Analysis of Route Concepts

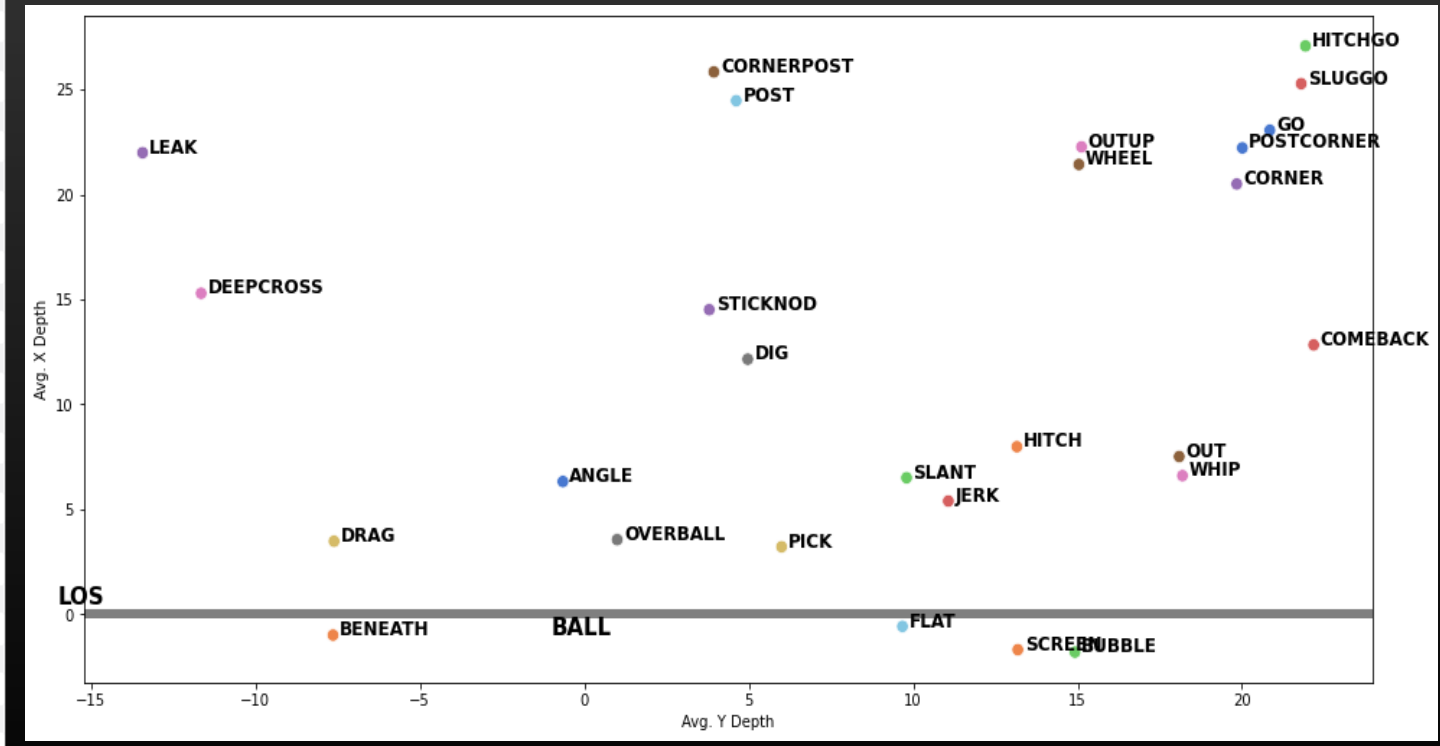
An approach to measuring the effectiveness of different route combinations during the 2020 NFL Season

Joe Andruzzi

Old route	New route	Avg. X Depth	Avg. Y Depth
Angle	ANGLE	6.32	-0.65
Beneath	BENEATH	-1.0	-7.64
Screen - Bubble	BUBBLE	-1.81	14.92
Comeback	COMEBACK	12.83	22.18
Corner	CORNER	20.5	19.84
Corner Post	CORNERPOST	25.84	3.94
Deep Cross	DEEPCROSS	15.29	-11.65
Dig	DIG	12.15	4.97
Chip - Drag	DRAG	3.46	-8.34
Drag	DRAG	3.49	-6.88
Swing - Right	FLAT	-0.78	9.19
Swing - Left	FLAT	-0.76	8.8
Flat - Right	FLAT	-0.12	10.05
Flat - Left	FLAT	-0.14	10.52
Jet Sweep Pass	FLAT	-3.25	8.95
Chip - Flat	FLAT	0.44	10.65
Check & Release	FLAT	-0.01	9.72
Chip	FLAT	-0.05	9.52
Fade	GO	23.23	21.6
Fade - Back Shoulder	GO	22.65	21.29
Chip - Seam	GO	19.0	18.81
Go/Fly	GO	27.68	21.85
Seam	GO	22.75	20.68
Chip - Curl	HITCH	7.8	10.37
Curl	HITCH	8.16	15.94
Hitch & Go	HITCHGO	27.08	21.93
Jerk	JERK	5.39	11.07
Leak	LEAK	21.99	-13.43
Out	OUT	7.51	18.09
Out & Up	OUTUP	22.27	15.12
Over Ball	OVERBALL	3.55	1.0
Pick	PICK	3.21	6.0
Post	POST	24.47	4.62
Post Corner	POSTCORNER	22.22	20.01
Screen - Tunnel	SCREEN	-1.7	14.62
Screen - TE	SCREEN	-2.11	8.61
Quick	SCREEN	-1.33	15.2
Screen - Quick	SCREEN	-1.72	14.74
Screen - Drag	SCREEN	-1.12	15.04
Screen - Beneath	SCREEN	-1.96	13.87
Screen - Shovel	SCREEN	-1.92	10.2
Slant	SLANT	6.5	9.8
Sluggo	SLUGGO	25.28	21.8
Stick - Nod	STICKNOD	14.51	3.8
Wheel	WHEEL	21.43	15.04
Whip	WHIP	6.6	18.19

