Shot Quality

a methodology for
the study of the quality of
a hockey team's shots allowed.

Introduction

Not all shots on goal are created equal. If the puck would have entered the net without the intervention of the goaltender, a shot on goal is recorded. But even the casual observer can sense that some shots are more dangerous than others.

This paper explores the measurement of "Shot Quality". What do I mean by quality? If a shot is more "dangerous", it is of higher quality. What is a "dangerous" shot? It is a shot with a greater likelihood of becoming a goal.

Consider the following example:

	Team A	Team B
Shots on Goal	25	25
Goals Against	2	3
Save Percentage	92%	88%

On the surface, it looks like Team A has better goaltending on the basis of a 92% save percentage. But if we assume that low quality shots are always turned away and we knew that Team A allowed 5 "quality" shots and Team B allowed 10 "quality" shots, we reach a different conclusion – that Team B had superior goaltending and, therefore, inferior team defense:

	Team A	Team B
Shots on Goal		
… High Quality	5	10
… Low Quality	20	15
Save Percentage (HQ Shots)	60%	70%

A measure of shot quality would give us greater insight into the relative contribution of goaltending and defense, but current goal prevention metrics (I reserve the term "defense" to describe goal prevention efforts other than goaltending) do not give us a clear picture of this:

- Goals Against (GA) and Goals Against Average (GAA) tell us about the combined goal prevention efforts of the goaltender and the defense. As such it is the murkiest defensive statistic.

- Shots On Goal (SOG) is almost exclusively a defensive measure. The goaltender only contributes by giving up juicy rebounds. But one could argue that a defensive role is to deal with those rebounds. I attribute all of the responsibility of shots on goal to defense.

- Save Percentage (SV) also a murky statistic. If we assume that goaltenders face an array of shots of similar quality, it would be a great measure of goaltending. But this assumption is just plain false.

The role of the defender is to minimize both the quantity and the quality of shots on goal. The role of the goaltender is to stop shots. He will face shots of varying quality. A goaltender playing behind a poor defense may have either or both of more shots or more dangerous shots. And he has no control over this. His job is to pick up the pieces, to stop the shots that are permitted, no matter what the quality of shots.

To measure defense, it is necessary to measure shot quality. To measure goaltending, it is necessary to neutralize shot quality. This paper demonstrates that there is substantial variation, from team to team, in the quality of shots allowed. By understanding this, we can finally get a clear understanding of the quality of team defense and the quality of goaltending.

And now for some disclaimers:

- This analysis is performed on the NHL's 2002-03 season. One would expect the results to vary from season to season.
- About 10% of the data was missing. However, the data used would certainly qualify as a representative sample.
- There are data quality issues (see below).
- One can only use the data available. Certain factors, which would seem to lead to shot quality variation, are not tracked (see below). As such, the shot quality model developed is cruder than I would prefer.

The Data

The NHL publishes several game summaries for each game played. One such summary details many of the on ice "events", including shots on goal and goals. For both of these, this summary tells us the period, time, shooting team, defending team, shooter, shot type and shot distance. It also tells us the situation (even handed, power play, short handed) and indicates if the shot was a penalty shot. For goals, we are also told the players on ice for both teams and we have an indication if the goal was scored into an empty net.

These game summaries do not capture the angle of the shot or its circumstances. A shot subsequent to a cross-ice pass is a more dangerous shot than otherwise. A screened shot is more dangerous. These and other circumstances clearly matter, but are not captured in the data.

I undertook a review of the game summaries for the 2002-03 NHL season. There were 1230 games played in 2002-03. For some reason only about 90% of the summaries were still available at the time of this study. But I was able to build a database of 62,351 shots including 5,810 goals, containing the information detailed above.

Data Quality

The source of these game summaries is the NHL's Real Time Scoring System (RTSS). RTSS scorers have a tough job to do, recording each on ice "event" and player ice time. When it comes to a shot, the scorer records the shooter, the distance and the shot type by tapping several times on a screen. The time is recorded by the system based on one of these taps. Distance is captured by a tap on a screen resembling the rink. The system calculates the distance.

All of this happens pretty quickly. The highest priority is the shooter, as this data does get summarized and published. In the heat of battle, it is easy to get the time, shot type and distance wrong. The database clearly has embedded errors. There are shots that are impossibly close together in time. There are "wrap" shots from 60 feet. There are "tip in" shots from 60 feet. There are likely to be other coding errors (slap shots coded as wrist shots). It is easy to imagine that the record of distance is off, at least by small amounts. It is easy to imagine that a "snap" shot and a "wrist" shot are frequently confused. It is easy to imagine that two different scorers would give us two different records of the same event.

