Participation to Reward Incentives in NAR Competition

NARAM-55 Research & Development

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Summary:

The current U.S. Model Rocket Sporting Code (Pink Book) point system and contest structure currently rewards competitors and contestants to fly four regionals, and to recruit 10 competitors for those regionals. Beyond the minimum number of competitors, there is a diminishing returns to recruit additional members (under some simplifying assumptions), furthermore recruiting additional contestants has an expected point decrease for an individual competitor. Changing to a different scoring system could incentivize recruitment of additional competitors, removing the diminishing returns system and moving towards one that rewards all contestants based on the number of entered contestants, for instance, based on some multiplier of the number of contestants that each contestant beat in the event, for instance, beating 10 contestants could be worth 11 points, beating 4 could be worth 5 points, all the way down to the last place contestant who would only get 1 point (times the usual Weighting Factor and Contest Factor multipliers). This system results in an expected value for an individual contestant that is positive, recruiting an additional contestant has an expected increase for every contestant, in fact it is at worst zero. Additionally, a survey of several NAR contestants was conducted, resulting in a strong preference for this new type of system, though many details would need ironed out before a Rule Change Proposal could be submitted. In fact, many NAR contestants currently have very little idea which of the many possible scoring systems are in use today! Additional improvements under the system are discussed, for instance, age divisions could be removed for the purposes of point assignment, though remain for the purposes of placing and trophies. Finally, how this would affect NARAM and the section championships would be affected by the suggested changes, along with future work, is discussed.

ORIGINAL

Objectives

The objective of this report was to examine the participation to reward incentives currently provided by the NAR competition structure and seek out ways of improving them to increase participation. This would advance the state-of-the-art of model rocketry by attracting new competitors with new ideas and approaches, increasing the level of competiton at the local and national level. While no specific improvement was made as part of this report, certainly improvements in the competition structure leading to additional competitors and an improved system would increase participation directly and the state-of-the-art indirectly through additional ideas.

Approach

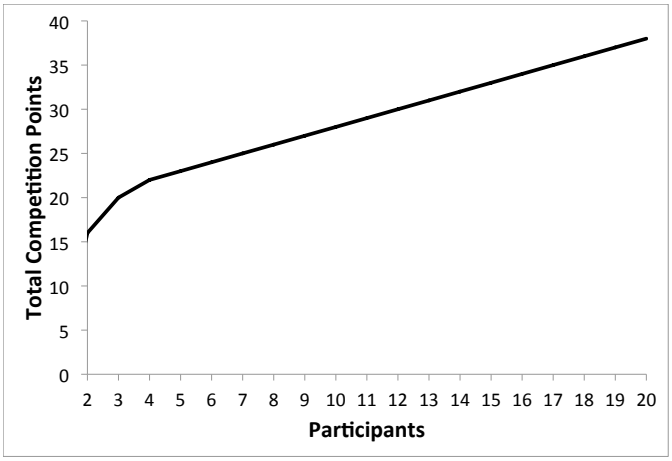
The current incentive structure as provided by the 2012-2013 U.S. Model Rocket Sporting Code[1] was examined, many theoretical models were derived showing a simplified payoff system for purposes of examining the current structure. Data from this contest year was examined to see how participation at the local level reflected the incentive structure. Many proposed new payoff models were examined theoretically and discussed. A brief survey was conducted amongst NAR members to learn 1) what NAR members think the payoff structure is 2) what NAR members think the payoff structure should be. After examining these various data, a conclusion is arrived at, which will be submitted as a Rule Change Proposal in the 2013-2014 cycle.

Data & Results

Current Incentive Structure

As spelled out in Rule 13.1[1], contestants receive a Competiton Points for placing 1st, 2nd, etc based on a 10-6-4-2-1* system (10 points for first, 6 for second, 4 for third, 2 for fourth, and 1 for all further places). Age divisions, Weighting Factors (WF) for different events, Contest Factors (CF) for different types of meets (Local, Open, Regional and National), complicate the scenario, as do disqualifications, flights which are only eligible for flight points (unreturned duration models for instance), most of these complicating factors will be ignored for this theoretical analysis.

