at Fair Market Value as they did not come from the current year's KOP.~~

~~An "identical functional replacement" is an item which, to any reasonably astute observer, has the same form, fit, feature set, and function as the original component.~~

~~For example, any CIM motor can replace a CIM motor or a sheet of polycarbonate paid for completely by a voucher can be replaced with a sheet of polycarbonate of the same parameters (thickness, color, size, etc.). As another example, a motor controller that has the same form, fit, and function (i.e. controlling motors) as the original motor controller, but a different feature set (i.e. can communicate over CAN vs. the original controller which was PWM only) is not an identical functional replacement because the controllers' feature sets differ.~~

R12. No individual, non-KOP item or software shall have a Fair Market Value that exceeds $500 USD. The total cost of COMPONENTS purchased in bulk may exceed $500 USD as long as the cost of an individual COMPONENT does not exceed $500 USD.

Teams should be ready to show inspectors documentation of Fair Market Value (FMV) for any COMPONENTS that appear to be in the range of the $500 USD limit.

The Analog Devices ADIS16448 IMU MXP Breakout Board does not have a published FMV. This device is considered to comply with R12 regardless of its true FMV.

The FMV of a COTS item is its price defined by a VENDOR for the part or an identical functional replacement. This price must be generally available to all *FIRST* Robotics Competition teams throughout the build and competition season (i.e. short-term sale prices or coupons do not reflect FMV), however teams are only expected to make a good faith effort at determining the item price and are not expected to monitor prices of ROBOT items throughout the season. The FMV is the cost of the item itself and does not include any duties, taxes, tariffs, shipping, or other costs that may vary by locality.

The FMV of COTS software is the price, set by the VENDOR, to license the software (or component of the software) that runs on the ROBOT for the period from Kickoff to the end of the *FIRST* Championship. The FMV of software licensed free-of-cost, including through the Virtual KOP, for use on the ROBOT is $0.

The FMV of FABRICATED parts is the value of the material and/or labor, except for labor provided by team members (including sponsor employees who are members of the team), members of other teams, and/or event provided Machine Shops. Material costs are accounted for as the cost of any purchasable quantity that can be used to make the individual part (i.e. the purchasable raw material is larger than the FABRICATED part).

Example 1: A team orders a custom bracket made by a company to the team's specification. The company's material cost and normally charged labor rate apply.

Example 2: A team receives a donated sensor. The company would normally sell this item for $450 USD, which is therefore its FMV.

Example 3: A team purchases titanium tube stock for $400 USD and has it machined by a local machine shop. The machine shop is not considered a team Sponsor but donates two (2) hours of expended labor anyway. The team must include the estimated normal cost of the labor as if it were paid to the machine shop and add it to the $400 USD.

Example 4: A team purchases titanium tube stock for $400 USD and has it machined by a local machine shop that is a recognized Sponsor of the team. If the machinists are considered members of the team, their labor costs do not apply. The total applicable cost for the part would be $400 USD.

It is in the best interests of the teams and *FIRST* to form relationships with as many organizations as possible. Teams are encouraged to be expansive in recruiting and including organizations in their team, as that exposes more people and organizations to *FIRST*. Recognizing supporting companies as Sponsors of, and members in, the team is encouraged, even if the involvement of the Sponsor is solely through the donation of fabrication labor.

Example 5: A team purchases titanium tube stock for $400 USD and has it machined by another team. The total applicable cost for the part would be $400 USD.

Example 6: A team purchases a widget at a garage sale or online auction for $300, but it's available for sale from a VENDOR for $700. The FMV is $700.

If a COTS item is part of a modular system that can be assembled in several possible configurations, then each individual module must fit within the price constraints defined in R12.

If the modules are designed to assemble into a single configuration, and the assembly is functional in only that configuration, then the total cost of the complete assembly including all modules must fit within the price constraints defined in R12.

In summary, if a VENDOR sells a system or a kit, a team must use the entire system/kit FMV and not the value of its COMPONENT pieces.

Example 1: VENDOR A sells a gearbox that can be used with a number of different gear sets, and can mate with two different motors they sell. A team purchases the gearbox, a gear set, and a motor, then assembles them together. Each part is treated separately for the purpose of determining FMV, since the purchased pieces can each be used in various configurations.

Example 2: VENDOR B sells a robotic arm assembly that the team wants to use. However, it costs $700 USD, so they cannot use it. The VENDOR sells the "hand", "wrist", and "arm" as separate assemblies, for $200 USD each. A team wishes to purchase the three items separately, then reassemble them. This would not be legal, as they are really buying and using the entire assembly, which has a FMV of $700 USD.

Example 3: VENDOR C sells a set of wheels or wheel modules that are often used in groups of four. The wheels or modules can be used in other quantities or configurations. A team purchases four and uses them in the most common configuration. Each part is treated separately for the purpose of determining FMV, since the purchased pieces can be used in various configurations.