One has to accept that measurement error is present and address this fact when trying to use the data. One example of this is my search for rebound shots within the data. I had a thesis that a rebound shot was more dangerous and wanted to explore this. The NHL does not identify a shot as a rebound. I was able to identify 1,899 rebound shots ("rebounds") by defining a rebound as a goal or shot within two seconds of another shot with no intervening "event". In order to filter out bad data, I also had to apply a requirement that the shot distance was less than 25 feet.

Analysis

I split the data into two basic groups, carving off what I considered to be special cases from "normal" shots. My measure of shot quality is the rate of conversion of shots into goals, or the probability of a goal under the studied circumstances. **A higher goal probability means a higher shot quality.**

Special Cases

Certain special cases were best studied separately. Here are the observations about the quality of shots in these cases

- Empty Net Goal Shots are 100% "dangerous". They go in every time. This assumes that no defender was able to block the goal. I could have gone looking for this rare situation in the data, but I didn't.

- Penalty Shots produced goals 25% of the time. "Shot quality" is therefore 25%.

- I defined a "Long Shot" as a shot of more than 61 feet that was not an empty net goal. The data had a definite discontinuity at this distance. Long shots went in

0.6 % of the time (32 goals on 4,979 shots). Inside the blue line, the probability of a goal was much higher. And, yes, you can have a 61 foot shot from inside the blue line.

- I defined a "Scramble Shot" as a shot of less than 6 feet that was neither a rebound nor an empty net goal. The data for shots under 6 feet was all over the place. On the power play, 25% and 32% of 4 and 5 foot shots respectively were goals, while shorter shots never entered the net. In even handed and short handed situations, 3, 4 and foot shots went in the net about 17%, 26% and 20% of the time respectively. Shorter shots never scored. On average, these scramble shots were goals 21.2% of the time (44 goals on 208 shots). Shot type did not seem to matter.

- Rebounds, as I was able to identify them, were converted to goals 36.4% of the time. I looked at these shots by shot type, situation and by shot distance. Situation did not materially affect the shot quality. Power play rebounds went in 41.1% of the time and other rebounds went in 34.8% of the time. Shot type did not materially affect shot quality. Although goal probabilities were slightly higher for shots of 7 feet or less, I concluded that shot distance was not a material factor. In both of these cases, the fact that a shot was a rebound was much more significant than the factor under scrutiny.

"Normal" Shots

The remainder of the data (55,334 shots) I categorized as a normal shot. I studied this data looking at shot distance, shot type, situation and the interaction of shot type and situation.

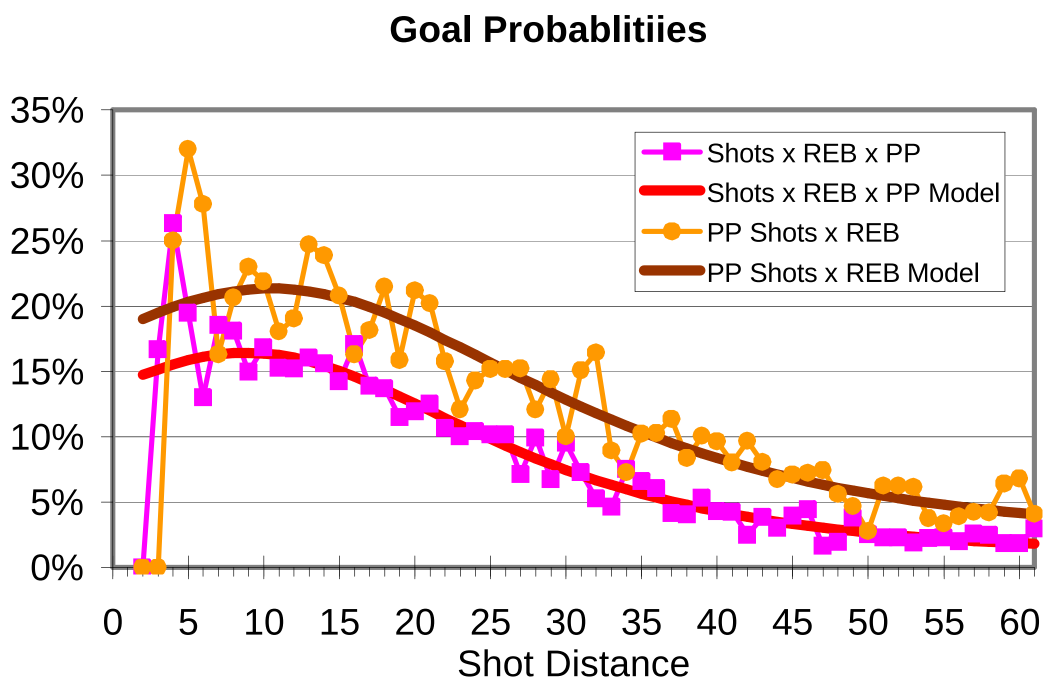
Situation

There was no statistical evidence that short handed situations created any real difference in shot quality. In non-statistical terms, the data indicates that short handed shots are about as dangerous as even handed shots. These shots tend to arise under circumstances much like those of even handed play. On balance, short handed shots tend to be a little bit (1%) more dangerous than even handed shots. But short handed shots average about 1.5 feet less distance and this explains most of the observed difference.