Creating Expected X & Y Depth Target Coordinates

- Using 2018 Big Data Bowl tracking data, we can use a model to create expected X and Y target locations for each route – estimates are based on position, player alignment, and other features.
- This information will only be used to help include backside routes when evaluating all route combinations – otherwise this process would need to be done manually.
- Eligible combinations will include all routes that are on the same side as the targeted player, or any backside route that has an expected location within 20 yards of the targeted route. (20 yards - same assumption made by Sterken's 2018 RouteNet paper)



This is the POV for the right side of the formation – Expected Coordinates are subject to change based on position, alignment, and other various factors

Top Two-Man Concepts

Routes	count
FLAT,HITCH	2250
DIG,FLAT	1259
HITCH,HITCH	1153
DIG,HITCH	1083
FLAT,SLANT	888
DRAG,FLAT	850
FLAT,OUT	800
GO,HITCH	744
HITCH,OUT	738
GO,OUT	682
DIG,OUT	644
DIG,DRAG	641
DEEPCROSS,FLAT	616
HITCH,SLANT	537
SLANT,SLANT	524
DRAG,OUT	491
CORNER,FLAT	470
FLAT,GO	467
DRAG,HITCH	459
DEEPCROSS,GO	458
HITCH,OVERBALL	428
FLAT,OVERBALL	407
DIG,DIG	395
DIG,POST	379
FLAT,FLAT	363
DEEPCROSS,HITCH	363
HITCH,POST	362
DIG,SLANT	356
GO,GO	342
DIG,GO	341
DEEPCROSS,DIG	307
FLAT,POST	305
OUT,OUT	301
CORNER,OUT	297
DEEPCROSS,OUT	288
GO,SLANT	251
CORNER,HITCH	239
BENEATH,DEEPCROSS	219
DRAG,GO	207
DEEPCROSS,POST	207
DRAG,DRAG	194
DEEPCROSS,DRAG	192
GO,POST	190
OUT,SLANT	185
OUT,POST	171
GO,WHIP	151
DRAG,POST	143
BENEATH,FLAT	141
CORNER,DEEPCROSS	135
DRAG,SLANT	134
DEEPCROSS,WHIP	132
OUT,OVERBALL	126
DIG,WHIP	125
CORNER,DRAG	111
OVERBALL,SLANT	111
DIG,OVERBALL	109
CORNER,DIG	106
CORNER,WHIP	106
ANGLE,HITCH	102
OUT,WHIP	100
ANGLE,OUT	94
DRAG,WHEEL	90
COMEBACK,HITCH	85
DRAG,OVERBALL	85
FLAT,WHIP	83
HITCH,WHEEL	81

Top Three-Man Concepts

Routes	count
FLAT,HITCH,HITCH	647
DIG,FLAT,HITCH	641
DIG,DRAG,FLAT	426
FLAT,HITCH,OVERBALL	382
FLAT,HITCH,SLANT	348
FLAT,FLAT,HITCH	280
DIG,FLAT,OUT	265
HITCH,HITCH,HITCH	259
DRAG,FLAT,HITCH	255
FLAT,HITCH,OUT	249
FLAT,SLANT,SLANT	248
DIG,HITCH,HITCH	246
DIG,DIG,FLAT	242
DIG,DRAG,OUT	220
GO,HITCH,HITCH	194
DIG,FLAT,POST	190
DRAG,FLAT,OUT	184
DIG,FLAT,SLANT	177
DIG,HITCH,OUT	177
CORNER,FLAT,HITCH	175
DEEPCROSS,FLAT,HITCH	171
FLAT,GO,HITCH	168
DEEPCROSS,DIG,FLAT	167
DIG,DIG,HITCH	165
DEEPCROSS,FLAT,GO	162
DIG,HITCH,POST	156
FLAT,GO,OUT	148
HITCH,SLANT,SLANT	146
DRAG,DRAG,FLAT	143
DIG,GO,HITCH	142
FLAT,HITCH,POST	137
HITCH,HITCH,OVERBALL	136
FLAT,OVERBALL,SLANT	134
HITCH,HITCH,OUT	134
DIG,FLAT,GO	132
DIG,DRAG,HITCH	131
DIG,FLAT,FLAT	129
CORNER,DEEPCROSS,FLAT	127
SLANT,SLANT,SLANT	126
GO,HITCH,OUT	122
DIG,GO,OUT	121
DEEPCROSS,DRAG,FLAT	117
DIG,DIG,OUT	116
CORNER,DRAG,FLAT	113
DEEPCROSS,DIG,HITCH	110
HITCH,HITCH,SLANT	109
DEEPCROSS,FLAT,OUT	100
DIG,FLAT,OVERBALL	98
DRAG,GO,OUT	97
DIG,DRAG,GO	97
BENEATH,DEEPCROSS,FLAT	95
DIG,DRAG,POST	92
CORNER,DIG,FLAT	91
DEEPCROSS,GO,OUT	90
DIG,DIG,DRAG	88
DRAG,HITCH,OUT	87
HITCH,HITCH,POST	86
DIG,OUT,POST	86
DRAG,FLAT,SLANT	83
DEEPCROSS,GO,HITCH	83
DEEPCROSS,FLAT,FLAT	82
DIG,SLANT,SLANT	82
DIG,HITCH,SLANT	82
FLAT,FLAT,SLANT	81
DEEPCROSS,FLAT,POST	80
FLAT,OUT,POST	80
DEEPCROSS,GO,GO	80
DIG,DRAG,DRAG	80
DEEPCROSS,DIG,DRAG	77
FLAT,OUT,SLANT	76
FLAT,FLAT,OVERBALL	76
DEEPCROSS,DIG,GO	75

Data Preparation

Removed Observations

- Play contains Spike/Kneel/Throw away/Screen
- Play contains Sack or receiver fumble (Skews EPA)
- Play containing receiver positions other than: WR, TE, RB/FB
- Trick plays – Flea Flicker, Other, RB/WR Pass, WR Reverse Pass, Double Reverse Pass
- Unique/Rare route combinations where sample size is < 80 for Two-Man Concepts and < 75 for Three-Man Concepts

Removed Routes

- "Run Fakes" – play labeled play-action, and route was removed from dataset
- "Blocking" – route was removed from dataset

Data Transformation

The data is "melted" to focus on all potential route combinations for each play – I believe this is the best method to isolate certain route pairs/trios, even in complex formations.

