The Differences between Urethane and Reactive Bowling Balls

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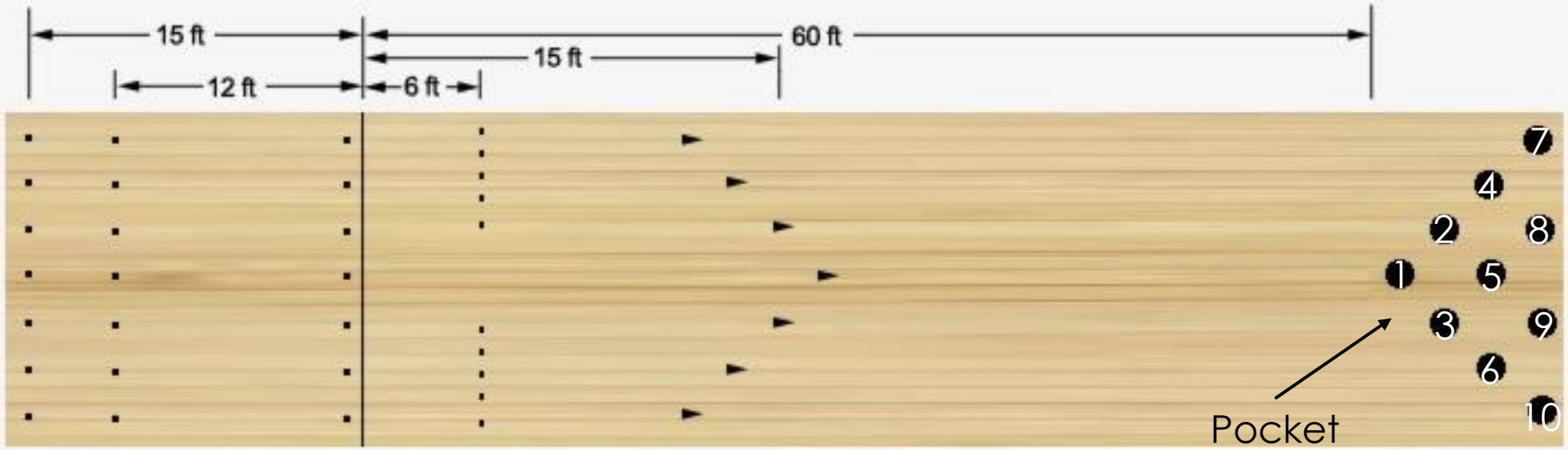
BUS-450C CAPSTONE PRESENTATION

Purpose of this study

- To explain how bowling ball materials differ
- To investigate the effects these differences have
- To explore other variables that influence success in bowling

Bowling Background

- Bowling is a target sport where a player rolls a ball down a lane to try and knock down as many pins as possible
- Lanes are composed of wood or synthetic material, are 60 feet in length from foul line to the front pin, and are 41 inches in width with gutters (channels) on either side
- Bowling balls have a diameter of 8.5 inches and weigh upwards of 16 pounds



Source: https://www.pngkit.com/

Modern Bowling

- American Bowling Congress was established in 1885
  - Established the modern rules for bowling
- Professional Bowlers Association was founded in 1958
- USBC was formed in 2005
  - Governing body for bowling
  - Merger of all previous governing bodies

Bowling Scoring

- Players are given 2 rolls per frame to try and knock down all 10 pins
  - If all 10 pins are knocked down in 1 throw, a strike is recorded
  - If all 10 pins are knocked down in 2 throws, a spare is recorded
  - If a bowler fails to knock over all 10 pins in 2 throws, an open frame is recorded

Bowling Scoring

- Games consist of 10 frames with the final frame allowing a maximum of 3 balls if the bowler records a strike or a spare in that frame.