Plotting the curve of Participants to total NAR Competition Points earned yields:



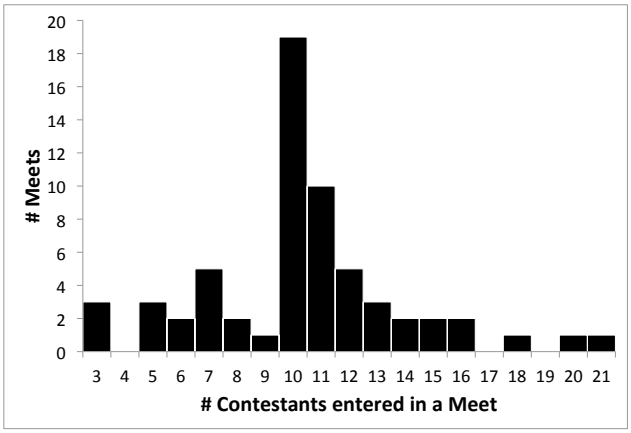
This curve suggests a possible problem, there are diminishing returns with recruiting additional contestants in terms of total number of club points. While individual points may be maximized in other ways, this report focuses on growing additional participation. 28 Competition Points are earned for the first 10 contestants (again, assuming no age divisions, no WF, no CF, etc), however only 10 additional Competition Points are earned for the second 10 and for each 10 beyond the first. After recruiting the first ten competitors, to double the number of Competition Points earned at a given meet, you must recruit 28 additional competitors. Assuming a single club is flying the meet, this gives the individual club very little incentive to heavily recruit new members and competitors, as there are significantly diminishing returns.

There is, in fact, another angle to this incentive structure. For a given competitor who has earned 1st place (or expects to earn first place in any given event), there is not a strong incentive to recruit additional competitors beyond the 10th to qualify for the regional (flying 4 regionals under the current NAR structure is the way to maximize potential pre-NARAM points). In fact, if all competitors were equal, recruiting an additional contestant beyond the 10th decreases each contestants expected points by 2.8 (1/10th of a chance of the new contestant placing 1st, 1/10th of a chance of them placing second, 1/10th for 3rd, 1/10th for 4th, and 6/10ths for 'flight points'). If a competitor thinks very highly of themselves and thinks they are twice as good as any potential competitor, the expected point decrease is still 1.4. If the competitor thinks exceptionally highly of themselves and thinks they are 10 times better than any new competitor they would recruit, there expected point decrease is still 0.28.

This expected point increase or decrease will be re-examined later in terms of other proposed scoring systems.

Current Participation Levels

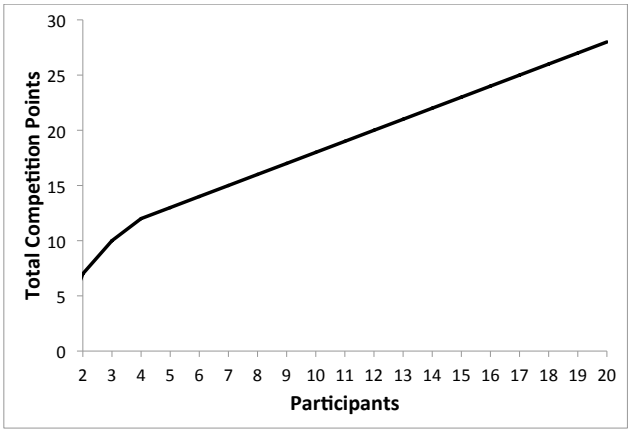
The pre-NARAM points were downloaded from the NAR webpage[2] and processed through the use of handmade scripts to extract the participation levels at all 62 meets flown in the 2012-2013 Contest Year. The data is shown below:



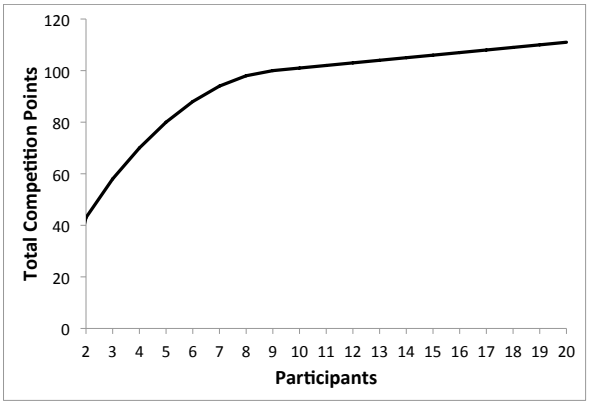
As can be plainly seen, very few local, section or open meets are held. Many regional meets are held, but the largest number have exactly the minimum number of competitors (10) for a valid regional meet. Those with 10 or 11 competitors (29) comprise over 63% of the number of meets held with more than 10 competitors (46), most of which are regionals. Whatever the cause, there appears to be a strong trend towards getting 10 competitors, but very little incentive to attract more competitors at the local or regional level.