Potential interaction routes will be any route that begins on the same side of the targeted receiver, or any backside route that has an expected location within 20 yards of the receiver.

An example of a melted frame, isolating all potential two-man concepts

gameId	playId	epa	displayName	Target	route	position	Exp_Dist_from_Tar
2793	425	0.693953	Demarcus Robinson	0	SLANT	WR	5.288011
2793	425	0.693953	Sammy Watkins	1	SLANT	WR	0.000000
2793	425	0.693953	Tyreek Hill	0	DIG	WR	7.437969
2793	425	0.693953	Clyde Edwards-Helaire	0	OUT	RB	9.761561
2793	425	0.693953	Travis Kelce	0	OUT	TE	20.340507

gameId	playId	epa	targetName	tar_pos	tar_route	route2	position2	On_Tar_side	Exp_Dist_from_Tar
2793	425	0.693953	Sammy Watkins	WR	SLANT	DIG	WR	1	7.437969
2793	425	0.693953	Sammy Watkins	WR	SLANT	SLANT	WR	1	5.288011
2793	425	0.693953	Sammy Watkins	WR	SLANT	OUT	RB	0	9.761561

Modeling & Determining Value

2 Models

A single metric evaluation system to identify optimal route combinations is not sufficient – Instead, 2 metrics will be used: EPA for "High upside" & First down/Yards-to-go success for "High Reliability".

2 Models will be used – One to predict "EPA", and the other to predict "Success"

- "Success" = When Actual Yards Gained >= Yards-to-go
- "EPA" = Sports Info Solutions Expected Points Added metric

Scenarios

Using the 2 expected values, we will run 2 different scenarios on each defensive coverage to show how different combinations provide value when the situation changes. We will weigh EPA and Success differently depending on the situation.

Model 1: x_EPA

Model 2: x_Success

Scenario 1: 1st Down & 8+

"Seeking High Upside"

Model 1: Scaled(x_EPA)*(.75)

Model 2: Scaled(x_Success)*(.25)

Scenario 2: 3rd Down & 3 or less

"Seeking The Sticks"

Model 1: Scaled(x_EPA)*(.25)

Model 2: Scaled(x_Success)*(.75)

Determining Value

To determine a route combinations value, the assumption will be that both routes in two-man concepts and all three routes in three-man concepts will have quality value across the board – when the 1st read breaks down, it is assumed that the 2nd read and/or 3rd read will also have a high value, thus making the route combination as foolproof as possible.

Brute Force – Optimal Position Groups, Alignment and more

After we train the models, we will attempt to determine what other factors can improve route combination effectiveness by going through thousands of different scenarios - changing position groups, adding play-action, changing receiver alignment and much more.

Model: Catboost

Features Used for EPA & Success Models

Two-Man Concepts

- Coverage Type
- Target Route
- Down
- Distance Bin (8+, 8-3, <3)
- QB Rollout (1/0)
- Shotgun (1/0)
- Play Action (1/0)
- Target Location #
- Redzone (1/0)
- Complementary Route
- Complementary Route Position
- Complementary Route on Target Side (1/0)
- Complementary Route Location #
- Routes Group (Target Route + Complementary Route)
- Positions Group (Target Position + Complementary Route Position)

Three-Man Concepts

- Coverage Type
- Target Route
- Down
- Distance Bin (8+, 8-3, <3)
- QB Rollout (1/0)
- Shotgun (1/0)
- Play Action (1/0)
- Target Location #
- Redzone (1/0)
- Complementary Route 1
- Complementary Route Position 1
- Complementary Route 1 on Target Side (1/0)
- Complementary Route1 Location #
- Complementary Route 2
- Complementary Route Position 2
- Complementary Route 2 on Target Side (1/0)
- Complementary Route 2 Location #
- Routes Group (Target Route + Comp Route 1 + Comp Route 2)
- Positions Group (Target Pos + Comp Route1 Pos + + Comp Route 2 Pos)

Cover 0

Scenario 1: “Seeking High Upside”

Top Two-Man Concepts

Routes	On Target side	tar1 Score	tar2 Score	Avg. Score
SLANT_2,SLANT_2	0	0.668	0.668	0.668
DEEPCROSS,DIG	0	0.779	0.501	0.640
DEEPCROSS,DIG	1	0.778	0.502	0.640
DEEPCROSS,POST	0	0.805	0.469	0.637
DEEPCROSS,POST	1	0.802	0.471	0.637
DEEPCROSS,GO	1	0.809	0.413	0.611
DEEPCROSS,GO	0	0.810	0.409	0.609
SLANT_1,SLANT_2	0	0.554	0.656	0.605
SLANT_1,SLANT_2	1	0.554	0.656	0.605
DEEPCROSS,OUT	0	0.773	0.424	0.598

The Play

Analysis

The double slant is estimated to provide the highest average foolproof upside, however the Deep Cross + Dig coming from the backside may pose for higher upside on the Deep Cross.

Exploring other variables

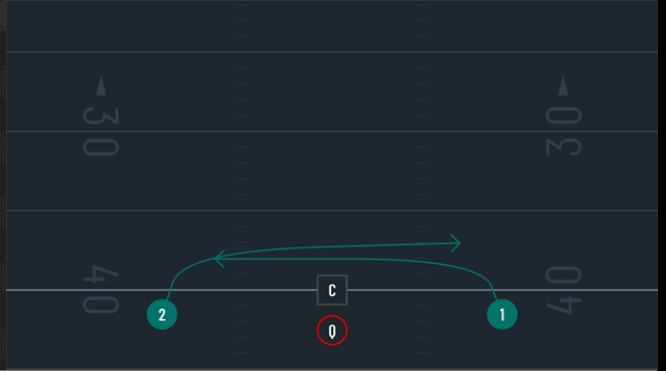
Target on Farside	Add Rollout	Target is WR	Add Shotgun	Add Play Action
0.004236	-0.011991	0.014148	-0.073572	0.012718

Scenario 2: “Seeking The Sticks”

Top Two-Man Concepts

Routes	On Target side	tar1 Score	tar2 Score	Avg. Score
DRAG_3,DRAG_3	0	0.811	0.811	0.811
DRAG_2,DRAG_3	1	0.715	0.808	0.762
DRAG_2,DRAG_3	0	0.714	0.807	0.760
DRAG_1,DRAG_3	1	0.691	0.813	0.752
DRAG,FLAT	1	0.758	0.745	0.751
DRAG_1,DRAG_3	0	0.689	0.812	0.751
DRAG,FLAT	0	0.756	0.741	0.748
FLAT,WHIP	0	0.704	0.731	0.717
FLAT,WHIP	1	0.701	0.730	0.715
DRAG_2,DRAG_2	0	0.711	0.711	0.711

The Play



Analysis

The drag route seems popular here, with a double drag coming from both sides as the optimal combination.