Source: Samuel Northam, September 28, 2015

1	2	3	4	5	6	7	8	9	10
X	9 /	X	9 /	X	9 /	X	9 /	X	9 / X
20	40	60	80	100	120	140	160	180	200

1	2	3	4	5	6	7	8	9	10
X	X	X	X	X	X	9 /	9 /	9 /	9 / 9
30	60	90	120	149	169	188	207	226	245

1	2	3	4	5	6	7	8	9	10
9 /	9 /	9 /	9 /	9 /	9 /	X	X	X	X X X
19	38	57	76	95	115	145	175	205	235

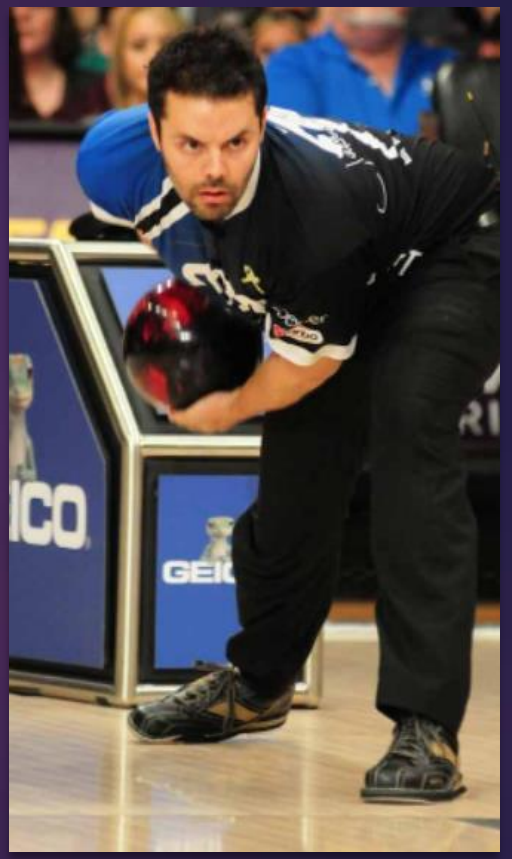
Lane Oil

- A lane machine applies oil to approximately the front 45 feet of the lane
- Provides a buffer between the ball and the lane
- The amount of oil, length it is placed, and pattern in which is laid out in can be modified to increase the difficulty of the lanes

Throwing a ball

- One-Handed
  - Less revolutions, easier to target and maintain speed
- Two-Handed
  - More revolutions, harder to target and maintain speed
- More revolutions create a stronger reaction on the lane

Source: Getty Images for PBA



Source: Getty Images for PBA

Phases of a Throw

- Skid Phase
  - First ~20 feet of a throw
  - Ball has highest axis rotation causing ball to skid through the oil
- Hook Phase
  - 20-45 feet
  - Ball loses speed at starts gaining end-over-end roll
- Roll Phase
  - Last 15 feet of the lane
  - Bowling ball hits break point and begins motion towards the pocket
  - Ball has least amount of axis rotation and most amount of end-over-end roll allowing the ball to drive through the pins rather than deflecting

Bowling Ball Cores

- The core of a ball is shaped in a specific way to distribute the weight differently throughout the ball

- Symmetric Cores
  - Smooth and predictable motion
- Asymmetrical Cores
  - Pronounced shape and sharp motion

Two examples of asymmetrical cores

Source: hammerbowling.com

Source: stormbowling.com

- The way a ball is drilled in relation to the core can lead to different motion and different lengths of each phase

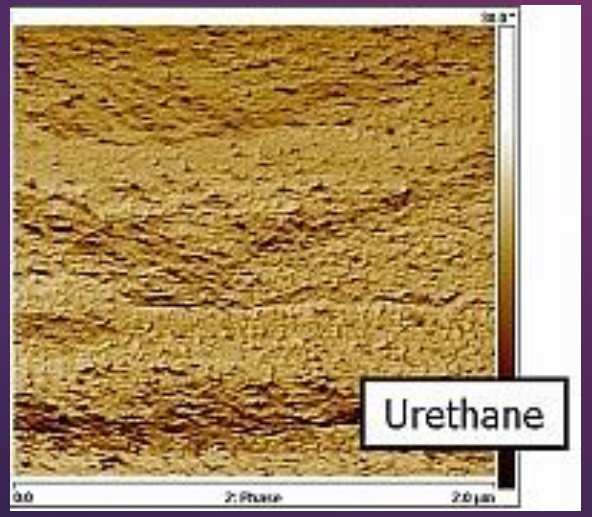
Bowling Ball Materials

- Early bowling balls were made of hard wood
- Rubber bowling balls were introduced in 1905
- Polyester plastic balls were introduced in 1970

- Urethane Coverstocks were introduced in the 1980s
  - Offer improved friction between the surface of the lane and the ball
  - Does not absorb oil, but instead ‘pushes’ oil down lane
  - Controllable skid with low backend hook
  - Weak finish results in lower pin carry

Bowling Ball Materials

- Reactive Coverstocks were introduced in the 1990s
  - Even greater amount of friction between ball and lane than urethane
  - Absorbs oil instead of pushing it down lane
  - Strong backend finish
  - Higher pin carry and more versatility, but harder to control
  - (*New Bowling Ball Specification Will Affect Manufacturers, Not Bowlers | Bowlingdigital.Com*, 2008)



