

Should You Be Measuring or Monitoring Scoring Efficiency?

Efficiency – *“the ratio of effective work to the energy expended in producing it, as of a machine; output divided by input.”*
- Webster’s New World Dictionary.

We coach to averages. The concept of regression to mean tells us that every player and team has an average level of play. Then, day in and day out they will perform around that average – sometimes better, and sometimes not. A player or team having a great day will eventually make some mistakes and drop back to a more normal (for them) level of play. By the same token, a player/team that is struggling will eventually improve their performance and play back up to their average performance levels. As coaches, our job is to, over time, to increase the player’s and the team’s average level of performance.

How do we measure that average performance and if it is increasing? Some coaches rely on their experience and instincts to tell whether a player or team is improving. Others look for solid measurable statistics to document those averages and their changes. Some use the statistics as a guide to support or contradict their instincts. Most of us are probably a little of all three.

So what is behind a team’s hitting stats? The simplest answer of course - is the players on the team. Is it possible to analyze individual player’s contribution to an overall team performance? And is it possible to compare their contributions to each other?

Hitting Statistics

There are a lot of standard statistics that we use to measure and use to describe the hitting or scoring ability of individual players or entire teams. Different levels of play use and track hitting stats in a variety of ways. Maxpreps (USA High School Volleyball) records hitting stats of: Sets Played, Kills, Kills/Set, Kill%, Attacks, Errors, and Hit%. The Data Volley recap sheets for the USA Women’s National Team tracks: Sets Played, Total Attacks, Errors, Blocks, Points, and Points%.

- Sets Played – number of sets played to collect the data.
- Total Attacks – This is a statistic that is completely dependent on how many times a hitter gets set. It tells you nothing about the hitter, other than whether the setter likes setting her or not.
- Attacks per set – (see total attacks). Total attacks divided by the number of sets played.
- Attack percentage (points percentage) – $(\# \text{ of Kills} - \# \text{ of errors} - \# \text{ of blocked shots}) / \text{total attack attempts}$. If a middle hits two set balls, and scores two kills she has a 100% attack percentage. That is the highest percentage possible. Does that make her a better hitter than an outside who scores 7 kills off 10 sets with one error and has an attack percentage of 60%? Walk into a group of coaches and offer \$10 to the first person that can prove to you which of those two hitters is the best... Like many performance statistics – attack percentage tends to level off if the sample size becomes large enough - after enough matches - good days and bad days average each other out. With smaller sample sizes, like single games or matches, attack percentage can vary wildly depending on the hitter. But also on the quality of blockers and defense the hitter is facing.
- Total Kills – Like total attacks and attacks per set this number is by itself is a useless stat. It is heavily dependent on, and effected by the hitter, the number of sets or attempts the hitter takes, and the defense.
- Kills per set – (see Total Kills). Simply the number of kills divided by the number of sets played. Again this stat is very dependent on how many attack attempts the hitter gets.
- Kill percentage – $(\# \text{ of kills} / \text{total kills})$ This is the percentage of a players attack attempts that they score with. It is a form of scoring efficiency. Except that it isn’t good for comparing one player to another. Like the example

used in attack percentage – the middle still has a 100% but now the outside hitter is up to a 70%. But how do you compare a hitter with only 2 attack attempts to a player with 10 attempts?

Volleyball is a Team Sport

Everything a player does on the court effects, or is effected by, their teammates, and their opponents. No one plays this sport in a bubble. Most hitting stats focus attention on an individual's hitting stats and many coaches use them to track a players hitting prowess. What traditional volleyball statistics don't tell us is how to compare one player's hitting to a teammate's hitting. Traditionally how the team's hitting prowess is measured from game to game or match to match is up to each individual coach's philosophy to evaluate. Individual scoring efficiency will not change that or help with it. Individual scoring efficiency is used to evaluate each individual on the team's contribution to that team's total performance.

The most important aspect of hitting, from a team point of view, is "Did we score more points than our opponent?" From an individual player's point of view the most important thing on every attack is "Did she score a point?" The only hitting stats that don't rely on scoring points are 'total attacks' and 'attacks per set'. And no one ever brags – "We lost 10-25 and I didn't score any points but I had 12 attacks with no errors."

Scoring Efficiency

Over a specific period of time (a few rallies, a game, a match, or a season) every team will attempt a certain number of attacks and score a specific number of points (kills). Instead of looking at players attack percentage or kill percentage how about a different statistic that looks at a player's contribution to the team scoring? Scoring Efficiency is calculated as a player's contribution to a team's overall ability to score points. Looking at the original description of efficiency (from the top of this essay) scoring efficiency is calculated as scoring output divided by attempts input. But since we want to know this based on contribution to the team effort, we will use a player's percentage of scores and attacks instead of raw total scores and attack attempts. This generates two new intermediate stats:

1. PCT Points – the percentage of the team's total points scored were scored by a specific player.

$$PCT\ Points = Player\ Points \div Team\ Total\ Points$$

Adding up all the PCT Points for every player on the team, the total should be 1.0 (100%).

