



Citrus Circuits
Fall Workshop Series

Scouting

Presented by Richard McCann & Bryton Moeller



no papr jam

#wow



such disk

STEVE HARVEY MONEYBOT\$

BASED ON A TRUE STORY

CELEBRITY PICTURES PRESENTS A SCOTT BROWN/MICHAEL DE LUCA/FACADE PRODUCTIONS PRODUCTION A FILM BY BENNETT MILLER
"MONEYBOT\$" STARRING STEVE HARVEY AND ANTHONY MANNING COSTUME DESIGNER GREGG WILSON EXECUTIVE PRODUCERS JESS GONICKER AND DAVID PRATER
PRODUCED BY SCOTT BROWN ANDREW W. HANSEN STEVE KRAMER AND DAVID BAZZO WRITTEN BY MICHAEL LEUNG AND SHAN CHERYL DIRECTED BY BENNETT MILLER
CASTING BY STEVEN JACOBSON AND LARSON TRUMAN
EDITED BY MICHAEL DE LUCA AND DAVID BAZZO EXECUTIVE PRODUCERS ANDREW W. HANSEN AND STEVE KRAMER
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THIS FALL



Introduction to our system

OVERVIEW



Principles

- Combine quantitative and qualitative data to allow us to discover otherwise overlooked value in competitive robots
- Sabermetrics
 - The image is just to make the word easier to remember



Objectives

- Find alliance mates with specific complementary attributes
- Create match strategies with an accurate understanding of your alliance's and opponents' capabilities



Reported Statistics

- OPR = Average offensive contribution
 - CCWM & DPR - Don't bother...
- Actual scoring vs. OPR
 - ~0.95 correlation in 2012, 2013, 2015; not so close in 2014, 2016
 - 2013 example: 1678 on Curie
 - OPR = 42.8 but Avg Score = 69.5
 - Other teams averaged 28.5 fewer points with us
 - $69.5 - 28.5 = 41 \approx \text{OPR}$



Beginning of build season

ANALYZING THE GAME



The union of strategy and scouting

- Your strategy defines what you scout for
 - 2016: High vs low goal, scaling
- Identify all valuable robot actions
 - Identify most effective scoring method, for determining first pick
 - Identify effective second roles/scoring methods



Reading the Rule Book

- Know the game rules inside and out
 - Strategies don't work if they're illegal
 - Rules test
 - 2014: Knowing “assist” definition
- Understanding ranking/tie breakers
 - coopertition, assists, auto, breech & capture
- Win margin \neq seeding order



Efficient Match Strategy

- Consider every method of scoring points
 - 2014: Assists
 - 2016: Capturing and breaching
- Difficulty vs. points awarded
 - What is the most cost-effective scoring method?



Defense = “Descoring”

- Preventing 10 points is just as valuable as scoring 10 points
 - Consider every method of preventing opponents from scoring: 2015 canburglars
- Remember, protected scoring zones are not always defendable: 2012, 2013, 2016



First pick robot

- Robot that best complements your strategy
 - 2014: Midfielders pick finishers, and vice-versa
- Reliability
- Consistency
- Versatility

1	148	205.77
2	971	199.74
3	1678	187.46
4	4334	174.03
5	869	168.08
6	4967	166.79
7	294	164.72
8	1425	163.99
9	1323	161.75
10	2046	161.29
11	70	159.43
12	1538	159.3



Second pick robot

- Robot that fills gaps
- Likely not scoring or playing offense
 - Remember limiting number of game pieces
- Value-added paramount
 - 2016: defense + climb + auto
 - 2014: Inbound + defense + auto
- Driver ability defines defense



What information do we want

OUR STATISTICS



Intended Results

- A functional alliance that has synergy
- First pick: offensive robot that doesn't compete with us for scoring objects
- Second pick: versatile defensive robot that can respond flexibly including counter-defense, auto, end-game, etc.