But the data suggests that the story is different on the power play. The probability of a goal on a power play shot was 12.2%. The probability of a goal on other situational shots was 7.9%. This is a big difference. This could be due to shots of more dangerous distance, or due to more dangerous shot types. Indeed, this part of the story. But the bigger part of the story is that the same shot type from the same distance has a better chance of going in the net on a power play (see below). It would seem that greater puck control gives rise to more dangerous shots.

Shot Distance

Distance matters. Below is a graph of the probability of a goal by shot distance (excluding, of course, scramble shots, long shots, rebounds, empty net goals and penalty shots).



The gold data is from power plays. The purple data is from even handed and short handed situations. The solid "model" lines represent curves of best fit through these two sets of data. Although I show the data and model results for shots of 5 feet or less, the model was never required to fit the data for these shots.

It is very clear from this that distance does matter. It is also very clear that, for a given distance, the goal probabilities are significantly higher on the power play.

Shot Type

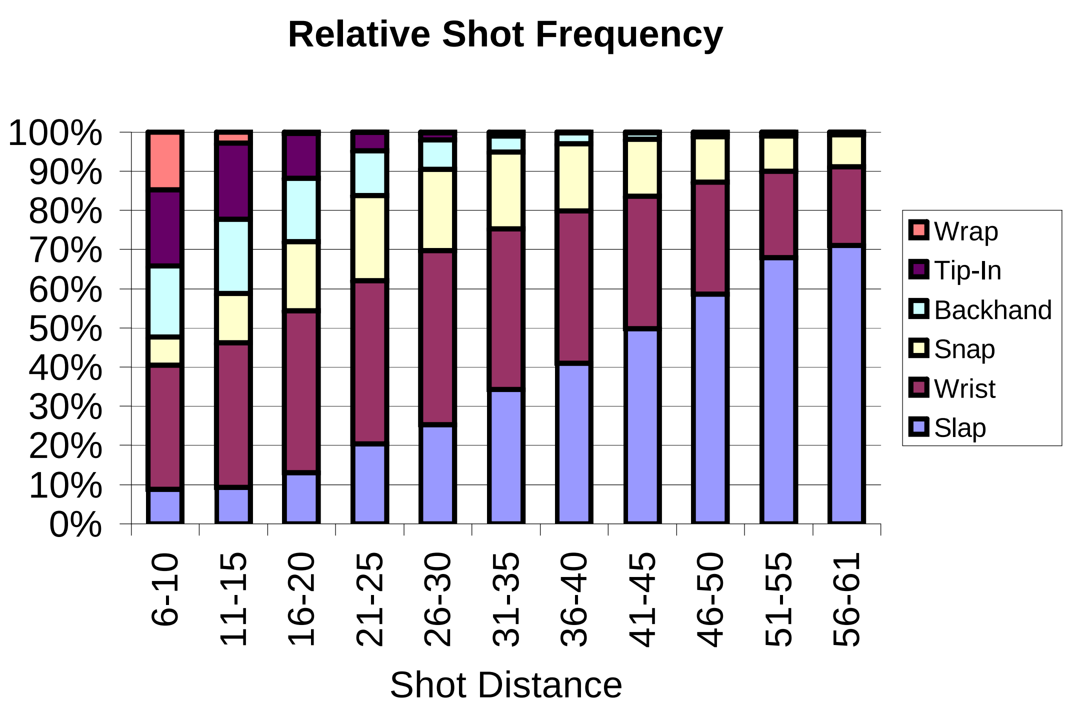
The NHL identifies 6 different shot types. Four are straight forward: the backhand, the slap shot, the snap shot and the wrist shot. The latter two are potentially confused. Two other shots scored are the wrap shot and the tip-in. The "wrap" shot is intended to describe the sweeping shot taken after emerging from behind the goal. The tip in is intended to describe a deflection.