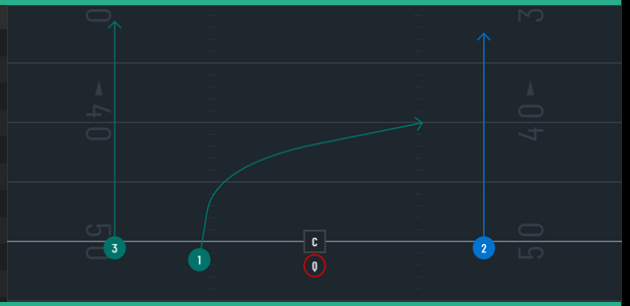
Exploring other variables

Target on Farside	Add Rollout	Target is WR	Add Shotgun	Add Play Action
0.003175	-0.047711	-0.022197	-0.008744	0.001126

Top Three-Man Concepts

Routes	Tar side1	Tar side2	tar1 Score	tar2 Score	tar3 Score	Avg. Score
DEEPCROSS,GO_1,GO_1	0	1	0.767	0.641	0.641	0.683
DEEPCROSS,GO_1,GO_1	0	0	0.762	0.635	0.635	0.678
DEEPCROSS,GO_1,GO_2	0	1	0.758	0.650	0.591	0.666
DEEPCROSS,GO_1,GO_2	1	1	0.762	0.650	0.582	0.665
DEEPCROSS,GO_1,GO_2	0	0	0.752	0.645	0.585	0.660
DEEPCROSS,GO_1,GO_3	1	1	0.741	0.665	0.572	0.659
DEEPCROSS,GO_1,GO_2	1	0	0.753	0.645	0.577	0.658
DEEPCROSS,GO_1,GO_3	1	0	0.738	0.661	0.563	0.654
DEEPCROSS,GO_1,GO_3	0	1	0.738	0.653	0.568	0.653
DEEPCROSS,GO_1,GO_3	0	0	0.735	0.649	0.560	0.648

The Play



Analysis

The Deep Cross from the slot with different variations of double Go routes are optimal here. Having the double Go’s clear out, while hitting the Deepcross over the middle on most likely man-to-man coverage.

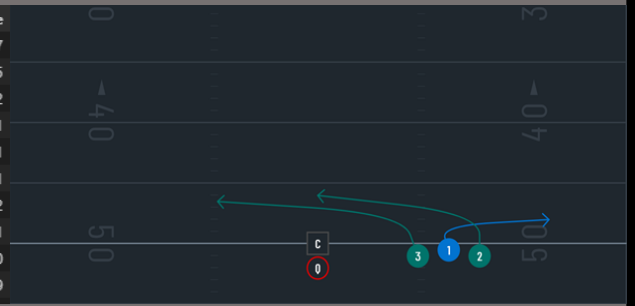
Exploring other variables

Target on Farside	Add Rollout	Target is WR	Add Shotgun	Add Play Action
0.008797	-0.011391	-0.050472	-0.038852	-0.002019

Top Three-Man Concepts

Routes	Tar side1	Tar side2	tar1 Score	tar2 Score	tar3 Score	Avg. Score
DRAG_1,DRAG_3,FLAT	1	1	0.621	0.702	0.736	0.687
DRAG_1,DRAG_3,FLAT	1	0	0.620	0.700	0.735	0.685
DRAG_3,DRAG_3,FLAT	0	0	0.682	0.682	0.682	0.682
DRAG_3,DRAG_3,FLAT	0	1	0.681	0.681	0.682	0.681
DRAG_2,DRAG_3,FLAT	0	1	0.657	0.691	0.666	0.671
DRAG_2,DRAG_3,FLAT	0	0	0.657	0.690	0.665	0.671
DRAG_2,DRAG_3,FLAT	1	1	0.653	0.686	0.647	0.662
DRAG_1,DRAG_3,FLAT	0	1	0.614	0.703	0.666	0.661
DRAG_2,DRAG_3,FLAT	1	0	0.652	0.685	0.643	0.660
DRAG_1,DRAG_3,FLAT	0	0	0.612	0.701	0.663	0.659

The Play



Analysis

Even in 3-man concepts, the drag rules in short yardage situations. The optimal solution includes double drag and a flat route all from the same side.

Exploring other variables

Target on Farside	Add Rollout	Target is WR	Add Shotgun	Add Play Action
0.008204	-0.025907	-0.072989	0.023944	-0.002303

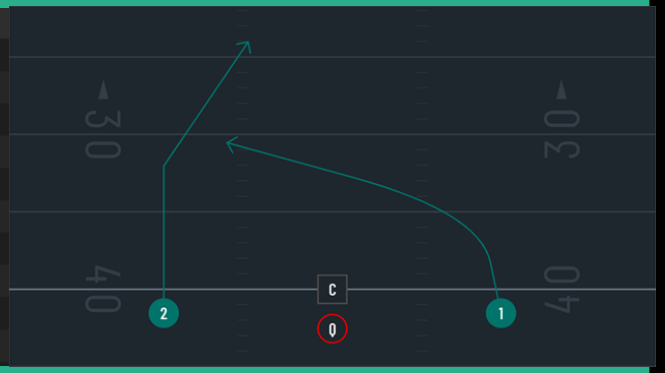
Cover 1

Scenario 1: “Seeking High Upside”

Top Two-Man Concepts

Routes	On Target side	tar1 Score	tar2 Score	Avg. Score
DEEPCROSS,POST	0	0.752	0.694	0.723
DEEPCROSS,POST	1	0.750	0.696	0.723
DEEPCROSS,GO	0	0.810	0.582	0.696
DEEPCROSS,GO	1	0.808	0.582	0.695
GO_2,GO_2	0	0.676	0.676	0.676
GO,POST	0	0.587	0.738	0.662
GO,POST	1	0.585	0.737	0.661
DEEPCROSS,DIG	0	0.758	0.560	0.659
DEEPCROSS,DIG	1	0.756	0.560	0.658
SLANT_3,SLANT_3	0	0.654	0.654	0.654

The Play



Analysis

The Deep Cross + Post combination shows the highest upside here – The post will keep the single-high safety occupied while the Deepcross comes underneath.