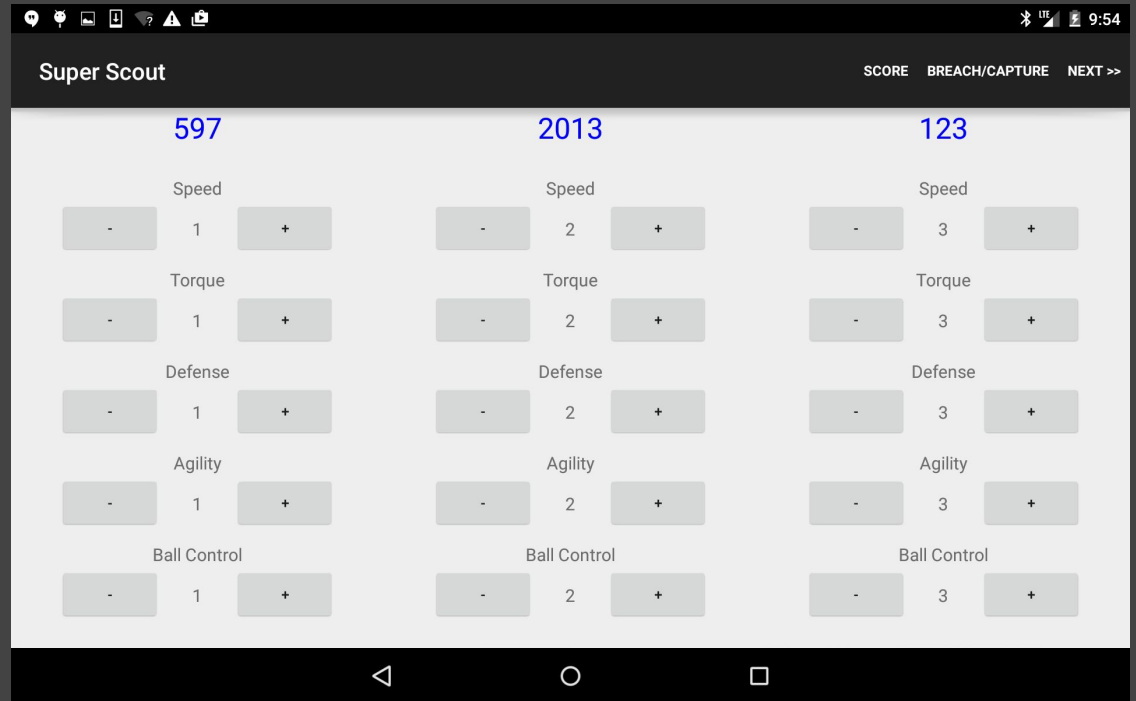
Effective Data To Scout

- List every robot action which has value in the game, including those which require multiple robots
- Start choosing what to scout by setting objectives for an effective eliminations alliance
 - Identify unique offensive and defensive traits
- What do we need from our picks?
 - What unique traits do we value the most?



Simple Data

- Easily understood
- Observable in the field
- Ordinal Ranking



Reported Metrics

- Quantitative:
 - Most offensive stats
 - Everything that can be counted (discrete numbers)
- Qualitative:
 - Subjective but comparative
 - Driver ability, evasion, blocking
 - Robot aspects (e.g. speed, torque)



Combined Quantitative & Qualitative Observations

- Quantitative fairly easy to gather and analyze
- Qualitative
 1. Gathered in consistent manner
 2. Converted to quantity metric
 3. Weighted



Abstract Values

- Cannot scout a robot's contributed score directly, instead scout for ability and execution
- Converting abstract values into discrete values
 - 2014: Quantifying assists
 - Redefined as possessions and passes
 - 2016: Defenses crossed and how fast



Quantities Made of Qualities

- Ordinal ranking within a single match
 - Within a match based on transitive property
 - $A > B, B > C, \text{ therefore } A > C$
- Cumulative match rankings over all matches
- Added “Z score” normally distributed ranking



Quantities Made of Qualities Continued...

- How much are these values really worth?
- Iterative multi-step process
- Initial step using previous year's data
- Update with early event results
- Compare draft list with quantitative analysis
- Update weights to match preferred qualities



Quantities Made of Qualities

Continued...