As I mentioned before, I think that shot type data is unreliable in any given instance. However, in the aggregate it provides useful information. Here is a summary of the data:

Shot Type	Shots	Goals	Shooting Percentage
Backhand	4246	405	9.5%
Slap	20148	1354	6.7%
Snap	8047	812	10.1%
Tip-In	3034	615	20.3%
Wrap	730	40	5.5%
Wrist	19129	1640	8.6%
Total	55334	4866	8.8%

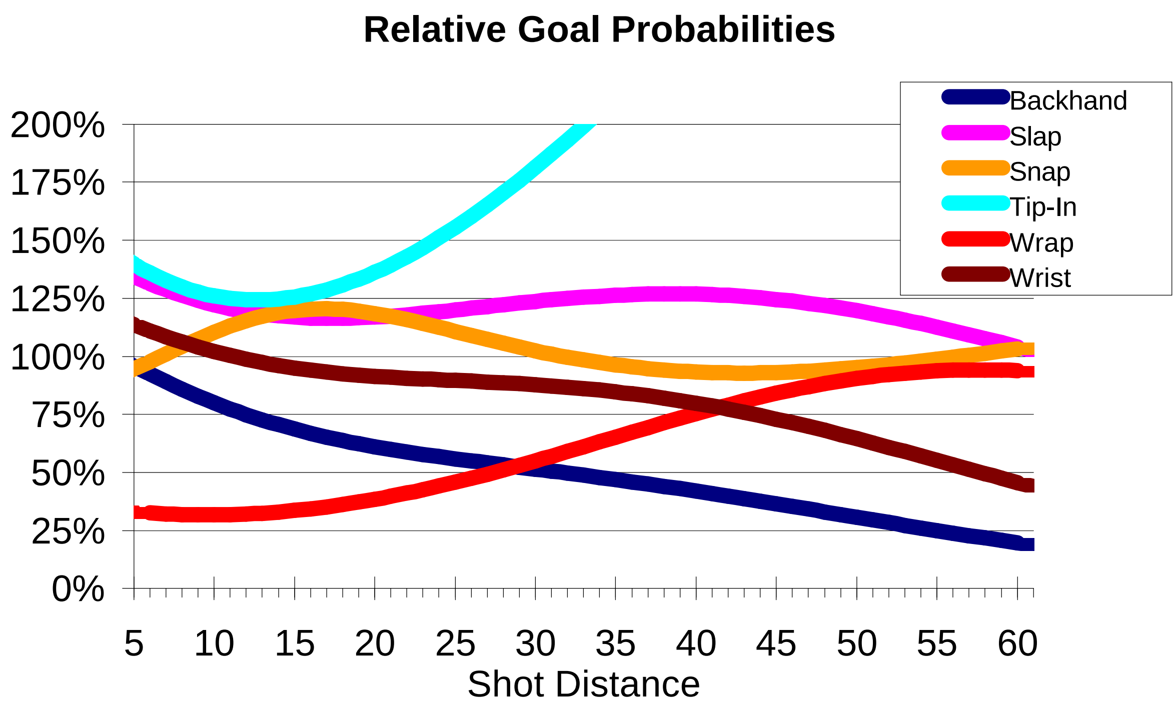
Presented this way, the data is useless. If this were all that you knew, you would be inclined to take a backhand instead of a slap shot. But we also can observe that players select each of the slap shot and wrist shot more frequently than all other shots combined.

If you extend this analysis to include the consideration of shot distance, you can see that each shot has its place.



Within 15 feet of the goal, slap shots are outnumbered about 9 to 1. But, from over 50 feet, slap shots account for about 70% of all shots. Within about 35 feet, the wrist shot dominates. But its relevance diminishes at longer distances. The wrap, backhand and tip-in shots are clearly short range weapons.

To blend an analysis of both shot type and distance, I repeated the curve fitting process described above for the six shot types and then compared the modeled results to the model for all shots. Below is a graph of those six comparisons.



Let's look at each shot in turn:

- The slap shot is the most frequently used shot in hockey. Other than the tip-in, it is the most dangerous shot in hockey at almost all distances. The graph demonstrates that, to about 45 feet, the slap shot is about 25% more potent than an average shot. Over that distance, the slap shot predominates and an "average" shot is closer and closer to the slap shot. Of course, we all know that its utility is limited near the net as it is the shot that takes the greatest time to prepare.

- As it is the dominant shot under 35 feet, the wrist shot has about average effectiveness up to that distance. But, over that range, its effectiveness slowly falls from about 120% of average to about 80%. On longer shots, effectiveness continues to decline until it drops below 50% over 55 feet.

- I expected to find the snap shot with a very similar profile to the wrist shot, but it did not happen. Over all distances, it is the most average of all shots. It's relative effectiveness peaks in the 15-20 foot range where it is actually the weapon of greatest impact. Only under about 10 feet is the snap shot less effective than the wrist shot.

- The backhand is usually a shot of necessity. Only on a breakaway would a player normally choose this shot over a forehand. The data shows why. In close, the shot is of nearly average effectiveness. By 10 feet the shot has dropped to 75% effectiveness. The effectiveness drops to about 50% at 30 feet and about 25% over 50 feet.