What Is Expected

- Higher strike rate with reactive
- Higher rate of hitting the pocket with urethane
- More strikes when hitting the pocket with reactive

Data Acquisition

- 30 games were bowled over the course of 5 sessions
  - 6 games a session: 3 with one ball then 3 with the other, alternating order each session.
  - 3-4 warmup shots before first game of a set
- Bowled on lanes of various condition
  - 2 day on fresh oil, 2 day on breakdown from previous nights league, and 1 day in the middle of the two
  - Different lane each session

Bowling Balls Used

Black Widow Urethane

- Released Early 2022
- Pearl Urethane with asymmetrical core

UFO Alert

- Released Summer 2021
- Hybrid reactive with asymmetrical core
- Controversially ruled illegal due to softness issues in Spring of 2022
  - Banning was delayed while more tests are conducted

Data Acquisition

- 169 shots with the urethane ball and 166 with the reactive ball for a total of 335 shots

	ball	day	day_shot	set_shot	game_shot	feet	target	arrows	pocket	count
330	1	5	62	29	7	36.0	17	17	0	9
331	1	5	63	30	8	37.0	17	16	1	10
332	1	5	64	31	9	37.0	17	17	0	9
333	1	5	65	32	10	38.0	17	18	1	10
334	1	5	66	33	11	38.0	17	17	1	10
335	1	5	67	34	12	38.5	17	17	1	9

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Source: Samuel Northam

Strike Rate

Overall	
Total Strikes	165
Total Shots	335
Strike Rate	49.25%
Strike Odds	0.971

Urethane	
Total Strikes	86
Total Shots	169
Strike Rate	50.89%
Strike Odds	1.04

Reactive	
Total Strikes	79
Total Shots	166
Strike Rate	47.59%
Strike Odds	0.91

Source: Samuel Northam

Pocket Rate

Overall	
Total Pocket	224
Total Shots	335
Pocket Rate	68.87%
Pocket Odds	2.02

Urethane	
Total Pocket	110
Total Shots	169
Pocket Rate	65.09%
Pocket Odds	1.86

Reactive	
Total Pocket	114
Total Shots	166
Pocket Rate	68.67%
Pocket Odds	2.19

Source: Samuel Northam

Carry Rate

		Strike		
		yes	no	
Pocket	yes	153	71	224
	no	12	99	111
		165	170	335

This gives us a carry rate of $\frac{153}{224}$ or 68.30%

Our odds of striking are 17.78 times greater when we hit the pocket (2.15) then when we miss the pocket (0.12)