2. PCT Attacks – the percentage of the team's total attack attempts that were attempted by a specific player.

$$PCT\ Attacks = Player\ Attacks \div Team\ Total\ Attacks$$

Adding up all the PCT Attacks for every player on the team, the total should be 1.0 (100%).

These new stats give us the scoring output and the attacks input to determine a player's scoring efficiency. Divide the player's percentage of team points scored by the player's percentage of the team's attacks gives the player's Scoring Efficiency.

$$Scoring\ Efficiency = PCT\ Points \div PCT\ Attacks$$

What does scoring efficiency mean? A scoring efficiency of 1.00 is when the player scores the same percentage of team points as their percentage of team attacks. i.e. if a player gets 40% of her team's attacks and she scores 40% of the team's points her scoring efficiency will be 1.00. If she gets 40% of the team's attacks and only scores 30% of the team's points her scoring efficiency is 0.75. If she gets 40% of the team's attacks and scores 50% of their points her scoring efficiency is 1.25.

Scoring efficiency will not determine whether a player is hitting well or not. It will only tell us if the player is making the most efficient use of her scoring opportunities. In fact you can draw no direct correlation between a players attack percentage or kill percentage and her scoring efficiency. Attack percentage and kill percentage calculations are based on the individual player's total number of kills and attacks. Scoring efficiency depends on the percentage of the team totals

each player scores and attempts. However, you might expect to see a favorable comparison between scoring efficiency and attack percentage, or kill percentage, simply because a struggling player is not likely score a large percentage of her team's points.

Example 1:

Penn State hitting stats from the 2013 NCAA Div 1 National Championship Match between Penn State and Wisconsin

Penn State

No	NAME	Sets	Kills	Err	TA	Att%	Kill%	PCT Kills	PCT Att	Scoring Efficiency
17	Megan Courtney	4	5	5	22	0	0.227	0.081	0.129	0.62
7	Nia Grant	4	4	2	10	0.2	0.400	0.065	0.059	1.10
12	Micha Hancock	4	5	5	14	0	0.357	0.081	0.082	0.98
18	Deja McClendon	4	11	8	44	0.068	0.250	0.177	0.259	0.69
1	Ariel Scott	4	21	6	51	0.294	0.412	0.339	0.300	1.13
16	Katie Slay	4	14	1	27	0.481	0.519	0.226	0.159	1.42
9	P. Prieto Cerame	3	2	0	2	1	1.000	0.032	0.012	2.74
Total		4	62	27	170	0.206	0.365			

So what does this mean? The column PCT Kills is the percentage of the teams total kills (62) that were scored by each player. PCT Att is the percentage of the team's total attacks (170) that were attempted by each player. Scoring efficiency is PCT Kills divided by PCT attempts. Looking at the stats above you can see that Katie Slay had a relatively high scoring efficiency of 1.42. She scored 22.6% of her teams total points, and did so with only 15.9% of their attacks. On the other hand Deja McClendon scored 17.7% of her teams points but she used 25.9% of their attacks to do so, hence her 0.69 scoring efficiency.

This could mean a lot of things:

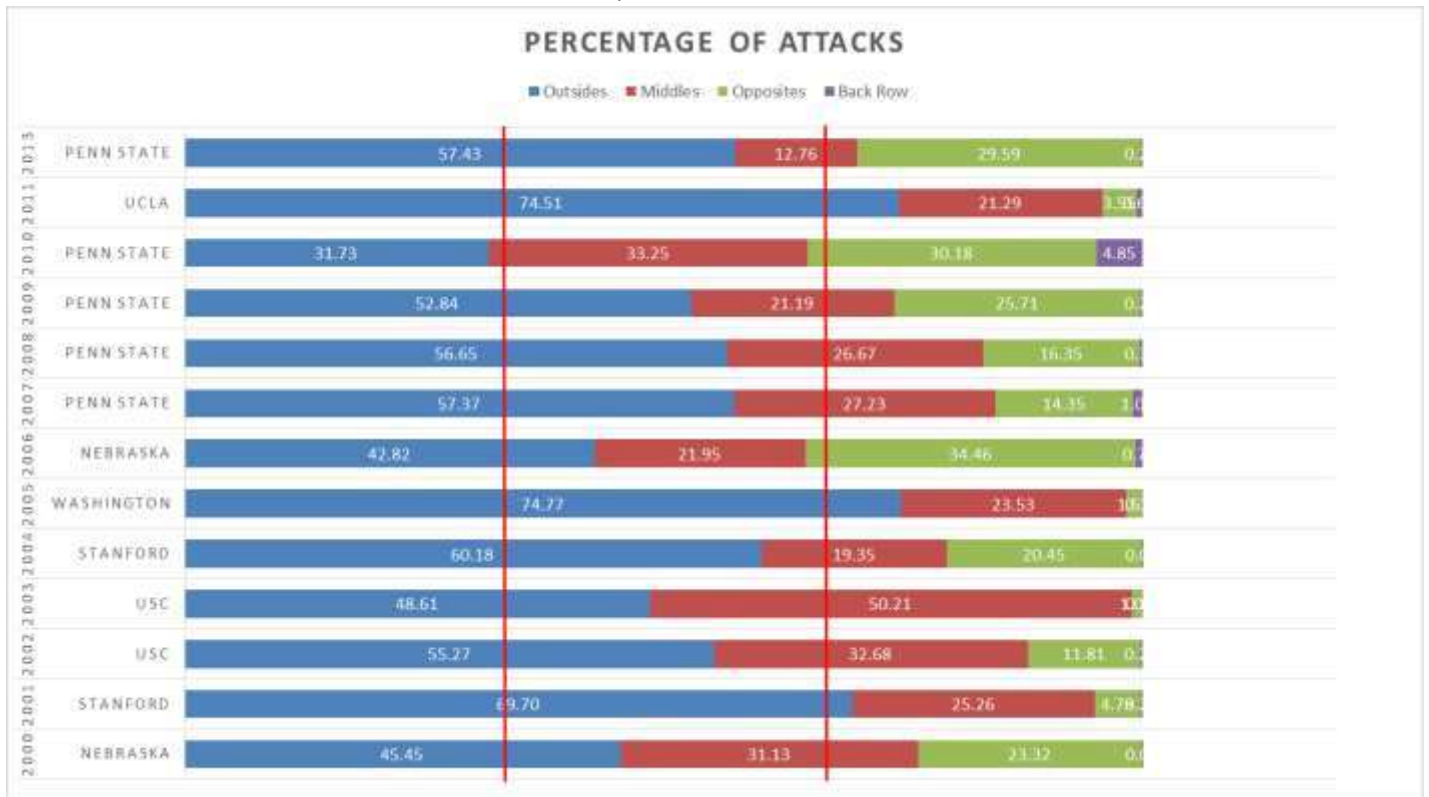
- Katie Slay was having a good day. Looking at Katie's season long attack percentage of .4143 and her season kill percentage of 0.5160 (see supplemental 1) you will see that for the championship match that both her attack percentage and her kill percentage were up over her average for the season. Overall a good day.
- Deja McClendon was having a bad day. Looking at Deja's season long attack percentage of .2739 and her season kill percentage of 0.3966 (see supplemental 1) you will see that for the championship match that her attack percentage and her kill percentage were significantly down from her season averages. Overall not a good day.
- If you don't have their season stats to compare today's stats against - you could just look at their scoring efficiency and see that Katie was making much better use of her scoring attempts than Deja was.
- If this was a trend that was tracked over several games or matches you could argue that the Penn State setter should shift some of the sets she would normally send Deja's way and set Katie instead, or Grant, or Scot.
- Or perhaps the coaching staff needs to work with their setter to better evaluate who is scoring the most efficiently at the moment and put the ball into that girls hands.
- Or it could mean nothing because the coach and/or team doesn't care who scores their points as long as they get scored and they win the match.

Example 2:

This all started looking for a way to give a setter a little more hard data about how to distribute sets to the three main hitting positions in the front row. But I didn't have the right stats to answer that question for her. When I needed some more data to work with so I took a look at the last 13 NCAA Div 1 Women's National Champion. (Sorry there was no data available online for Texas in 2012).

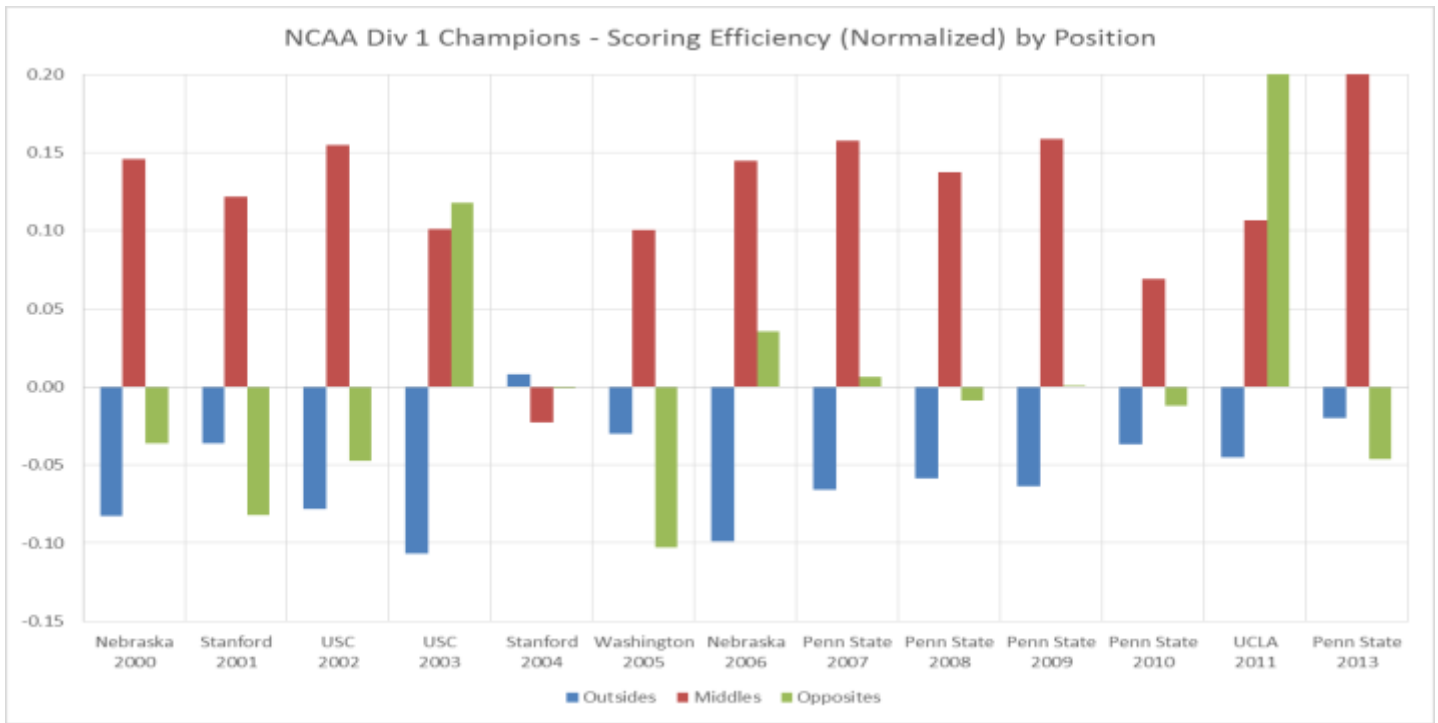
Since the initial question was set distribution I sorted the data from our national champions by position instead of by individual hitters.