- The tip in is the most dangerous of all shots. Anyone who has spent any time watching hockey has figured out the goaltender has little hope on a deflection. The shooter is the player who last touched the puck. As a consequence, a tip in should be recorded as a shorter shot. There were very few tip ins coded over 25 feet, so one must be careful drawing conclusions about longer tip-ins. These could be coding errors. But I think that it is safe to say that tip ins are 25% to 50% more effective than the average shot.

- The wrap is a low probability play. The traffic is normally high and the angle is bad. Wrap shots under 15 feet are about 1/3rd as dangerous as a typical shot of that distance. There were very few (about 60) wrap shots coded over 15 feet. I suspect that most wraps over that distance are coding errors. That is why the relative goal probability trends up towards that of an average shot.

Interactions

Finally, let me dismiss the interaction analysis. The question is, do certain shot types become more or less dangerous on the power play? The answer is no. I used a very powerful statistical tool to prove this. Enough said.

Measuring the Aggregate Quality of Shots on Goal

At the highest level, this analysis confirms what we already know. Close in shots are more dangerous. Deflections are more dangerous. Slap shots make the most sense from outside of 35 feet. Backhands are second choice shots. And so on …

But the real value of this analysis is in its ability to finely measure the quality of any given shot, to the best of our current ability. And if we can measure one shot, we can measure a whole game or a whole season for a given team. I am interested in the latter question for the moment.

To measure the quality of shots against for a given team is a six step process:

1. Collect the data and analyze goal probabilities for each shooting circumstance. Done.

2. Build a model of goal probabilities that relies on the measured circumstance. Done. I did not include the details, but my model reflects all of the observations made above.

3. Apply the model to the shot data for the team in question for the season. For each shot, determine its goal probability. This is a spreadsheet exercise.

4. Expected Goals: EG = the sum of the goal probabilities for each shot.

5. Neutralize the variation in shots on goal by calculating
   Normalized Expected Goals: NEG = EG x Shots< / Shots
   (Shots< = League Average Shots).

6. Shot Quality Against: SQA = NEG / GA< (League Average Goals Against).

SQA gives us a measure of shot quality that is independent of the number of shots on goal and independent of goaltending. Below are the results of the study, sorted from best to worst.

The way to interpret an SQA of 1.050 is that the quality of shots allowed by the team is such that it would result in 5% more goals than a team with an SQA of 1.000, all other things being equal. As you can see, SQA ranges from .915 to 1.087. This is a big range. NHL teams averaged 218 goals against in the 2002-03 season. A swing of +/- 8.5% goals means +/- 19 goals for an average team, worth almost 4 wins over the course of the season. A team that both gives up a lot of shots and allows more dangerous shots will have the effect multiplied.

SQA Index 2002-03

Team	Shots	SQA Index
NJD	1765	0.915
PHI	1813	0.935
MIN	2047	0.947
CAL	1959	0.953
TOR	2129	0.956
TB	2070	0.965
BUF	2087	0.969
OTT	1893	0.970
ANA	2126	0.972
DAL	1812	0.972
WAS	2174	0.973
DET	2131	0.976
PHO	2149	0.980
MON	2417	0.982
CHI	2158	0.996
PIT	2222	0.996
NAS	2033	1.000
VAN	1985	1.004
EDM	2033	1.018
COL	2113	1.018
SJ	2178	1.022
CAR	2062	1.024
BOS	2087	1.027
NYI	2121	1.037
CBJ	2400	1.041
ATL	2327	1.045
LA	1921	1.048
NYR	2111	1.057
FLA	2398	1.078
STL	1898	1.087

It came as no surprise to me that New Jersey lead the league in this metric, allowing 8.5% fewer goals than an average team because of its ability to minimize shot quality. Philadelphia and Minnesota are also not surprising teams to see on the leader board. These three teams have a reputation for solid defense.

At the other end of the list were St. Louis, Florida and the Rangers. St. Louis and Florida were bookends in one respect. The Blues were thought to have awful goaltending whereas the Panthers were thought to possess outstanding goaltending. The SQA index tells us clearly that both of these teams had better goaltending than previously thought. Obviously the reverse is true. When a team is at the top of the SQA list, it means that its goaltenders faced softer shots and that their statistics are misleadingly good.

Going in to this study I expected to see SQA highly correlated with shots allowed. Although there is a positive correlation present, it is weak (r^2 = .15). New Jersey had the lowest number of shots allowed in the study and the lowest SQA. The Flyers were 3rd and 2nd in shots and SQA respectively. But St. Louis allowed the 5th fewest shots and was last in SQA. LA was another team with low shots against and a poor SQA. Montreal and Florida allowed a similar number of shots, but were far apart in shot quality.

What Does This Tell Us About Goaltending?