Possible Incentive Structures

A variety of possible incentive structures were considered. An even lesser structure that gives less attention to the 1st place contestant would be a 4-3-2-1-1* structure.

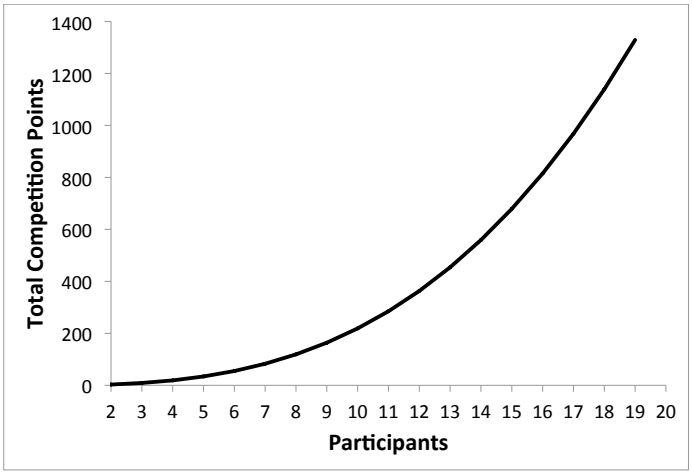


Another alternative is the scoring used in Formula 1 racing[3], 25-18-15-12-10-8-6-4-2-1-1*, which results in a system like this:



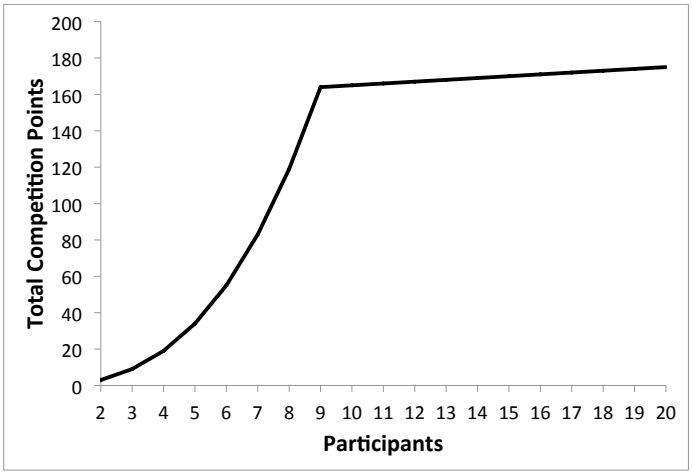
Of course, any of these three systems, the current NAR system, the 4-3-2-1-1* or the Formula 1 system could be modified to not given any points to places beyond the 1, the "flight points" part of the equation. This would completely level the graphs instead of having the slow incline, and totally remove the incentives to recruit additional participants. All these systems are diminishing returns systems, eventually, recruiting new competitors does not increase the points the section or meet can get significantly.

Bob Parks suggested a system loosely based on the League of Silent Flight scoring system[4], whereby the points are computed based on a formula which includes "multiplying the resultant value by one (1) plus the number of lower standing contestants.". If we use this system of each contestant scoring 1 plus the number of lower standing contestants, the graph of total points looks like this:

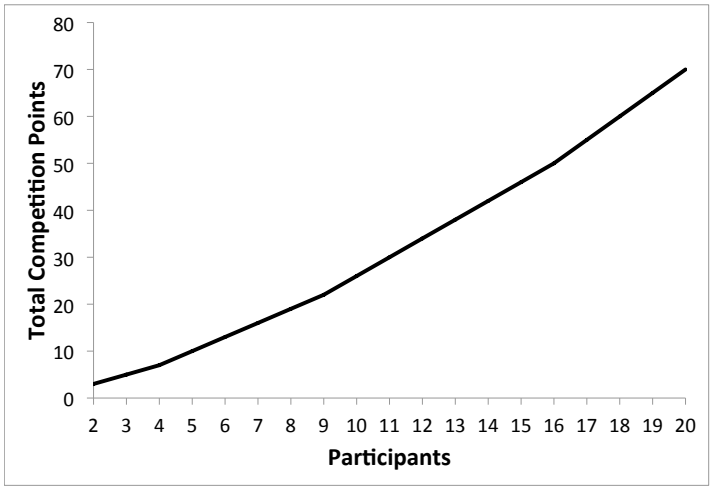


This results in an exponential reward system, where each additional entrant that flies the event increases the total score by quite a lot, since even if they place last, everyone's score goes up by 1. Of course, some may find this too extreme, or that some sort of diminishing

returns should still exist, see the following 'capped' system where the exponentially increasing points only work up until 10 competitors, at which point a linear system takes over:

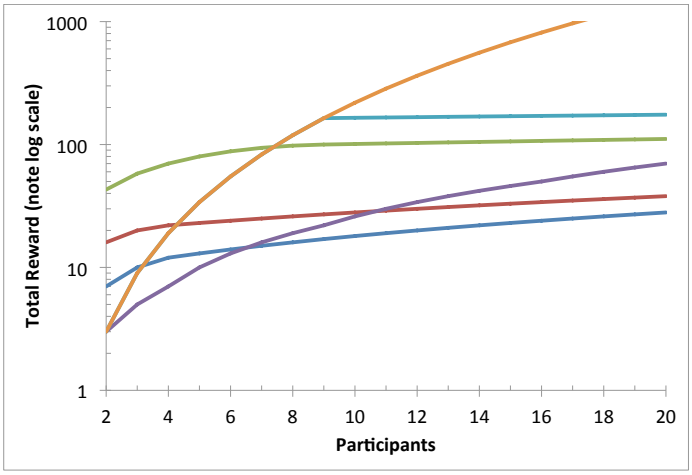


Another variant of this proposal is to use the square root of the number of contestants who were bested for each place's score, rounded up, which results in the following total points curve:



While this system dose not dole out as many points as quickly as the original system, it still does not have diminishing returns, for the first 10 competitors 26 points are earned, for the second 10 contestants 44 points are earned for a total of 70 points.

All six of these systems are shown in the next Figure, of course the scale on the y-axis was changed to log scale to show the dramatic effect of two of scoring programs.



Dark Blue = NAR current system, Red = 4-3-2-1-1* system, Green = Formula 1 based system, Orange = Original LSF type system, Light Blue = Capped LSF system, Purple = LSF root system.

Compare these graphs to the originals shown above to see the effect of the log scale. The orange (Original LSF type system) may favor sections able to gather a large amount of contestants too much, putting them too far in the lead, the Purple line (Square Root LSF system) may be a good compromise, as large clubs would be only slightly ahead of medium sized clubs, and at NARAM the clubs would still have to face off in direct competition, where the stakes would be substantially higher, as the hundred or so contestants common at today's NARAMs means highly increased scores for the top places, well above the 10-6-4-2-1* system in place today. Additionally, this system rewards competition events which are more popular with higher scores, and events like Research & Development, which have a high WF, would be worth less points if they are not well entered. This WF and Competition Point assignment system would likely balance itself out. Indeed, entering events with bad models only helps everyone ahead of you, some sections may opt out of some events altogether at NARAM unless they had a good strategy or strength in the particular event.

Expected Value of Additional Participant Analysis

As stated before, the expected value of adding another participant after 10 for an individual contestant is negative, ranging from 0.28 to 1.4 to 2.8 depending on a multiplier of the expected skill of the new competitor. The decrease of 2.8 is under a model assuming all competitors are equal (a fair world model), the decrease of only 0.28 is under a model where the new competitor is 10 times worse than an experienced competitor.

Under the Original LSF Model, the expected point change of a new competitor is always positive, instead of negative. Even if the new competitor beats all the other competitors, the scores are identical for the original competitors. Using the same models of a fair world to a new

competitor being 10 times worse, the expected point INCREASE for an indivdual contestant of recruiting an 11th competitor is 0.55 (10x world) to 5.5 (fair world).