- Calculate from match results
 - Derive “defensive” value
 - How much does score deviate from predicted based on offensive stats from scouting system
 - Calculate best weights that explain “defense”
 - Minimize squared error on predicted match scores using Solver
 - Estimate updated weights and defensive values regressing on preferred draft order



Draft Pick Metrics

- Combining our recorded numbers into meaningful values
- **Offense**
 - 2016: Auto + teleop + breach + challenge/scale
- **Value added**
 - 2016: auto + breach + challenge/scale + driver ability
- **Driver ability**
 - Speed + blocking + evasion + torque



Hardware and software

OUR SYSTEM



Implementation

- Whitepaper Available
- Ease of use
 - Scouting interface isn't so difficult to use that it causes poor data
- Robustness
- Easy troubleshooting
 - Don't reinvent the wheel



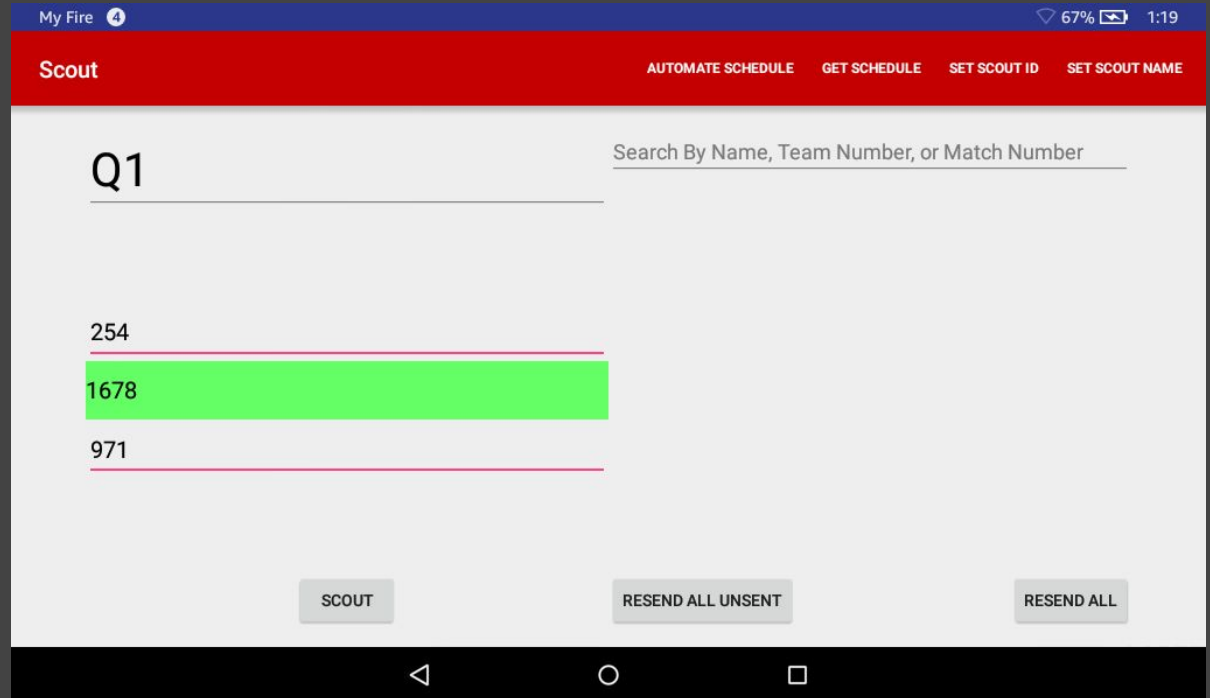
Hardware and Software

- Understand programmer experience, time, budget
 - Better to be simple, ugly and working than sophisticated, beautiful, and working the week after the competition that you need it
 - Schedule/Testing
 - Require stamp of approval from future users



Hardware Continued

- Tablets
- Bluetooth
- Smart phones
- Server



Software

- Java for Android, Swift for iOS, Python for Server
- Javascript etc. for web app
- Spreadsheet Magic/Other Technologies



scout-viewer-2016-android

Recent Matches

Upcoming Matches

			MATCH
Our Schedule	1732	5910	
Starred Matches	346	1684	117 / 143
Schedule	1323	4920	109 / 128
Seeding	5254	6153	
Predicted Seeding	5618	5232	123 / 100
First Pick	4377	597	88 / 167
Overall Second Pick	70	1678	
Super Data	3019	1736	121 / 103
	4587	5801	162 / 89
	4216	172	
	3414	812	

AT&T LTE 13:52 83%

1678

Matches Teams

5	670	1678	2990	122 / 74
	5805	4334	5232	
14	5847	4256	1678	114 / 137
	5166	148	5431	
38	2013	1678	1323	157 / 92
	3397	3414	5254	
45	364	422	971	98 / 101
	812	686	1678	
	172	5546	2046	