The attack distribution for the last 13 National Champions was:



Notice that 2010 Penn State ran the most balanced offense. Most of the rest of the teams ran a very “outside” oriented offense.

Here are the Scoring efficiencies of the same teams, once again sorted by position instead of player. Note this chart was normalized by subtracting 1.0 from all the efficiencies. In this chart a 0.00 is the same as a 1.0 in the previous example. But normalizing the results makes the differences in scoring efficiency more easily recognizable when graphing.



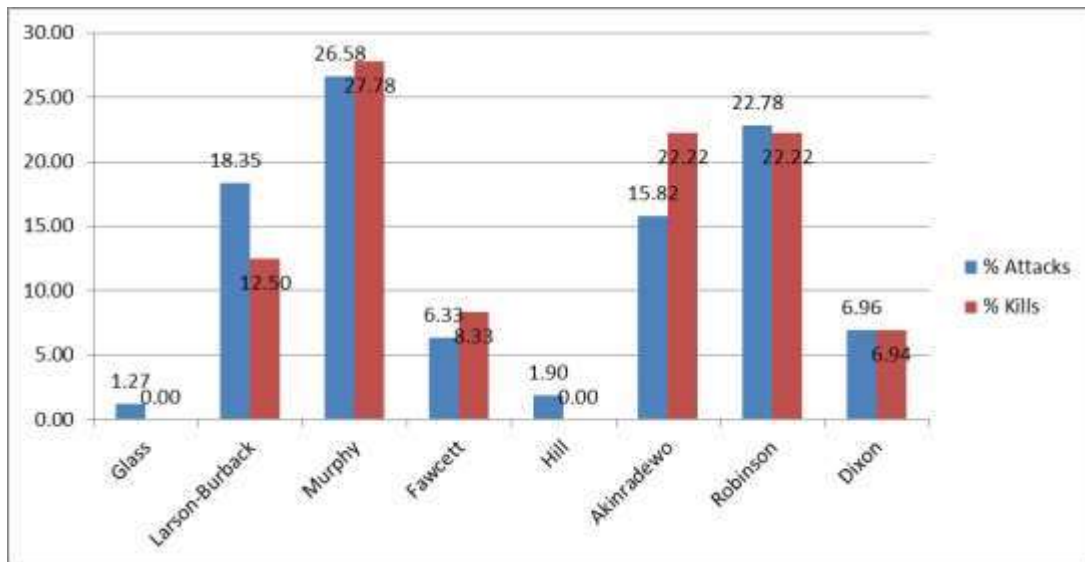
So what does this show – other than Stanford in 2004 every single National Championship team over the last 14 years has had middles that are more efficient at scoring than their outside hitters. Even though the outsides overwhelming get more attack attempts than the middles. But since all these teams were national champions – does that matter? Draw your own conclusions...