~~If a COTS item is part of a modular system that can be assembled in several possible configurations, then each individual module must fit within the price constraints defined in R12.~~

~~If the modules are designed to assemble into a single configuration, and the assembly is functional in only that configuration, then the total cost of the complete assembly including all modules must fit within the price constraints defined in R12.~~

~~In summary, if a VENDOR sells a system or a kit, a team must use the entire system/kit Fair Market Value and not the value of its COMPONENT pieces.~~

~~Example 1: VENDOR A sells a gearbox that can be used with a number of different gear sets, and can mate with two different motors they sell. A team purchases the gearbox, a gear set, and a motor (which are not offered together as an assembly or kit), then assembles them together. Each part is treated separately for the purpose of BOM costing, since the purchased pieces can each be used in various configurations.~~

~~Example 2: VENDOR B sells a robotic arm assembly that the team wants to use. However, it costs $700 USD, so they cannot use it. The VENDOR sells the "hand", "wrist", and "arm" as separate assemblies, for $200 USD each. A team wishes to purchase the three items separately, then reassemble them. This would not be legal, as they are really buying and using the entire assembly, which has a Fair Market Value of $700 USD.~~

~~Example 3: VENDOR C sells a set of wheels or wheel modules that are often used in groups of four. The wheels or modules can be used in other quantities or configurations. A team purchases four and uses them in the most common configuration. Each part is treated separately for the purpose of BOM costing, since the purchased pieces can be used in various configurations.~~

R13. ~~The BOM cost of each non-KOP item must be calculated based on the unit Fair Market Value for the material and/or labor, except for labor provided by team members (including sponsor employees who are members of the team), members of other teams, event provided Machine Shops and shipping.~~

~~The Fair Market Value of a COTS item is its price defined by a VENDOR for the part or an identical functional replacement. This price must be generally available to all FIRST Robotics Competition teams throughout the build and competition season (i.e. short-term sale prices or coupons do not reflect Fair Market Value), however teams are only expected to make a good faith effort at determining the item price and are not expected to monitor prices of ROBOT items throughout the season in response to price fluctuations. The Fair Market Value is the cost of the item itself and does not include any duties, taxes, tariffs, shipping, or other costs that may vary by locality. If COTS parts were sourced in bulk, the cost may be scaled proportionally to assess the Fair Market Value of one unit.~~

~~The Fair Market Value of COTS software is the price, set by the VENDOR, to license the software (or component of the software) that runs on the ROBOT for the period from Kickoff to the end of the *FIRST* Championship. The Fair Market Value of software licensed free-of-cost, including through the Virtual KOP, for use on the ROBOT is $0.~~

~~The Fair Market Value of raw material used to construct FABRICATED parts may be accounted for in one of two ways:~~

- ~~The cost of any purchasable quantity that can be used to make the individual part (i.e. the purchasable raw material is larger than the FABRICATED part).~~

- Grouping parts made from the same raw material and accounting for the cost of a single quantity that can produce all of those parts.

Example 1: A team orders a custom bracket made by a company to the team's specification. The company's material cost and normally charged labor rate apply.

Example 2: A team receives a donated sensor. The company would normally sell this item for $52 USD, which is therefore its Fair Market Value.

Example 3: Special price discounts from National Instruments and other *FIRST* Suppliers are being offered to all teams for the whole season. The discounted purchase price of items from these sources may be used in the additional parts accounting calculations.

Example 4: A team purchases steel bar stock for $10 USD and has it machined by a local machine shop. The machine shop is not considered a team Sponsor but donates two (2) hours of expended labor anyway. The team must include the estimated normal cost of the labor as if it were paid to the machine shop and add it to the $10 USD.

Example 5: A team purchases steel bar stock for $10 USD and has it machined by a local machine shop that is a recognized Sponsor of the team. If the machinists are considered members of the team, their labor costs do not apply. The total applicable cost for the part would be $10 USD.

It is in the best interests of the teams and *FIRST* to form relationships with as many organizations as possible. Teams are encouraged to be expansive in recruiting and including organizations in their team, as that exposes more people and organizations to *FIRST*. Recognizing supporting companies as Sponsors of, and members in, the team is encouraged, even if the involvement of the Sponsor is solely through the donation of fabrication labor.

Example 6: A team purchases steel bar stock for $10 USD and has it machined by another team. The total applicable cost for the part would be $10 USD.

Example 7: A team purchases a 4 ft. by 4 ft. (~122 cm by 122 cm) sheet of aluminum, but only uses a piece 10 in. by 10 in. (~25 cm by 25 cm) on their ROBOT. The team identifies a source that sells aluminum sheet in 1 by 1 ft. (~30 cm by 30 cm) pieces. The team may cost their part based on a 1 by 1 ft. (~30 cm by 30 cm) piece, even though they cut the piece from a larger bulk purchase. They do not have to account for the entire 4 by 4 ft. (~122 cm by 122 cm) bulk purchase item.