Source: Samuel Northam

Urethane

Pocket	Strike: yes	Strike: no	
yes	80	30	110
no	6	53	59
	86	83	169

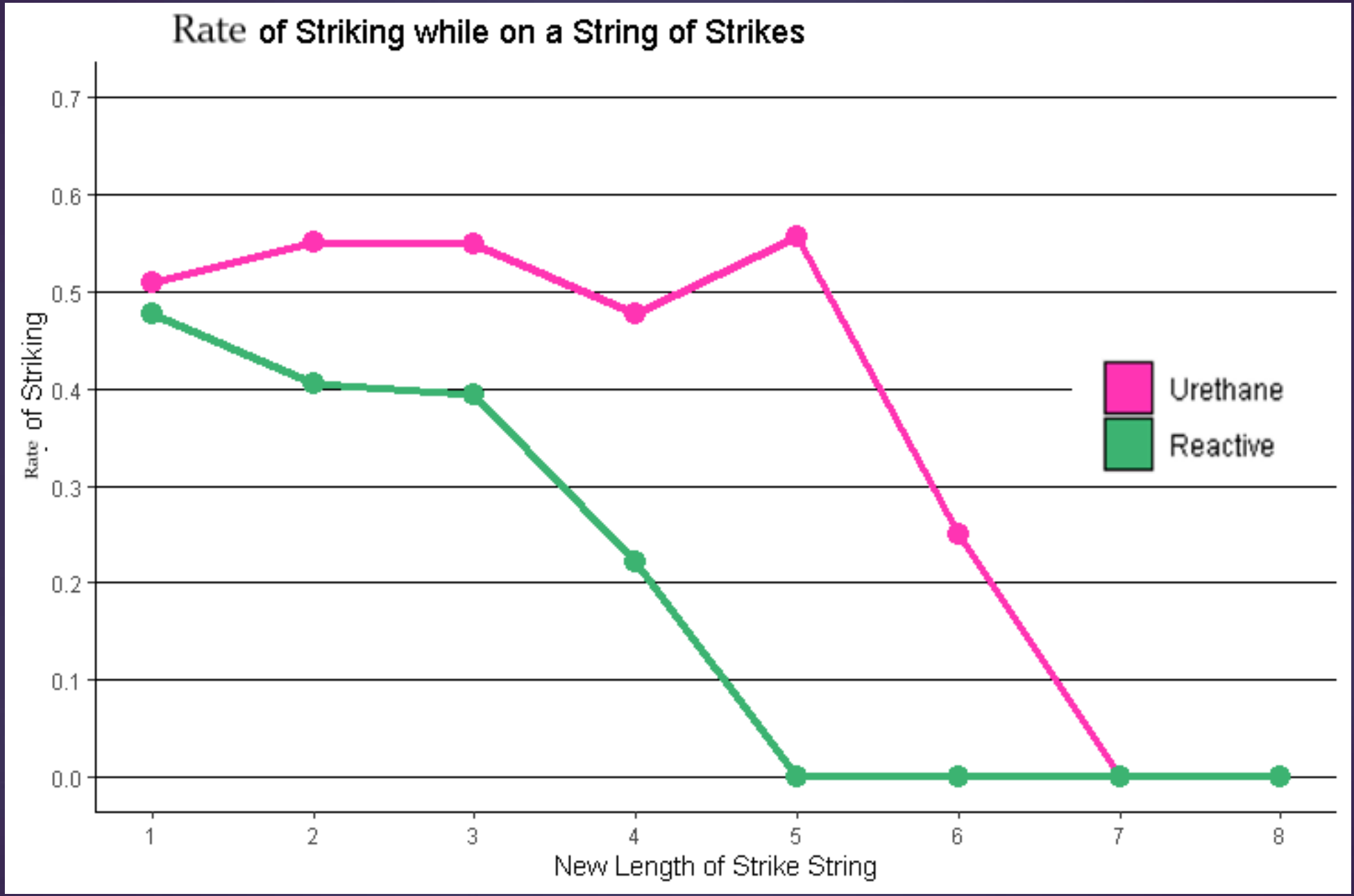
- This gives us a carry rate of $\frac{80}{110}$ or 72.72%
- Our odds of striking are 23.56 times greater when we hit the pocket (2.67) then when we miss the pocket (0.11)