Example 3:

USA Women’s National Team USA Volleyball Cup match vs Brazil July 11, 2014 – Stats from Data Volley

USA	Set					Vote	Points			Serve			Reception				Attack			BK Pts					
	1	2	3	4	5		Tot	BP	W-L	Tot	Err	Pts	Tot	Err	Pos%	(Exc%)	Tot	Err	Blo		Pts	Pts%			
1	Glass	5	5	5	5	3	6.1	1	1	+1	22	.	.	.	.	.	2	.	.	.	.	1
2	L Barwarth						.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
3	Thompson						.	.	.	.	7	.	.	.	.	.	.	.	.	.	.	.
4	Paolini						.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
6	L Davis						.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
7	Lichtman						.	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.
8	Gibbemeyer						.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
9	Hildebrand						.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
10	Larson-Burbach	3	3	3	3	3	5.9	11	5	+2	16	3	.	19	1	53%	(16%)	29	2	3	9	31%	2		
12	Murphy	2	2	2	2	6	5.9	21	5	+14	12	1	1	42	4	2	20	48%	.		
14	Fawcett						.	7	1	+6	10	.	1	6	60%	1		
15	Hill					1	2	3	1	1	.	.	.		
16	Akinradewo	4	4	4	4	2	6.5	18	5	+14	18	.	1	1	1	100%	(50%)	25	3	.	16	64%	1		
17	Klineman							
22	Adams							
26	Robinson	6	6	6	6	4	6.1	21	8	+12	17	2	1	58	3	50%	(21%)	36	2	2	16	44%	4		
28	Dixon	1	1	1	1	5	6.3	12	7	+10	13	.	1	11	1	1	5	45%	6		
Team totals							91	32	+57	112	6	4	98	5	52%	(21%)	158	13	10	72	46%	15			
							Points won:			Ser	Att	Blo	Op	Er											
							Set 1	1	20	.	4	23	4	1	18	.	39%	(28%)	35	2	.	20	57%	.	
							Set 2	.	11	6	5	23	.	.	20	2	40%	(10%)	25	3	1	11	44%	6	
							Set 3	.	19	2	6	26	.	.	24	.	62%	(21%)	45	5	4	19	42%	2	
							Set 4	3	12	4	6	26	1	3	25	2	60%	(24%)	36	3	3	12	33%	4	
							Set 5	.	10	3	2	14	1	.	11	1	55%	(27%)	17	.	2	10	59%	3	
Head coach																									
Assistant																									

Charting each player’s individual percentage of the team’s attacks and kills gives us:

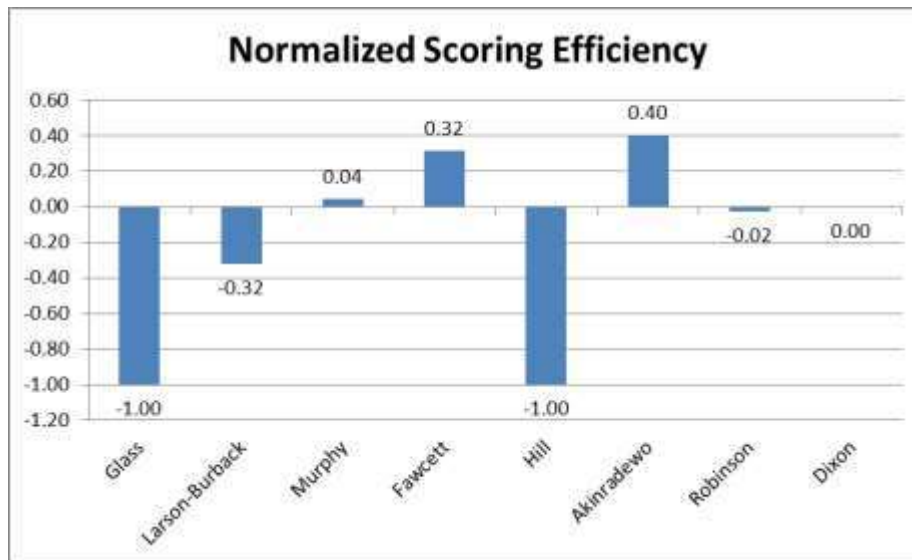


Just glancing at this chart you can easily see that Glass, Larson-Burback, Hill and Robinson were not making the best use of their attack attempts. Murphy, Fawcett and Akinradewo were being more efficient with their attack opportunities and Dixon was pretty much producing points commensurate with her attack opportunities.

Charting their actual scoring efficiency gives us:



Normalizing this chart around zero looks like this:



So what should we do with this information? Like all stats – that is up to the coach and the team.

But it appears that Glass and Hill did not appreciably contribute to their teams scoring. Larson-Burback was not having a good night. Murphy, Robinson and Dixon were working hard and contributing well to their team’s offense. Fawcett and Akinradewo should have been given a more dominate roll in hitting that night, as they were both making good use of their scoring opportunities.

Conclusions:

Stats are stats. They can lead you places you didn’t expect. They can mislead you. They can clarify situations that have you confused. They can be used to lie, and to tell the truth. They can support preconceived “truths” or they can blow them out of the water.

I was looking for a way to compare different players, or different hitting positions within a team – to each other. I was looking for something other than attack percentage and kill percentage as a way of judging a hitters contribution to her team.