1 2 3

4 5 6

7 8 9

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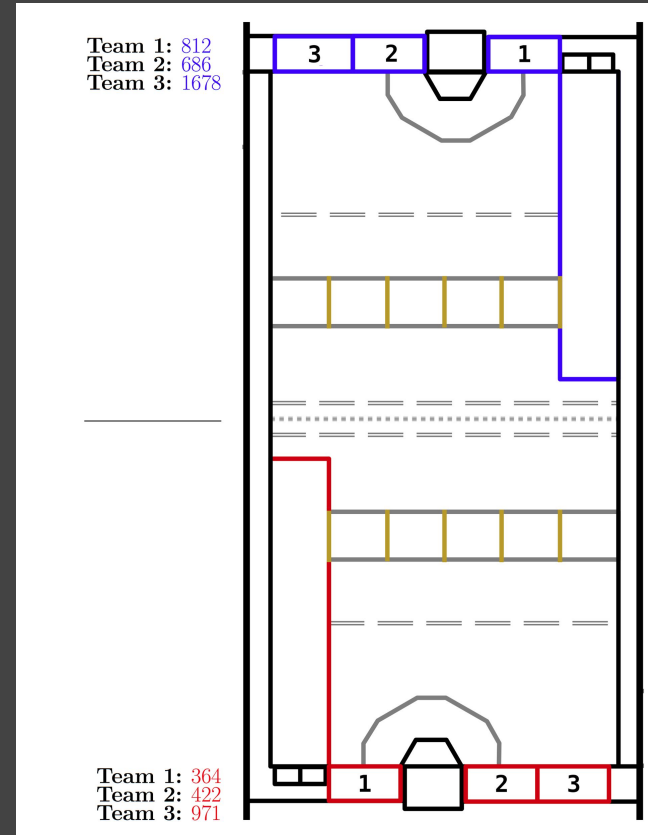
Applied scouting

AT COMPETITION



Pre-Competition Preparation

- Training and organizing scouts
 - Scout week 1 events
- Updating statistical weightings
- Score prediction
- Pre-match strategy sheets



Training and Organization

- Scouting team layout
 - Head scout
 - Programmers
 - Scouts
 - Super Scouts
 - Strategist
 - Videographer
 - Mentors for strategic insight
- Train by scouting old matches
- Schedule scouts, give breaks



Prediction and Strategy

- Watching other teams to determine future match strategies
- Identify most difficult matches, which teams to focus on and roles of alliance members
- Develop match strategy and help allied robots
 - use databases prior to competition
 - use scout data prior to matches



Pit Scout

- Pictures:
 - Much easier to identify robots during draft night
- Team organization
 - Is their pit crew organized & can they fix a robot?
- Game-specific attributes
 - 2012 bridge balance
 - 2014 inbound speed
 - 2015 cheesecake



Gaming it out

DRAFT NIGHT



Draft Night Preparation

- Compiling materials
 - Data presentation keeps up with pace of discussion
- Include the person who will announce your team's pick, but make it a very small group (or a meticulously organized one)
- Picking draft team
 - Avoid hivemind, play devil's advocate
- Get food to-go, don't waste time eating



Scenarios

- Possible seeding order
 - Make pick list for each possible outcome
- Know which robots will be pairing together
 - Figure out how to break up good alliances or how to beat them
 - Know who you are facing quarters and semis
 - 2015 can races



The Draft

- Predicting seeding order
 - 90% accuracy predicting match outcomes with actual average scoring
- Preparing list of 1st and 2nd picks
- Predicting other 1st and 2nd picks
- Preparing counter-picks
 - counter defense, and defensive bots



The Final List

- DESTROY ALL NON-FINAL LISTS
 - Make sure the only list your captain has is the one they will use. Standing on the field, cross off teams as they become alliance captains or get picked.
- Have lists for every scenario, destroy them when seeding is finalized
- Have 2 - 3 people adjusting/perfecting lists if robots perform better or worse



Lessons Learned

- Scrapped original scouting system
- Changing to Bluetooth
- Server Issues
- Real-time data upload
- Scout practice / systems test / integration test



In The End...

- Sometimes you may override the system and go with experience and intuition
- No system is perfect, numbers can sometimes cause you to overlook good teams
- Computers need your sanity checks, they don't have their own



Improvements

- Measure and improve scouting accuracy
- Better elimination round scouting
- Linkage to streaming video for real time scoring



“It’s about getting things down to one number. Using the stats the way we read them, we’ll find value in players that no one else can see.”





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Thank You!