Under the LSF Root Model, the expected point increase change of recruiting an additional contestant is from 0.26 (10x world) to 2.6 (fair world). It is undoubtable that shifting to a system that encourages individual contestants to recruit additional contestants under the expectation of an increased score would be an improvement over a scoring system that discourages new competitor recruitment as the expected point change is -0.28 (10x world) to -2.8 (fair world).

Survey of NAR members

Three important lessons were learned from making and giving the survey, shown in the Appendix as given. 1) Make the axes more clear. 2) Do not use a log scale 3) Consult an expert when making surveys.

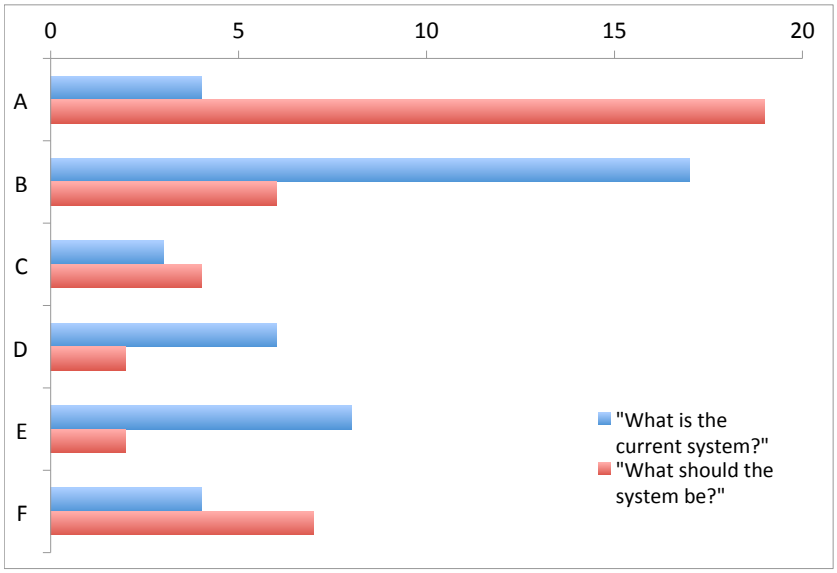
Regardless of the problems with the survey, here are the data from 42 ballots (though only 40 responses were entered for the second question):

	Model Name	What is the NAR System?
A	Original LSF	4
B	LSF Capped	17
C	Formula 1	3
D	4-3-2-1-1*	6
E	Current NAR System	8
F	LSF Root	4

When asked what system should be used, NAR members responded:

	Model Name	What should the system be?
A	Original LSF	19
B	LSF Capped	6
C	Formula 1	4
D	4-3-2-1-1*	2
E	Current NAR System	2
F	LSF Root	7

Or presented in a histogram form:



Remember, the current system is E, which was only the second most popular response to the question. Competitors seemed to think the system was B (the LSF Capped System). Competitors clearly favored system A, the original LSF system, though both B and F (LSF Capped and LSF Root systems) were second. Clearly, there is a preference among those surveyed to move away from the diminishing returns system and to a more fair model.

Conclusions

First, several easy conclusions. In practice, there is obviously very little incentive to recruit additional contestants at regional meets beyond the 10 contestant minimum, as 10 is the mode of contestants at meets this contest year. Under this theoretical model, many rationalizations for this effect are considered as potential sources. First, even for sections, there is very little incentive to recruit additional contestants, the diminishing returns for each new contestant makes additional recruitment not worth it. Second, for individuals, recruiting new contestants has an expected point value that is negative, they may very well hurt some individuals in the hunt for individual titles. When surveyed, many NAR members could not identify which system was actually in use, however this could be the result of poor survey design.

Several additional systems are examined. Something based on the League of Silent Flight system (LSF)[4] system where you receive a higher score for each contestant you best in competition seems to be a popular (based on the survey) replacement for the current system, even when put up against other diminishing returns systems. Under the LSF Original or LSF Root scoring systems, sections/meets receive much higher points for additional contestant recruitment. Additionally, recruiting new contestants does not hurt individuals in their point races. Even if the new recruit wins the event, you receive the same points as you would have before

(unless the new recruit wins every event, in which case they are well on their way to winning the individual National Championships due to skill regardless of point system). So the expected value of a new recruit is positive for both the section and the individual, a distinct advantage. When surveyed, NAR members showed a preference for the Original LSF model, despite the possible fault that the available points goes up very quickly! The LSF Root model, in which the points rise more slowly, but still without diminishing returns, was the second most popular when members were asked what they would prefer.