As indicated above, if defense is better than we thought, then goaltending must be worse (and vice versa). Before this study goal prevention looked like a simple model:

GA = SOG x (1 – SV)

We knew that Shots on Goal was a defensive responsibility, so we have historically attributed it to the team. We knew that Save Percentage was more a goaltender statistic than a team statistic, so we have historically attributed it to goaltenders. But we are now in a position to use a better model:

GA = SQA x SOG x (1 – SQNSV)

where SQA is the Shot Quality Allowed Index and SQNSV is the Shot Quality Neutral Save Percentage.

In this model we attribute both SQA and SOG to the defense and SQNSV to goaltending. Clearly SQNSV is a better measure of the goaltender's contribution to team success than is SV. You can think of it as the save percentage one would expect with no variation in shot quality from team to team.

How do you calculate SQNSV? The two models both give us goals against. So …

SOG x (1 – SV) = SQA x SOG x (1 – SQNSV),
or
(1 – SV) = SQA x (1 – SQNSV),
which means
SQNSV = 1 – (1- SV) / SQA

To the right is a calculation of SQNSV for each team in the NHL in 2002-03.

You can see what a huge difference this makes in our view of goaltending. Florida's goaltending, basically Roberto Luongo, jumps 7 positions into second place (but in a virtual tie for first). The Rangers also move up 7 positions to 10^{th}. Meanwhile, the Devils' goaltending slips 7 places to 14^{th}. Buffalo drops 4 places and

Shot Quality Neutral Save Percentage 2002-03

	SQA	SV	Rank	SQNSV	Rank
MIN	0.947	0.924	1	0.919	1
FLA	1.078	0.913	9	0.919	2
COL	1.018	0.916	5	0.918	3
ANA	0.972	0.919	2	0.916	4
DAL	0.972	0.918	3	0.916	5
PHI	0.935	0.918	4	0.912	6
DET	0.976	0.914	8	0.912	7
MON	0.982	0.913	10	0.911	8
TOR	0.956	0.914	6	0.910	9
NYR	1.057	0.905	17	0.910	10
NAS	1.000	0.909	14	0.909	11
WAS	0.973	0.910	12	0.908	12
OTT	0.970	0.910	11	0.908	13
NJD	0.915	0.914	7	0.906	14
TB	0.965	0.909	13	0.905	15
VAN	1.004	0.905	16	0.905	16
PHO	0.980	0.906	15	0.905	17
CBJ	1.041	0.900	20	0.904	18
NYI	1.037	0.900	21	0.904	19
CHI	0.996	0.904	19	0.903	20
SJ	1.022	0.900	22	0.902	21
BUF	0.969	0.905	18	0.902	22
LA	1.048	0.897	28	0.901	23
BOS	1.027	0.898	24	0.901	24
STL	1.087	0.892	29	0.900	25
CAR	1.024	0.897	27	0.900	26
EDM	1.018	0.898	25	0.899	27
PIT	0.996	0.899	23	0.899	28
ATL	1.045	0.890	30	0.895	29
CAL	0.953	0.897	26	0.892	30

Calgary drops 4 places to trail the league.

Another View of Defense

The goal prevention formula

GA = SQA x SOG x (1 – SQNSV)

gives us a new insight into goaltending, but it also gives us another view of defense. A single metric which captures all information about defense is Shot Quality Neutral Shots on Goal:

SQNSOG = SQA x SOG

SQNSOG is a bit like "wind chill" – a team allows 30 shots on goal but, to the goaltender, it feels like 35. To the right are the 2002-03 rankings of team defense based on this metric.

Shot Quality Neutral Shots on Goal 2002-03

	SQA	SOG	Rank	SQNSOG	Rank
NJD	0.915	1933	1	1769	1
PHI	0.935	2019	2	1888	2
OTT	0.970	2033	3	1971	3
DAL	0.972	2073	5	2016	4
CAL	0.953	2222	8	2117	5
VAN	1.004	2185	7	2194	6
MIN	0.947	2335	17	2211	7
TB	0.965	2298	12	2217	8
BUF	0.969	2297	11	2225	9
STL	1.087	2047	4	2225	10
LA	1.048	2141	6	2243	11
NAS	1.000	2252	10	2252	12
EDM	1.018	2248	9	2287	13
DET	0.976	2361	19	2305	14
ANA	0.972	2377	20	2311	15
TOR	0.956	2423	22	2317	16
CHI	0.996	2345	18	2335	17
COL	1.018	2323	15	2364	18
BOS	1.027	2322	14	2384	19
WAS	0.973	2454	24	2387	20
CAR	1.024	2332	16	2389	21
NYI	1.037	2318	13	2404	22
PHO	0.980	2458	25	2410	23
SJ	1.022	2392	21	2445	24
PIT	0.996	2535	26	2525	25
NYR	1.057	2426	23	2565	26
MON	0.982	2678	29	2631	27
ATL	1.045	2593	27	2709	28
CBJ	1.041	2641	28	2748	29
FLA	1.078	2725	30	2937	30