Pros:

- Gives a measure of player contribution based on overall team performance. Traditional stats treat each players performance as though she was in a bubble playing alone. Traditional stats also do not take into account the diverse distribution of sets in the game.
- Notice nowhere does wins and loses come into the calculation. Simply – this is how the team performed (good ot bad), and this is how each player contributed to that performance.
- Simple snapshot of player performance compared to her teammates. You don’t have to go look up past attack percentages to compare current percentage to them.

Cons:

- Does not lend itself to old fashioned pencil and paper stat taking. If you want efficiency stats during a match you will need electronic stat keeping that can keep a running total of not only player, but team performance and that perform calculations on that data – real time.
- Useless stat for comparing different players from different teams. Or from different matches. For the comparison to be accurate you have to evaluate every player over the same time, using the same overall stats. Whether that time period is a series of rallies within a game, a single game, a match, or an entire season as long as everyone contributed during that time period the results will be valid.

Finally – If you are looking for a way to evaluate individual performance as part of a team, and compare that performance to other members of that team this seems to be a solid method.

It also looks to have some use in evaluating offensive strategy. Are your “best” hitters really delivering the goods? Is that middle that you moved to the outside last week as effective there as she was in the middle? Should you spend a little more time with your setter talking about set selection? Should that quiet opposite that you tend to think of as just a blocker, get a few more opportunities to hit? Should you spend more time teaching some of your hitters to be more efficient?

But those are all questions for another day...

Supplimental 1

2012 Penn State Season Long Hitting Stats

2013		G	K	E	TA	Att%	Kill%
MH	Robertson, Kelly	3	6	1	9	55.56	66.67
MH	Slay, Katie	127	274	54	531	41.43	51.60
OH	Grant, Nia	118	208	64	411	35.04	50.61
OP	Hancock, Micha	127	129	36	281	33.10	45.91
OH	Whitney, Aiyana	32	42	12	95	31.58	44.21
OP	Scott, Ariel	115	383	103	971	28.84	39.44
OH	McClendon, Deja	126	378	117	953	27.39	39.66
OH	Courtney, Megan	120	297	96	740	27.16	40.14
OH	Prieto Cerame, P.	66	89	36	210	25.24	42.38
OH	Martin, Maddie	35	7	2	21	23.81	33.33
DS	Caraway, Lara	24	0	0	1	0.00	0.00
DS	Gonzalez, Dominique	127	1	2	8	-12.50	12.50

From: <http://www.gopsusports.com/sports/w-volley/stats/2013-2014/teamcume.html> Supplemental 2

Background: (or where did this all come from)

Author’s note: *I don’t want this to be a discussion of offensive theory of volleyball. I would love to have that discussion, but will save it for another day, and another forum. But much of what led me to this happened while teaching a young setter how to run our offense.*

I was having a discussion with a setter a couple years ago. I was explaining to her that under our team's theory of running a balanced offense, she would be responsible for distributing sets to ALL our hitters. But she would need to do so in a random manner, so she didn't get into a pattern of setting that our opponents could use to anticipate where our next attack was coming from. It would also be her prerogative as the setter to determine which hitter was "hot", or having a "good" day and get that player some extra opportunities to score. She asked me "how do I know who is "hot" right now, and who isn't?" The only answer I had for her was "Pay attention to your hitters, watch who is scoring, who isn't, who is emotionally "up" and who is "down" and lastly she had to develop and learn to trust her gut instincts."

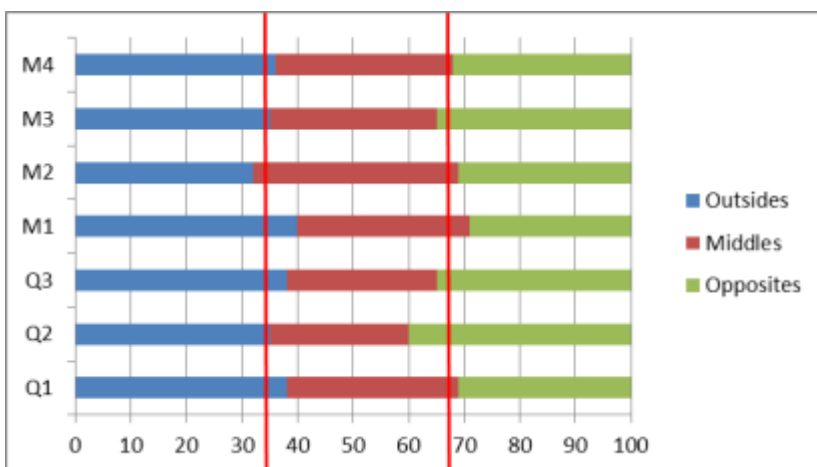
Over the next couple months we talked a lot about our hitters and her choices on set distributions. We discussed different offensive theories. She originally liked the theory that you put your best hitter at the outside and set them more than anyone else, because that is the way her High School team played, and she was used to it. Also, it was easy, simple, and took a lot of decision making pressure off her. But she got a little flummoxed when I asked her to "define your 'best' hitter."