Exploring other variables

Target on Farside	Add Rollout	Target is WR	Add Shotgun	Add Play Action
0.001736	-0.022008	0.016050	-0.040954	-0.014247

Scenario 2: “Seeking The Sticks”

Top Two-Man Concepts

Routes	On Target side	tar1 Score	tar2 Score	Avg. Score
DRAG_3,DRAG_3	0	0.824	0.824	0.824
OUT_3,OUT_3	0	0.776	0.776	0.776
DIG_3,DIG_3	0	0.764	0.764	0.764
DRAG_2,DRAG_3	1	0.645	0.850	0.747
OUT_2,OUT_3	1	0.680	0.812	0.746
DRAG_2,DRAG_3	0	0.642	0.848	0.745
OUT_2,OUT_3	0	0.677	0.810	0.744
OUT_1,OUT_3	1	0.662	0.811	0.736
OUT_1,OUT_3	0	0.660	0.808	0.734
FLAT,OUT	1	0.705	0.759	0.732

The Play

Analysis

Just like in Cover 0, the double drag coming from each end will have defenders chasing – either Drag acting as a potential rub route as well.

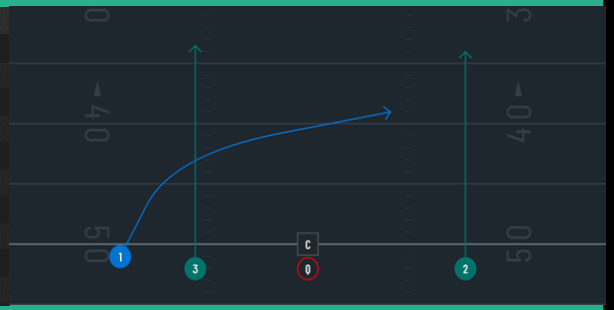
Exploring other variables

Target on Farside	Add Rollout	Target is WR	Add Shotgun	Add Play Action
-0.001260	-0.055928	-0.042881	-0.010744	0.006410

Top Three-Man Concepts

Routes	Tar side1	Tar side2	tar1 Score	tar2 Score	tar3 Score	Avg. Score
DEEPCROSS,GO_2,GO_2	0	1	0.745	0.629	0.629	0.668
DEEPCROSS,GO_1,GO_2	0	1	0.759	0.589	0.644	0.664
DEEPCROSS,GO_1,GO_3	1	1	0.772	0.593	0.623	0.662
DEEPCROSS,GO_2,GO_2	0	0	0.737	0.624	0.624	0.661
DEEPCROSS,GO_1,GO_2	0	0	0.751	0.584	0.638	0.658
DEEPCROSS,GO_1,GO_2	1	1	0.766	0.577	0.628	0.657
DEEPCROSS,GO_1,GO_3	1	0	0.768	0.589	0.613	0.657
DEEPCROSS,GO_1,GO_2	1	0	0.756	0.572	0.622	0.650
DEEPCROSS,GO_1,GO_3	0	1	0.732	0.585	0.629	0.649
DEEPCROSS,GO_2,GO_3	0	1	0.716	0.625	0.600	0.647

The Play



Analysis

Deep Cross + double Go’s just like the optimal cover 0 routes – except with a slight variation by lining the Deep Cross on the outside.

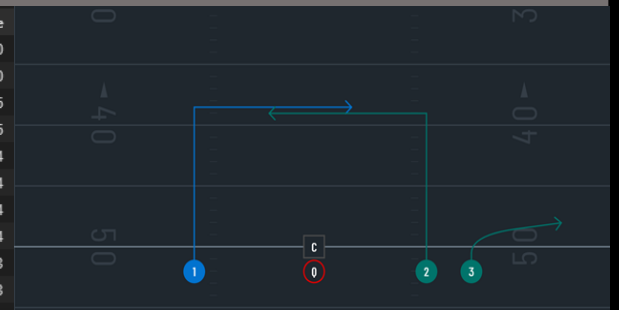
Exploring other variables

Target on Farside	Add Rollout	Target is WR	Add Shotgun	Add Play Action
-0.005894	-0.018996	0.016593	-0.047536	0.000888

Top Three-Man Concepts

Routes	Tar side1	Tar side2	tar1 Score	tar2 Score	tar3 Score	Avg. Score
DIG_3,DIG_3,FLAT	0	0	0.754	0.754	0.653	0.720
DIG_3,DIG_3,FLAT	0	1	0.753	0.753	0.652	0.720
DIG_3,DIG_3,OUT	0	1	0.732	0.732	0.685	0.716
DIG_3,DIG_3,OUT	0	0	0.733	0.733	0.680	0.716
DIG,GO,OUT	1	0	0.681	0.773	0.689	0.714
DEEPCROSS,GO_3,GO_3	0	0	0.672	0.735	0.735	0.714
DIG_3,DIG_3,HITCH	0	0	0.757	0.757	0.629	0.714
DIG_3,DIG_3,HITCH	0	1	0.756	0.756	0.629	0.714
DEEPCROSS,GO_3,GO_3	0	1	0.670	0.734	0.734	0.713
DIG,GO,OUT	1	1	0.677	0.769	0.691	0.713

The Play



Analysis

Wasn’t expect this one – but a double Dig coming from both directions and a Flat route as a safety valve.