There are no real surprises in this the top 6 teams in this table (New Jersey down through Vancouver). And at the bottom of the list (Pittsburgh down to Florida) the rankings don't change much either. But the reason that the correlation between shots allowed and SQA is so low is the middle of the table, where all hell breaks loose. The most extreme move was from Minnesota, which climbs 10 places. Other big improvements are from Toronto (+6), Detroit (+5) and Anaheim (+5). Big negative moves were from the Islanders (-9 places), St. Louis (- 6), Los Angeles (-5), Carolina (-5) and Boston (- 5). Nashville slid two places but, as the Predators had an SQA of 1.000, its SQNSOG was identical to its SOG.

Goal Prevention Indices

Now let's look at goal prevention from one more angle. If you express team goals against as a percentage of league average goals against, you get team defense expressed in terms of league averages:

GA / GA< = SQA x SOG x (1 – SQNSV) / GA<
= SQA x SOG x (1 – SQNSV) / (SOG< x (1 – SQNSV<))
= SQA x (SOG / SOG<) x (1 – SQNSV) / (1 – SQNSV<)

Note SQNSV< = SV<

This says that you can express goals against as a percentage of average as the **product** of three indices:

Goals Against Index = Shot Quality Index x Shots Allowed Index x Goaltending Index

The first two indices can also be combined as a Defense Index (which has SQNSOG as its relative). In each case, a lower value is a better value. Below are the results.

New Jersey, Philadelphia and Dallas were out in front, allowing respectively 23.7%, 23.7% and 22.4% fewer goals than the league average. New Jersey was a bit better than Philly, which was in turn a bit better than Dallas, in both shot prevention and shot quality. Both Dallas and Philadelphia improved on this with goaltending (the Star's goaltending ranked 5th and the Flyer's goaltending ranked 6th) … whereas New Jersey had average goaltending.

Thus we have finally undressed goal prevention. The world does not get it. Brodeur should not have won the Vezina Trophy. He simply played behind the league's most proficient defense. And Bobby Clarke gave up on Roman Cechmanek, not realizing that his goaltending was 6th ranked, 6.0% above average.

Goal Prevention Indices
2002-03

Team	Goals Against	Goals Against Index	Shot Quality Index	Shots Allowed Index	Defense Index	Goaltending Index
NJD	166	0.763	0.915	0.831	0.760	1.003
PHI	166	0.763	0.935	0.868	0.812	0.940
DAL	169	0.776	0.972	0.891	0.867	0.896
MIN	178	0.818	0.947	1.004	0.950	0.860
OTT	182	0.836	0.970	0.874	0.847	0.987
ANA	193	0.887	0.972	1.022	0.993	0.893
COL	194	0.891	1.018	0.999	1.016	0.877
DET	203	0.933	0.976	1.015	0.991	0.941
NAS	206	0.946	1.000	0.968	0.968	0.978
VAN	208	0.956	1.004	0.939	0.943	1.013
TOR	208	0.956	0.956	1.042	0.996	0.959
TB	210	0.965	0.965	0.988	0.953	1.012
BUF	219	1.006	0.969	0.987	0.956	1.052
WAS	220	1.011	0.973	1.055	1.026	0.985
LA	221	1.015	1.048	0.920	0.964	1.053
STL	222	1.020	1.087	0.880	0.957	1.066
CHI	226	1.038	0.996	1.008	1.004	1.034
CAL	228	1.047	0.953	0.955	0.910	1.151
EDM	230	1.057	1.018	0.966	0.983	1.075
PHO	230	1.057	0.980	1.057	1.036	1.020
NYI	231	1.061	1.037	0.996	1.034	1.027
NYR	231	1.061	1.057	1.043	1.103	0.962
MON	234	1.075	0.982	1.151	1.131	0.950
BOS	237	1.089	1.027	0.998	1.025	1.062
FLA	237	1.089	1.078	1.171	1.262	0.862
SJ	239	1.098	1.022	1.028	1.051	1.045
CAR	240	1.103	1.024	1.002	1.027	1.074
PIT	255	1.172	0.996	1.090	1.086	1.079
CBJ	263	1.208	1.041	1.135	1.181	1.023
ATL	284	1.305	1.045	1.115	1.164	1.121

Minnesota and Ottawa had similar defensive numbers – Ottawa with average goaltending and the Wild with the second best goaltending in the NHL. Going in to this study I suspected that the Wild were very good at the shot quality thing. Although they lead the league in save percentage, who really believed that Roloson and Fernandez were that good? Well, Minnesota was very good at limiting shot quality (their SQA ranked 3rd at .947). But they also had the goaltending, ranking number one. Ottawa was 3rd in shots on goal and 8th in SQA.