Example 8: A team purchases a widget at a garage sale or online auction for $3, but it's available for sale from a VENDOR for $13. The Fair Market Value that gets reported on the BOM is $13.

Example 9: A team 3D prints multiple parts for their ROBOT from a single spool of material. The cost of the spool (in the smallest available size able to produce the parts) may be included just once on the BOM to account for all parts.

R14. FABRICATED ITEMS created before Kickoff are not permitted. Exceptions are:

D. OPERATOR CONSOLE,
E. BUMPERS (a protective assembly designed to attach to the exterior of the ROBOT and constructed as specified in BUMPER Rules),
F. battery assemblies as described in R5B.
G. FABRICATED ITEMS consisting of one COTS electrical device (e.g. a motor or motor controller) and attached COMPONENTS associated with any of the following modifications:

i. wires modified to facilitate connection to a ROBOT (including removal of existing connectors)
ii. connectors and any materials to secure and insulate those connectors added (Note: passive PCBs such as those used to adapt motor terminals to connectors are considered connectors)
iii. motor shafts modified and/or gears, pulleys, or sprockets added
iv. motors modified with a filtering capacitor as described in the Blue Box below.

H. COTS items with any of the following modifications:
i. Non-functional decoration or labeling
ii. Assembly of COTS items per manufacturer specs, unless the result constitutes a MAJOR MECHANISM as defined in I1
iii. Work that could be reasonably accomplished in fewer than 30 minutes with the use of handheld tools (e.g. drilling a small number of holes in a COTS part)

Please note that this means FABRICATED ITEMS from ROBOTS entered in previous *FIRST* competitions may not be used on ROBOTS in the 2020 *FIRST* Robotics Competition (other than those allowed per R14-E through -E). Before the formal start of the Build Season, teams are encouraged to think as much as they please about their ROBOTS. They may develop prototypes, create proof-of-concept models, and conduct design exercises. Teams may gather all the raw stock materials and COTS COMPONENTS they want.

Parts with precision machined (mill, CNC, etc.) features may still meet R14-E part iii if functionally equivalent features could reasonably be made within the restrictions specified.

Example 1: A team designs and builds a two-speed shifting transmission during the fall as a training exercise. After Kickoff, they utilize all the design principles they learned in the fall to design their ROBOT. To optimize the transmission design for their ROBOT, they change the transmission gear ratios and reduce the size, and build two new transmissions, and place them on the ROBOT. All parts of this process are permitted activities.

Example 2: A team re-uses a 2020-legal motor from a previous ROBOT which has had connectors added to the wires. This is permitted, per exception D, because the motor is a COTS electrical COMPONENT.

Example 3: A team re-uses a piece of aluminum tubing from a previous ROBOT which has a precision machined bearing hole in it. On the current ROBOT, the bearing hole is not used. As the only function of the hole on the current ROBOT is material removal, which does not require precise tolerancing, a functionally equivalent hole could be made with a hand drill in under 30 minutes and the part is permitted per R14-E iii.

R15. Software and mechanical/electrical designs created before Kickoff are only permitted if the source files (complete information sufficient to produce the design) are available publicly prior to Kickoff.

Example 1: A team realizes that the transmission designed and built in the fall perfectly fits their need for a transmission to drive the ROBOT arm. They build an exact copy of the transmission from the original design plans, and bolt it to the ROBOT. This would be prohibited, as the transmission – although made during the competition season – was built from detailed designs developed prior to Kickoff.

Example 2: A team developed an omni-directional drive system for the 2019 competition. In July 2019 they refined and improved the control software (written in C++) to add more precision and capabilities. They decided to use a similar system for the 2020 competition.

They copied large sections of unmodified code over into the control software of the new ROBOT (also written in C++). This would be a violation of the schedule constraint and is not allowed.

Example 3: The same team decides to use LabVIEW as their software environment for 2020. Following Kickoff, they use the previously developed C++ code as a reference for the algorithms and calculations required to implement their omni-directional control solution. Because they developed new LabVIEW code as they ported over their algorithms, this is permitted.

Example 4: A different team develops a similar solution during the fall and plans to use the developed software on their competition ROBOT. After completing the software, they post it in a generally accessible public forum and make the code available to all teams. Because they have made their software publicly available before Kickoff, they can use it on their ROBOT.

Example 5: A team develops a transmission prior to Kickoff. After completing the project, they publish the CAD files on a generally accessible public forum and make them available to all teams. Because they have made the design publicly available before Kickoff, they can use the design to create an identical transmission, fabricated after Kickoff, for use on their 2020 ROBOT.

10 INSPECTION & ELIGIBILITY RULES

I6. **Document your costs.** A Bill of Materials (BOM), listing all items on the ROBOT except those listed in 9 and their relevant costs per Budget Constraints & Fabrication Schedule, must be presented at the time of Inspection.

Teams are encouraged to use the BOM Template posted on the *FIRST* website. Please note that while BOMs must be shown to Inspectors, teams are not required to submit their BOMs to the Inspectors.