Reactive

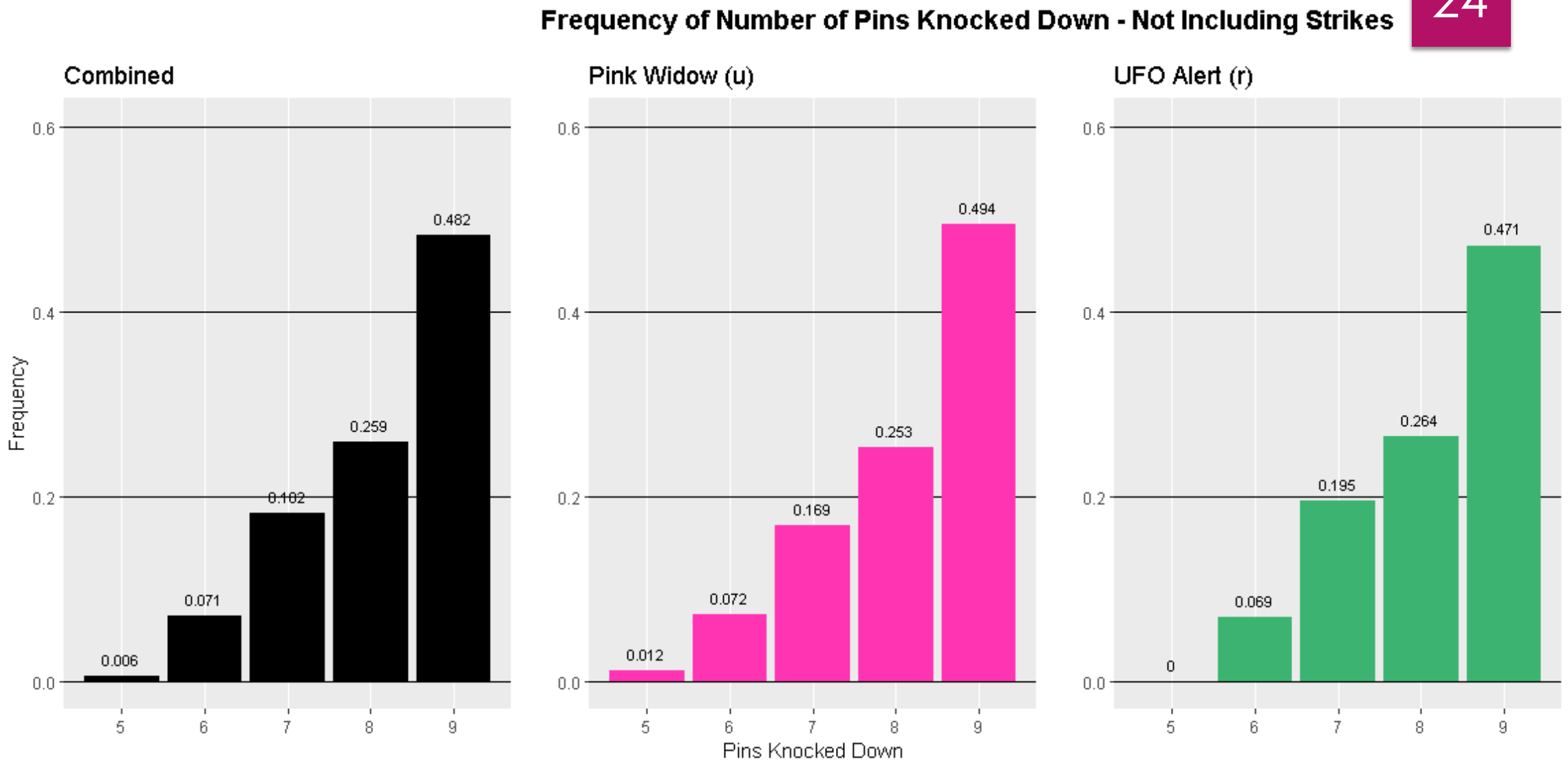
Pocket	Strike: yes	Strike: no	
yes	73	41	114
no	6	46	52
	79	87	166

- This gives us a carry rate of $\frac{73}{114}$ or 64.04%
- Our odds of striking are 13.65 times greater when we hit the pocket (1.78) then when we miss the pocket (0.13)

Source: Samuel Northam



Source: Samuel Northam



Source: Samuel Northam

Why I'm Comfortable with Urethane

- I have bowled 87 games of league this season
  - 2 games with reactive
  - 3 games with reactive / urethane
  - 82 games with urethane
- 27 Tournament games in the past year
  - 7 games with reactive
  - 1 game with reactive / urethane
  - 19 games with urethane
- In recorded practice games I averaged 207 with reactive and 220 with urethane

Reasons Behind Differing Strike %

- Not every shot is the same
  - Ideally my approach is identical every throw, but sometimes timing can get messed up
- Playing new angles causes discomfort and lack of confidence
- Probability of success increases as confidence in one's ability increases (Parfitt, G., & Pates, J.)
  - Being comfortable with a ball and a line leads me to being comfortable and confident that I will make a good shot and that the shot will strike
  - This causes my approach to be more natural and less forced, leading to a better ball

Flaws in Data Collection

- Did not have technology to measure where ball was at the arrows
  - Visual measurements could be slightly off due to looking at a 1-inch spot 15 feet away
- Treated pocket as a binary (yes/no) variable
  - There are multiple types of pocket hits such as light, half pocket, high flush, etc.
  - Again, visual measurements are difficult. Sometimes very little difference between shots that hit the pocket and shots that miss

Conclusion

- Despite the physics pointing towards a higher strike percentage with reactive, we see a higher and more consistent strike rate with urethane
- Lack of confidence directly correlates with a lower probability of success. It also causes me to rethink aspects of my approach and potentially make changes rather than keeping a consistent approach
- Higher confidence allows me to string strikes together more frequently directly resulting in higher scores.

Considerations

- I would like to see this study repeated with a larger sample of bowling balls and games in a more standardized setting
- I would like to see this study repeated with more bowlers of various styles and skill in other settings such as leagues or tournaments
- I would like to see this study repeated using technology to track more metrics that I could not capture by watching the shot
  - Such as speed, measurements at various parts of the lane, and revolution rate

More Information

More information on statistical methods and findings will be presented by Shristi Singh today at 5:00 pm in Adel Mathematics room 207

Sources

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Any Questions?

Source: Samuel Northam, April 2016