Who was our best hitter? What made her "the best"? Was she always our best hitter? Does she ever have an off-day? And what do we do if our best hitter happens to hit better as a middle or opposite, than an outside? If we move her to the outside will she still be out best? If we are going to set most balls to the outside, why are we spending so much time training our middles and opposites to hit? These questions led to a lot of talk, but not many answers. (And if I keep asking them here, this will become a treatise on offensive theory of VB).

So how do you define your best hitter? Does she jump the highest, hit the hardest, or do you just go with your gut and pick the one who is "obviously" the best hitter. Or do you look for some hard facts, some numbers, maybe even a little truth (don't start with me, we can argue about the truth of statistics later). Or is she the player who contributes the most to your overall team scoring.

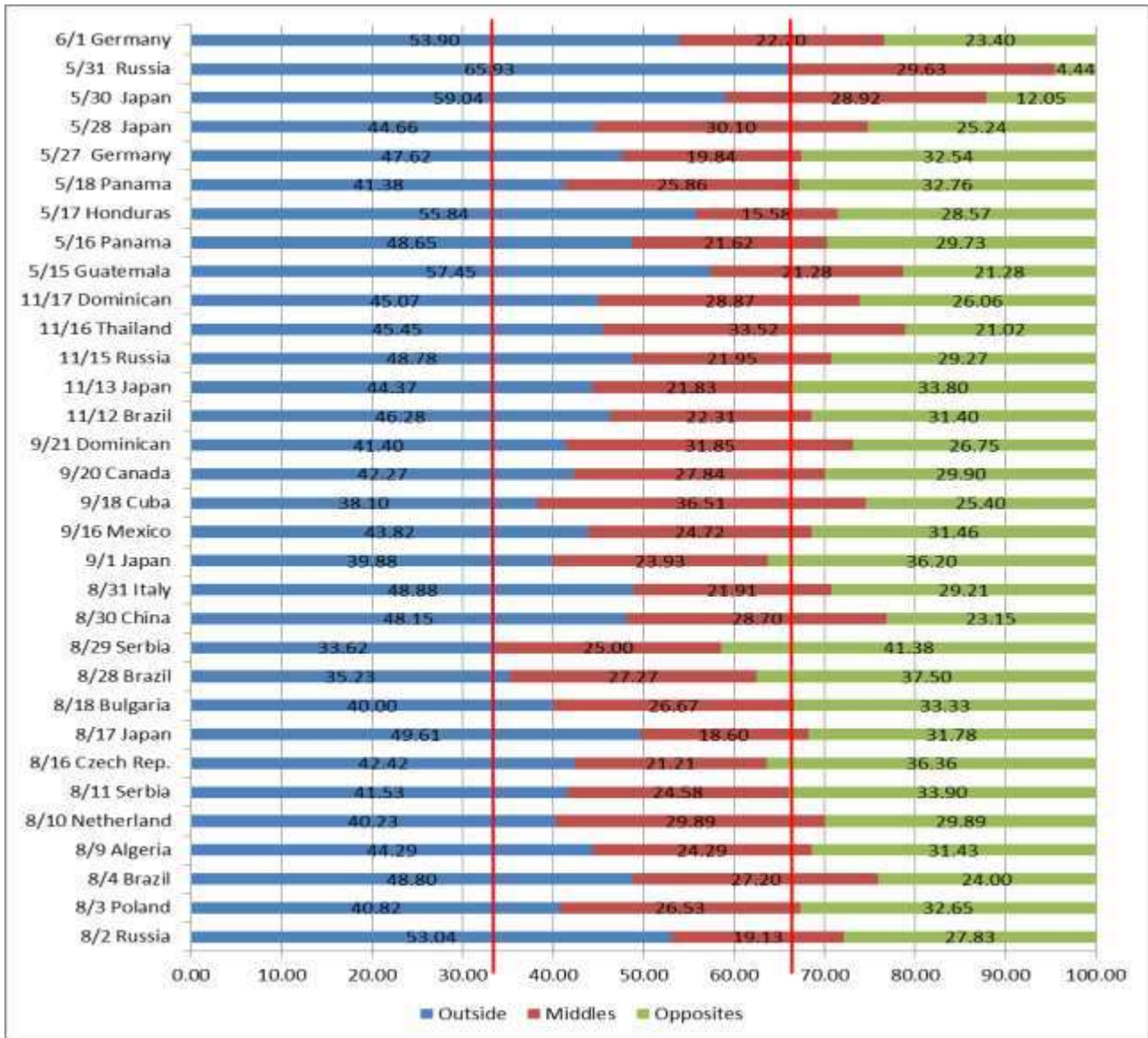
All the standard stats that we traditionally use in volleyball have one problem – they focus solely on a single player. Volleyball is a team sport and no one player plays in a bubble, separated from their teammates. So why do we take and track stats on individual basis?