Exploring other variables

Target on Farside	Add Rollout	Target is WR	Add Shotgun	Add Play Action
0.006623	-0.028283	-0.015188	0.029298	-0.001801

Cover 2

Scenario 1: “Seeking High Upside”

Top Two-Man Concepts

Routes	On Target side	tar1 Score	tar2 Score	Avg. Score
CORNER,DEEPCROSS	0	0.672	0.681	0.677
CORNER,DEEPCROSS	1	0.672	0.679	0.675
GO_2,GO_2	0	0.644	0.644	0.644
GO_2,GO_3	0	0.655	0.612	0.633
GO_2,GO_3	1	0.654	0.611	0.633
DEEPCROSS,GO	0	0.730	0.535	0.633
DEEPCROSS,GO	1	0.730	0.533	0.632
GO_1,GO_2	0	0.568	0.642	0.605
GO_1,GO_2	1	0.568	0.641	0.604
GO_3,GO_3	0	0.601	0.601	0.601

The Play

Analysis

The Corner + Deep Cross should be a staple combination against Cover 2 – the target side safety must decide on the Corner or the Deepcross

Exploring other variables

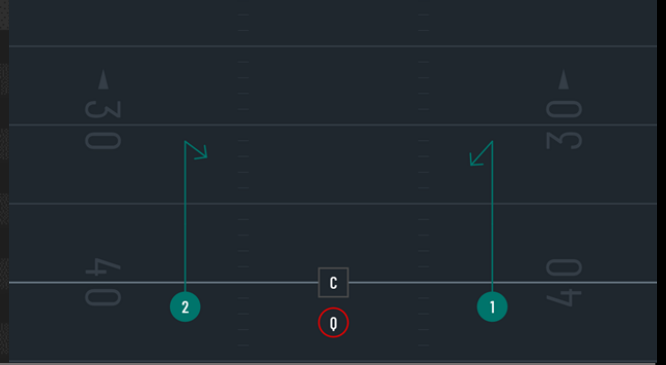
Target on Farside	Add Rollout	Target is WR	Add Shotgun	Add Play Action
0.002536	-0.018709	-0.070721	-0.047435	-0.014683

Scenario 2: “Seeking The Sticks”

Top Two-Man Concepts

Routes	On Target side	tar1 Score	tar2 Score	Avg. Score
HITCH_2,HITCH_2	0	0.820	0.820	0.820
HITCH_2,HITCH_3	1	0.829	0.768	0.798
HITCH_2,HITCH_3	0	0.828	0.767	0.797
HITCH_1,HITCH_2	1	0.770	0.803	0.787
HITCH_1,HITCH_2	0	0.768	0.802	0.785
HITCH_3,HITCH_3	0	0.779	0.779	0.779
HITCH,POST	0	0.774	0.762	0.768
HITCH,POST	1	0.775	0.761	0.768
HITCH_1,HITCH_3	1	0.783	0.749	0.766
FLAT,HITCH	1	0.717	0.814	0.766

The Play



Analysis

The double Hitch from opposite slots appear to be optimal.

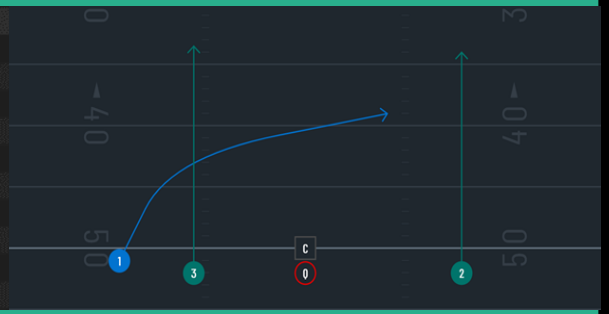
Exploring other variables

Target on Farside	Add Rollout	Target is WR	Add Shotgun	Add Play Action
0.007812	-0.035811	-0.064516	0.006580	0.000065

Top Three-Man Concepts

Routes	Tar side1	Tar side2	tar1 Score	tar2 Score	tar3 Score	Avg. Score
DEEPCROSS,GO_2,GO_2	0	1	0.817	0.631	0.631	0.693
DEEPCROSS,GO_1,GO_2	0	1	0.837	0.579	0.649	0.688
DEEPCROSS,GO_2,GO_2	0	0	0.810	0.627	0.627	0.688
DEEPCROSS,GO_1,GO_2	0	0	0.831	0.575	0.644	0.684
DEEPCROSS,GO_2,GO_3	1	1	0.809	0.646	0.593	0.683
DEEPCROSS,GO_1,GO_2	1	1	0.820	0.577	0.642	0.680
DEEPCROSS,GO_2,GO_3	1	0	0.806	0.643	0.586	0.678
DEEPCROSS,GO_1,GO_2	1	0	0.813	0.573	0.637	0.674
DEEPCROSS,GO_1,GO_3	1	1	0.834	0.585	0.602	0.674
DEEPCROSS,GO_2,GO_3	0	1	0.800	0.630	0.583	0.671

The Play



Analysis

The Deep Cross + double Go’s like cover 1, using the outside receiver Deep Cross appears optimal.

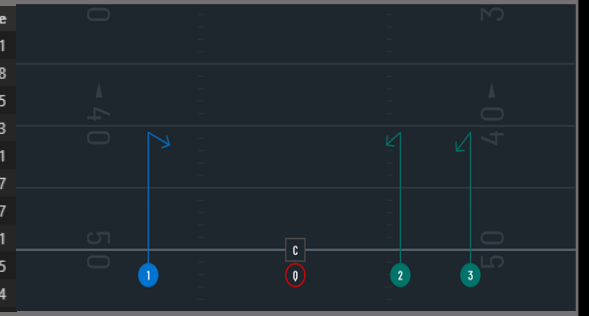
Exploring other variables

Target on Farside	Add Rollout	Target is WR	Add Shotgun	Add Play Action
-0.003280	-0.015558	-0.045713	-0.046897	0.001128

Top Three-Man Concepts

Routes	Tar side1	Tar side2	tar1 Score	tar2 Score	tar3 Score	Avg. Score
HITCH_2,HITCH_2,HITCH_3	0	0	0.796	0.796	0.751	0.781
HITCH_2,HITCH_3,HITCH_3	0	0	0.807	0.764	0.764	0.778
HITCH_2,HITCH_2,HITCH_2	0	0	0.775	0.775	0.775	0.775
HITCH_2,HITCH_2,HITCH_3	0	1	0.789	0.789	0.742	0.773
HITCH_2,HITCH_3,HITCH_3	0	1	0.801	0.757	0.757	0.771
HITCH_2,HITCH_2,HITCH_2	0	1	0.767	0.767	0.767	0.767
HITCH_3,HITCH_3,HITCH_3	0	0	0.767	0.767	0.767	0.767
HITCH_3,HITCH_3,HITCH_3	0	1	0.761	0.761	0.761	0.761
HITCH_1,HITCH_2,HITCH_3	0	0	0.646	0.815	0.773	0.745
HITCH_1,HITCH_2,HITCH_3	1	0	0.646	0.815	0.770	0.744

The Play



Analysis

Just like in the 2-man concept, all Hitches appear to be the way to go.

