



## Two Roads to the Same Start Gate

Our **Top 20 Rules of Rover Design** (Vinarcik & Biemer) and the [URC Advice](#) page maintained by the competition's own judges and staff were written independently, for different purposes — ours as a designer's field philosophy, theirs as hard-won lessons from watching hundreds of rovers succeed and fail. Read side by side, they are strikingly convergent: two sets of experienced eyes looking at the same desert and reaching the same conclusions. This piece maps where they agree, where each says something the other does not, and what that overlap tells a competing team.

**The headline is simple.** Both documents put *communications* first and loudest, both insist the rover is only one part of a larger system, and both treat testing and training as non-negotiable. The differences are mostly of emphasis and framing rather than disagreement — with a few genuinely distinct points worth absorbing from each.

## Where the Two Lists Line Up

The strongest shared themes, with the corresponding rule on our side and section on theirs:

| Theme                            | Vinarcik & Biemer — Top 20                                                                                                                                  | URC Judges & Staff — Advice                                                                                                                                                                                 |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Communications / the link</b> | Rules 2 & 7: the link is the spine; plan the 900 MHz sub-band shuffle, design for the no-line-of-sight half of Delivery, and throttle bandwidth gracefully. | "Communications" section: coms are the single biggest differentiator; design for near <i>and</i> far / wide-angle, control from inside the metal Hab (antenna outside + 25 m cable), and test relentlessly. |
| <b>Mobility &amp; ruggedness</b> | Rule 3: survive sand, gravel, boulder fields, drops, and steep slopes while carrying every deployable out of the gate.                                      | "Three Rs" — Reliability, Ruggedness, Robustness: the rover takes a half-hour beating in transit and gets driven into gulleys and flipped; build for the field, not the lab.                                |
| <b>Situational awareness</b>     | Rule 4: operators fly blind on the cameras; deliberate camera count/placement, plus a cheap under-chassis                                                   | "Single system" point: a camera view is not as good as the human eye — plan explicitly for awareness to                                                                                                     |

| Theme                              | Vinarcik & Biemer — Top 20                                                                                                                                | URC Judges & Staff — Advice                                                                                                                                      |
|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                    | fisheye for debris in the wheels.                                                                                                                         | spot targets, obstacles, terrain, and hazards.                                                                                                                   |
| <b>Connections &amp; integrity</b> | Rule 13: vibration finds every loose connector; Loctite, strain relief, and disciplined routing — the humble loose wire is the most common field failure. | Same lesson, told as a story: teams that worked perfectly in the motel parking lot then failed at the site over a single loose wire or connector.                |
| <b>Environment</b>                 | Rule 16: heat, dust, wind, and light rain attack connectors, optics, and cooling; seal, shade, and assume dust gets everywhere.                           | “Three Rs” framing: isolated site, extreme temperatures, dust, high winds, and unpredictable terrain from rock piles to powdery hillsides.                       |
| <b>Testing &amp; training</b>      | Rules 17 & 11: test in representative conditions (on-site testing is barred, so use Factory Butte) and practice operators to muscle memory with a coach.  | “Test, test, test” / “train, train, train”: build early, test continuously in field-like conditions, and show up already fluent at setup, operation, and repair. |
| <b>Whole-system view</b>           | Rule 19: the C2 station, antenna, and displays count against budget and decide whether you can fly — engineer the ground segment deliberately.            | “View ... as a single system”: the competition is not just the rover — weigh rover, logistics, communication, and operation together.                            |

**The most telling agreement is on communications.** The URC judges are blunt that coms are “far and away” the most common reason a team that worked all year ends up motionless at the start gate, and that the best teams always have reliable links. Our Rules 2 and 7 reach the same place from the design side — treating the link as the spine of the system and engineering it to degrade gracefully across the 900 MHz sub-bands and the no-line-of-sight stretches. Same conclusion, different vocabulary.

## What the URC Judges Stress That We Underweight

Three themes are far more prominent in the URC advice than in our list, and each is worth a competing team’s explicit attention:

- **Logistics and field repair as a discipline.** The URC page devotes a whole section to it, with the memorable line that amateurs talk strategy while professionals think logistics. The site is hours of rough road from Hanksville; the nearest real parts supply (Grand Junction) is a six-hour round trip with no cell service en route. Their advice: design for ease of repair, and bring every tool and

critical spare you might need. Our list touches repair only obliquely through robustness (Rule 15) and pre-planned troubleshooting (Rule 18); it never names *logistics* as a first-class concern.

- **“Keep it simple” and capability-vs-reliability tradeoffs.** The judges repeatedly counsel simplicity — a more complex rover is less reliable, takes longer to build, and leaves less time to test — and they explicitly note that no task needs superhuman ability; an ordinary human at walking pace could do them all. Our list celebrates using the full mass budget (Rule 20) and dense capability, and assumes a team that can manage complexity. Their caution against over-reaching is a useful counterweight.
- **Prioritizing the features that truly matter.** The URC advice asks teams to translate each task into the specific performance characteristics it actually requires and rank them, rather than chasing capability for its own sake. Our list implies prioritization through scoring logic but never states the discipline outright.

## What Our List Adds That the URC Advice Does Not

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Our Top 20 goes into specifics the URC page deliberately leaves out — fitting, since the URC text is careful to say it is not modifying the rules. Where we add value:

- **Rules-driven, point-aware specifics.** We tie advice directly to the 2026 requirements: the 900 MHz sub-band shuffle, the 20% additive intervention penalty, the 50/70 kg mass limits, the 36-team SAR cutoff, the 1 cm ArUco markers on the USB task. The URC advice stays deliberately general.
- **The operator as a designed-in element.** Beyond “have situational awareness,” we call for specific aids — HDR or task lighting against sun and self-shadow, alignment lasers, semi-autonomous routines, a non-driving coach, and a decision flowchart — turning the human-in-the-loop into an engineering surface.
- **“Don’t lose before you start.”** Our Rule 1 frames the milestone deadlines, budget, and weigh-in as the first place rovers fail. The URC advice, focused on field performance, doesn’t address the paperwork and qualification gauntlet at all.
- **The vivid mobility-and-manipulation detail.** Quarter-turn valves, cam-lock hose fittings, graspable features up to 7.5 cm, exclusion zones around autonomous targets — the concrete texture of what the rover must physically do.

## The Bottom Line for a Competing Team

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**Use both.** The convergence is the real signal: when an independent design philosophy and the judges’ own accumulated experience agree this completely on communications, ruggedness, the single-system view, and test-and-train, those are not opinions — they are the load-bearing walls of a competitive rover. Treat the shared themes as settled, then read the URC advice for the logistics-and-simplicity discipline our list underweights, and read our Top 20 for the rules-specific, operator-centric detail the URC page leaves

general. Neither is a template — as the URC judges rightly insist there isn't one — but together they cover the ground more completely than either does alone.

## Sources

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- Vinarcik, M. J., & Biemer, S. — *Top 20 Rules of Rover Design* (INCOSE Foundation systems engineering award judging, URC 2026).
- University Rover Challenge — *URC Advice* (judges and staff): [urc.marsociety.org/home/resources/urc-advice](http://urc.marsociety.org/home/resources/urc-advice).