How would this affect NARAM, individual and section National Championships. Under an LSF derived model, the points available at NARAM would skyrocket in the popular events. This would in fact, balance out some of the differences in weighting factors, popular and difficult events would become the place where the highest points are available. Individual would have every incentive to do as well as they can, but also to recruit additional members to fly each event (this would be true at regional and local meets as well). For the section championship, with many sections in the hunt along with many members flying for sections not in the race, having as many members participating and doing well in each event would be advantageous. There may be a hypothetical situation where if the competing section has an advantage in one event that some other competing sections would not participate, depriving the other section of some points. However, it would be rare that everyone except one section would withdraw from an event, as there are rarely cases where only 2 sections are at a NARAM competing and no one else is present.

This proposal would certainly be a difficult change for some individuals, used to competing with only one or two members at regionals througout the year (the other contestants being in other divisions) and getting the maximum 9600 points before NARAM. There would be no maximum under this system (though a maximum per individual or sections could easily be imposed as part of the Rules Change Proposal). Overall, healthy regional events would lead to well attended NARAMs and an infusion of new competitors may happen as the motivation to recruit new members, even for the most diehard individual competitors, would shift into the positive expectation.

Further Work

An infinite variety of scoring systems are possible, but some were considered here, one set (including the current NAR system) where additional competitors are rewarded with a single point each, two alternate systems based on the LSF system where additional contestants reward those that beat them by providing additional points, and one hybrid system where the first 10 contestants are rewarded in an LSF way, but beyond that, very few additional points are given. Both the reward curves and an expected value analysis could be considered for any number of alternate systems. Finally, an additional survey could be conducted (with better preparation and consulting of expert survey designers) with more options, or with fewer options that better span the variety of possibly scoring systems.

Of course, this work has been entirely theoretical, one future area would be to change the NAR system, changing the incentives for sections to recruit additional members to fly competition and see if the desired goals of increased competition result. By building up a base of local and regional competitors, NARAM participation would likely increase. Of course, perfecting the system could be done with iterations through the Rule Change Proposal system currently in place for changing NAR Sporting Code rules.

Additional Ideas

One might ask what removing the assumption of no age divisions does to the LSF or LSF Root model. In fact, one might remove age divisions for the purpose of Competition Points, but retain them for individual placing, ribbons and trophies. If an A divisioner bests many C divisioners in competition, they likely deserve the additional points they would receive. The same may not be true for C divisioners besting A and B divisioners, so the C division points could be calculated as the number of C Division contestants bested (or C plus Teams).

Rule Change Proposal

The natural extension of this report, a rule change proposal changing Rule 13.1, will be considered, discussed and submitted for the 2013-2014 RCP cycle. Feedback from this report will certainly affect the RCP submission.

Budget

No money was spent on this report.

Equipment

Computer (MacBook Pro) was owned by the author. Printer, copier and pencils were provided by the NARAM-55 host hotel.

Facilities

None used.

Related R&D Reports Entered by the Author

None

Acknowledgements

The author is indebted to Bob Parks for sparking the original idea for this proposal and research subject, many NAR members for discussions of these ideas, and 42 NAR members at NARAM for taking the survey.

References

1 http://nar.org/pinkbook/. ***U.S. Model Rocket Sporting Code*, 2012-2013.**

2 http://www.nar.org/competition/NARpoints.shtml. ***2012-2013 Final Pre-NARAM Points*, 2013.**

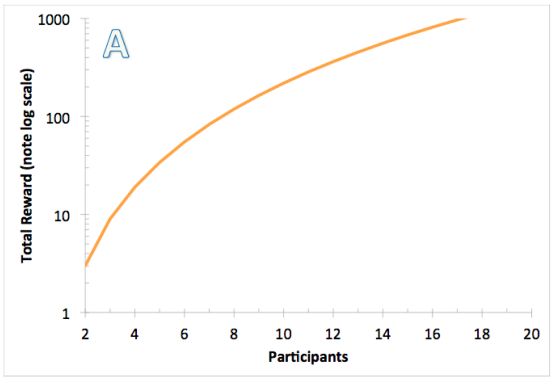
3 http://en.wikipedia.org/wiki/List_of_Formula_One_World_Championship_points_scoring_systems. ***Formula 1 Scoring Systems*, 2013.**