Exploring other variables

Target on Farside	Add Rollout	Target is WR	Add Shotgun	Add Play Action
0.001967	-0.030559	-0.090927	0.016049	0.000062

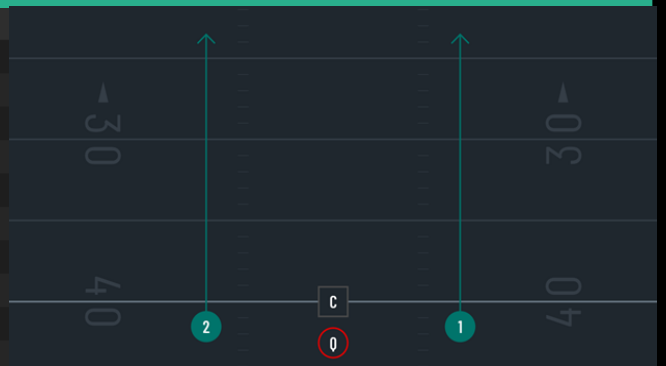
Cover 2 Man

Scenario 1: "Seeking High Upside"

Top Two-Man Concepts

Routes	On Target side	tar1 Score	tar2 Score	Avg. Score
GO_3,GO_3	0	0.689	0.689	0.689
GO_2,GO_3	0	0.607	0.705	0.656
GO_2,GO_3	1	0.607	0.705	0.656
DEEPCROSS,GO	0	0.698	0.570	0.634
DEEPCROSS,GO	1	0.697	0.572	0.634
GO_2,GO_2	0	0.612	0.612	0.612
GO_1,GO_3	0	0.510	0.703	0.607
GO_1,GO_3	1	0.510	0.703	0.606
GO_1,GO_2	0	0.522	0.606	0.564
GO_1,GO_2	1	0.522	0.606	0.564

The Play



Analysis

The dual slot seam routes appear optimal here – even in different variations. The Deepcross + Go is a close second.

Exploring other variables

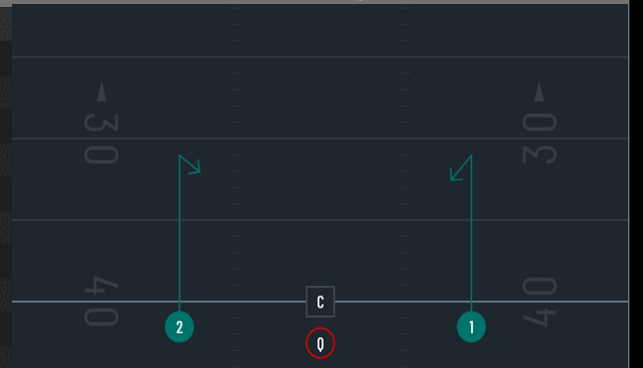
Target on Farside	Add Rollout	Target is WR	Add Shotgun	Add Play Action
-0.006182	-0.002010	-0.097050	-0.006948	0.018924

Scenario 2: "Seeking The Sticks"

Top Two-Man Concepts

Routes	On Target side	tar1 Score	tar2 Score	Avg. Score
HITCH_3,HITCH_3	0	0.830	0.830	0.830
HITCH_2,HITCH_3	1	0.743	0.822	0.783
HITCH_2,HITCH_3	0	0.741	0.820	0.780
HITCH_1,HITCH_3	1	0.672	0.790	0.731
HITCH_2,HITCH_2	0	0.730	0.730	0.730
HITCH_1,HITCH_3	0	0.668	0.788	0.728
HITCH_1,HITCH_2	1	0.672	0.698	0.685
HITCH_1,HITCH_2	0	0.668	0.696	0.682
FLAT,HITCH	1	0.559	0.770	0.664
FLAT,HITCH	0	0.556	0.767	0.662

The Play



Analysis

The double Hitches again – find those open zones.

Exploring other variables

Target on Farside	Add Rollout	Target is WR	Add Shotgun	Add Play Action
-0.000839	-0.030731	0.034789	0.009173	0.006552

Top Three-Man Concepts

Routes	Tar side1	Tar side2	tar1 Score	tar2 Score	tar3 Score	Avg. Score
DEEPCROSS,GO_1,GO_1	0	1	0.818	0.612	0.612	0.681
DEEPCROSS,GO_1,GO_3	1	1	0.778	0.636	0.613	0.676
DEEPCROSS,GO_1,GO_1	0	0	0.814	0.606	0.606	0.676
DEEPCROSS,GO_1,GO_3	0	1	0.775	0.633	0.619	0.675
DEEPCROSS,GO_1,GO_2	0	1	0.798	0.615	0.607	0.673
DEEPCROSS,GO_1,GO_2	1	1	0.802	0.611	0.606	0.673
DEEPCROSS,GO_1,GO_3	1	0	0.776	0.632	0.605	0.671
DEEPCROSS,GO_1,GO_3	0	0	0.772	0.629	0.611	0.671
DEEPCROSS,GO_1,GO_2	0	0	0.792	0.610	0.602	0.668
DEEPCROSS,GO_1,GO_2	1	0	0.793	0.607	0.601	0.667

The Play

Analysis

The Deep Cross + double Go again – the Go routes will occupy both safeties and allow the Deepcross plenty of room to work with.