The Colorado / Anaheim comparison shows two pretty similar teams, ranked 3rd (heir) and 4th (apparent?) in goaltending. The Rockies had a lower shot count. Anaheim ranked 9th in shot quality, but Colorado was well below average (rank 20th).

Detroit's goaltending (mainly Joseph) ranked 7th lifting a pretty average looking defense. Back in Toronto, the Leaf's strong SQA showing (5th) counteracting poor shot prevention and made goaltending look better (goaltending rank now 9th). Tampa Bay had similar shot quality to the Leaf's but traded off superior shot prevention for inferior goaltending. Nashville and Vancouver both had average SQA numbers. The Canucks were 7th in shots on goal but goaltending was only average. Nashville's profile was the reverse.

Buffalo ranked 7th in SQA and 11th in SOG but a 22nd ranking in goal put them above average in goals allowed. Washington was above average in both SQA and goaltending but allowed 5.5% more shots than the league average. St. Louis and Los Angeles were very proficient at shot prevention (4th and 6th respectively) but terrible in respect of shot quality (30th and 26th). Neither had impressive goaltending, but it was better than previously thought. Chicago was about average in terms of SQA and shots, but a bit softer in goal (rank 20th).

Calgary's defense ranked 5th, with SQA at .953 (4th) and the shot index at .955 (8th). This masked the league's worst goaltending (goaltending index of 1.151). The Oilers and Phoenix tied at 230 goals against. Edmonton's strength was the Coyote's weakness -- shot prevention (9th vs 25th). The two New York rivals also tied in goals allowed. Both teams lagged the league average in shot quality. The Rangers gave up too many shots (rank 23rd) but made up for it with goaltending (10th). Boston, San Jose and Carolina were similar teams defensively with similar SQA scores. All allowed above average quality shots and all were below average in goal (the Hurricanes ranked 26th).

Both Montreal (29th) and Florida (30th) allowed a ruinous number of shots (shots allowed index of 1.151 and 1.171 respectively). Montreal mitigated this with shot quality of .982 and 8th ranked goaltending. But the Panthers poured gasoline on the fire with an SQA of 1.078 (29th). How did a team with a defensive index which predicts 26.2% more goals than the league average allow only 8.9% more goals than the league average? By having the league's top goaltender. Luongo played in 65 games for the Panthers and was, at the age of 23, absolutely the most under rated goalie in the NHL last season and the real Vezina guy.

Pittsburgh's Goals Against Index of 1.172 was not a consequence of shot quality (where they were average). And the Blue Jacket's GA Index of 1.208 was not because of goaltending (18th). The Columbus defense ranked 29th (SQA ranked 25th and SOG ranked 28th). Finally we get to Atlanta where their SQA rank was 26th, their SOG rank was 27th and their goaltending rank was 29th (the goaltending index was way off the pace at 1.121).

Let's look at Tampa Bay and the Rangers to make one final observation:

Team	Goals Against	Goals Against Index	Shot Quality Index	Shots Allowed Index	Defense Index	Goaltending Index
TB	210	0.965	0.965	0.988	0.953	1.012
NYR	231	1.061	1.057	1.043	1.103	0.962

Tampa was better at shot prevention. New York was better at goaltending. When you multiply the Shots Allowed Index and the Goaltending Index you get 1.000 for Tampa and 1.003 for the Rangers. In other words, before variations in shot quality, Tampa and the New York were both average goal prevention teams. So we are forced to conclude that these two teams were 21 goals apart because of the variation in their SQA numbers: 231 ≈ 210 x 1.061 / .965. On offense, New York trailed Tampa Bay by 9 goals. This spread of 30 goals gave Tampa Bay 93 points and their (weak) division versus 78 points and an early start to the golf season for the Rangers … and 70% of this spread was from shot quality.

Shot Quality Matters

This paper develops a method for isolating shot quality. With shot quality information at hand, one can now get the clearest picture yet of team defense. And, because of that, goaltending comes in to sharper focus as well.

There were three possible outcomes of this work. The first was that there was no material variation in shot quality from team to team. The second was that SQA was highly correlated to shots on goal. Each of these outcomes would have allowed us to ignore the question of shot quality and still understand how goal prevention worked. The third outcome is the one we got. Shot quality varies significantly from team to team and it is not well correlated with shots on goal. This means that we have discovered an important new metric in understanding goal prevention.

The model to get to expected goals given the shot quality factors is simply based on the data. There are no meaningful assumptions made. The analytic methods are the classics from statistics and actuarial science. The results are therefore very credible.

Are there surprises in the results? You bet! Shot quality matters.