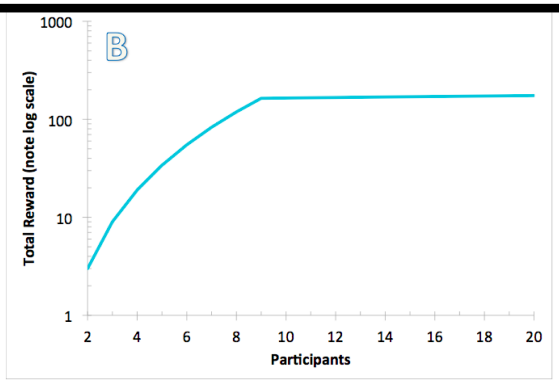
4 http://www.silentflight.org/index.php/lsf-program/lsf-tasks. **2013.**

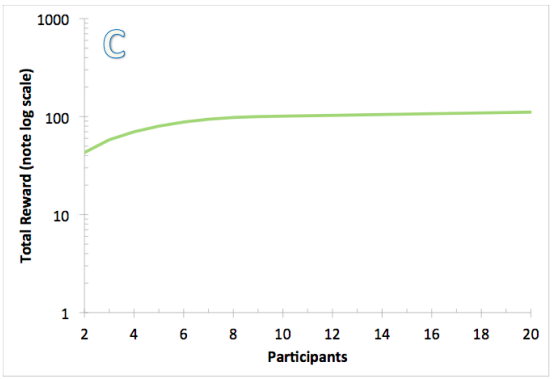
Appendix

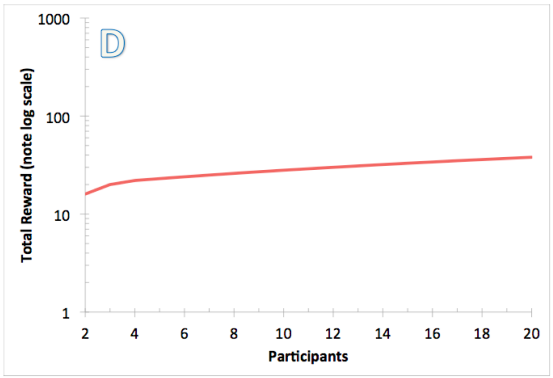
Survey Questionaire as used follows.

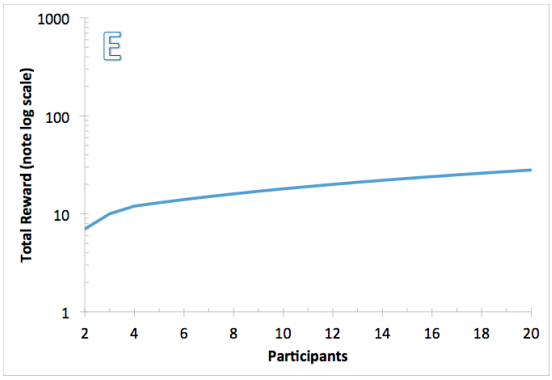
Which of these do you think represents the
NAR competition participation to Total Rewards structure?

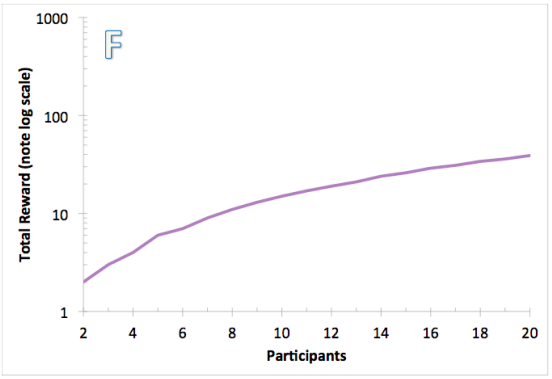












Which of these do you think SHOULD represent the
NAR competition participation to Total Rewards structure?