I started out looking at team stats to help my setter see how she was distributing sets among her hitters. This data could not be drawn from the standard stats I had collected for matches that season. Our hitters would play all three positions in the front row. So data had to be collected player by player, for every rotation from old videos:



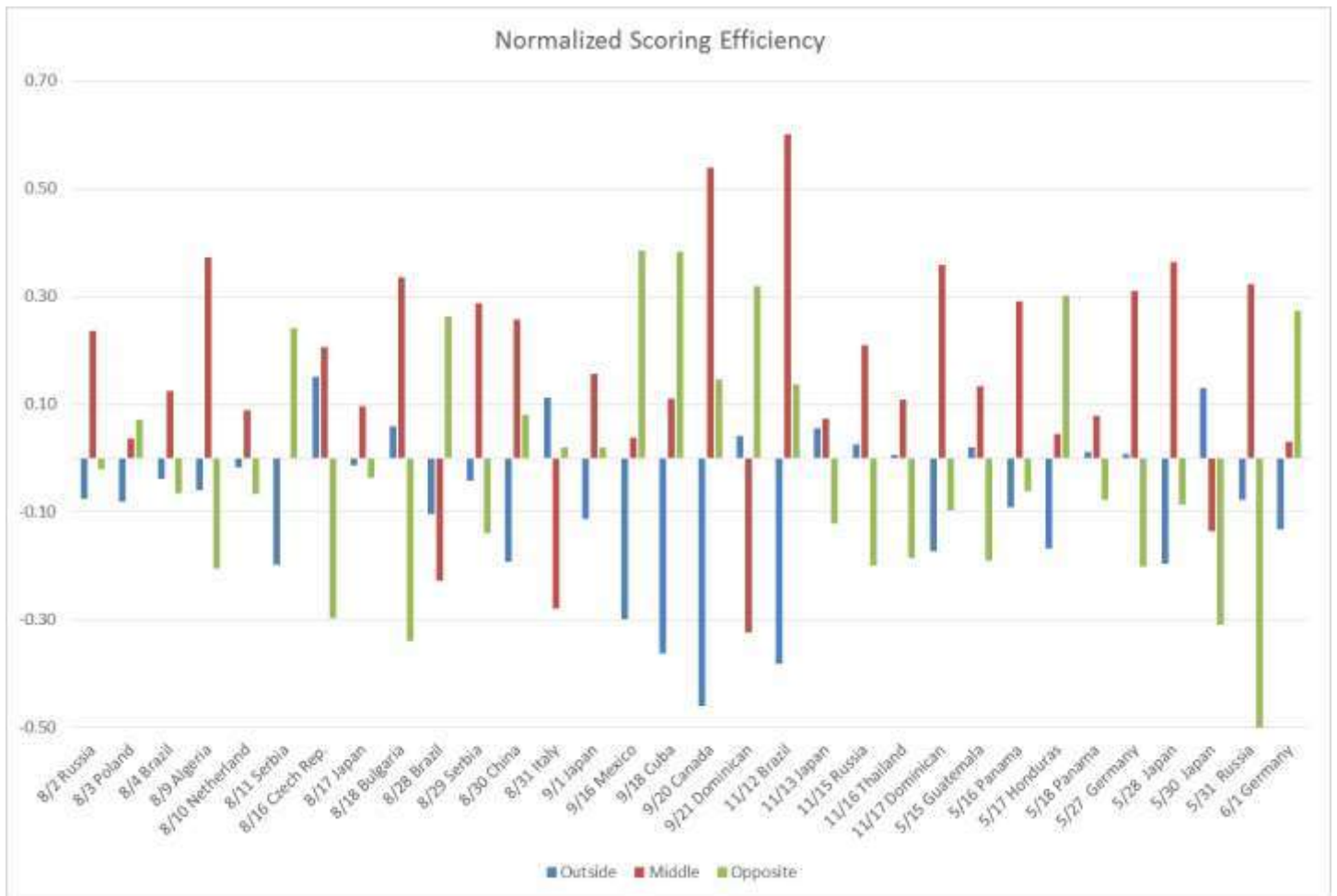
This data showed me that my setter was doing a pretty good job of distributing our attacks to all our hitters, or at least among our hitting positions. But then I started wondering - what are the hitters doing with those sets that come their way. That is where I started looking at Scoring Efficiency. Unfortunately I didn't record what happened with each attack when I collected the set distribution data above. In order to get that data I will have to go back through all those videos again. And I didn't feel like making this a major research project. So I got a little lazy and started looking for college and USAV data online and started working with it.

Grabbing data from the USAV website for matches played since last August for the USA Women's Nations team I plotted the attack distribution by position.



This data showed me that our US National Team runs a much more balanced offense than I expected. But then they have the best middles and opposites in the country to choose from, and the best setters to set to them, so why wouldn't they use them? They do still heavily favor the outside hitters but are much more balanced than the last 13 NCAA national champions. Also they use their Opposites a lot more than Championship College teams do.

But what does the scoring efficiency, by position for those matches look like?



Looking at the scoring efficiency showed that over the last year the middles for the National team have overwhelming been the most efficient hitters on the team, followed by the opposites. So why do the outside hitters still get the overwhelming number of sets?

This is the point where I stopped looking at data based on position and started looking specifically at the possibility of using Scoring Efficiency as a useful statistic. And that led to the essay that you started reading at the beginning.