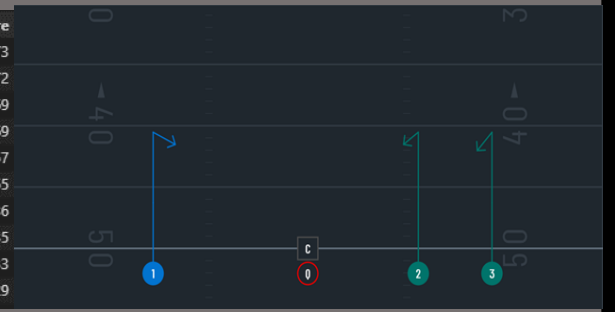
Exploring other variables

Target on Farside	Add Rollout	Target is WR	Add Shotgun	Add Play Action
0.000227	-0.019082	-0.035714	-0.029076	-0.000901

Top Three-Man Concepts

Routes	Tar side1	Tar side2	tar1 Score	tar2 Score	tar3 Score	Avg. Score
HITCH_3,HITCH_3,HITCH_3	0	1	0.773	0.773	0.773	0.773
HITCH_3,HITCH_3,HITCH_3	0	0	0.772	0.772	0.772	0.772
HITCH_2,HITCH_3,HITCH_3	0	0	0.774	0.767	0.767	0.769
HITCH_2,HITCH_3,HITCH_3	0	1	0.774	0.766	0.766	0.769
HITCH_2,HITCH_2,HITCH_3	0	0	0.759	0.759	0.751	0.757
HITCH_2,HITCH_2,HITCH_3	0	1	0.758	0.758	0.749	0.755
HITCH_3,HITCH_3,OUT	0	0	0.741	0.741	0.724	0.736
HITCH_2,HITCH_2,HITCH_2	0	0	0.735	0.735	0.735	0.735
HITCH_2,HITCH_2,HITCH_2	0	1	0.733	0.733	0.733	0.733
HITCH_1,HITCH_3,HITCH_3	0	0	0.650	0.769	0.769	0.729

The Play



Analysis

All these Hitch routes from the slot being optimal for short yardage is interesting – would love more data to explore this further.

Exploring other variables

Target on Farside	Add Rollout	Target is WR	Add Shotgun	Add Play Action
0.004716	-0.028316	-0.032969	0.029873	-0.000454

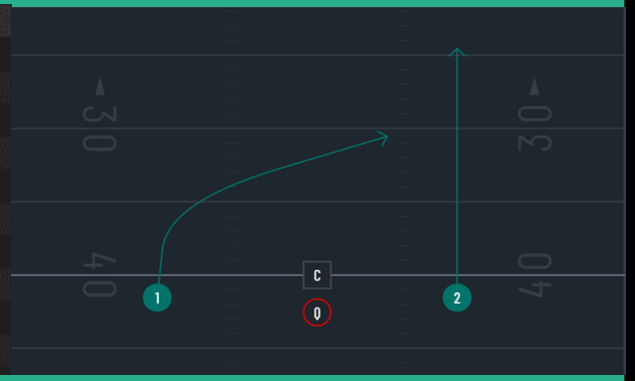
Cover 3 + Tampa 2

Scenario 1: "Seeking High Upside"

Top Two-Man Concepts

Routes	On Target side	tar1 Score	tar2 Score	Avg. Score
DEEPCROSS,GO	0	0.842	0.603	0.722
DEEPCROSS,GO	1	0.840	0.604	0.722
GO_2,GO_2	0	0.720	0.720	0.720
GO_1,GO_2	1	0.683	0.713	0.698
GO_1,GO_2	0	0.682	0.713	0.698
CORNER,DEEPCROSS	0	0.593	0.762	0.678
DEEPCROSS,POST	0	0.785	0.567	0.676
DEEPCROSS,POST	1	0.782	0.570	0.676
CORNER,DEEPCROSS	1	0.593	0.757	0.675
GO_2,GO_3	1	0.721	0.621	0.671

The Play



Analysis

Deep Cross + Go must be the way to go. Looks like it could be open right in-between the middle safety and the safety on the target side.

Exploring other variables

Target on Farside	Add Rollout	Target is WR	Add Shotgun	Add Play Action
-0.003013	-0.022364	-0.030794	-0.051055	-0.020356

Scenario 2: "Seeking The Sticks"

Top Two-Man Concepts

Routes	On Target side	tar1 Score	tar2 Score	Avg. Score
HITCH_3,HITCH_3	0	0.770	0.770	0.770
OUT_3,OUT_3	0	0.765	0.765	0.765
HITCH_2,HITCH_3	1	0.738	0.769	0.754
DIG_3,DIG_3	0	0.752	0.752	0.752
HITCH_2,HITCH_3	0	0.737	0.768	0.752
GO_2,GO_2	0	0.735	0.735	0.735
HITCH_2,HITCH_2	0	0.732	0.732	0.732
OUT_2,OUT_3	1	0.672	0.785	0.729
OUT_2,OUT_3	0	0.671	0.784	0.728
FLAT,OUT	0	0.708	0.743	0.725

The Play

Analysis

The dual Hitch slot is optimal again, just as Cover 2.

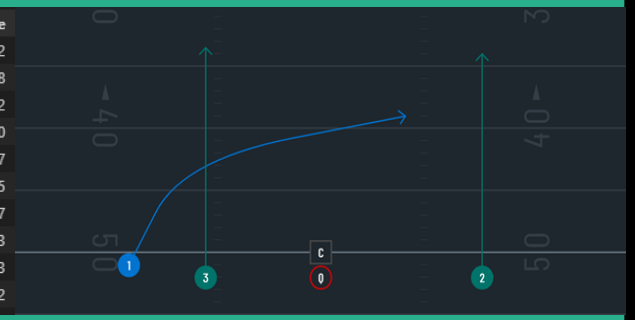
Exploring other variables

Target on Farside	Add Rollout	Target is WR	Add Shotgun	Add Play Action
0.012884	-0.045956	0.050419	-0.004586	0.002592

Top Three-Man Concepts

Routes	Tar side1	Tar side2	tar1 Score	tar2 Score	tar3 Score	Avg. Score
DEEPCROSS,GO_2,GO_2	0	1	0.832	0.652	0.652	0.712
DEEPCROSS,GO_2,GO_2	0	0	0.825	0.649	0.649	0.708
DEEPCROSS,GO_1,GO_2	0	1	0.845	0.596	0.666	0.702
DEEPCROSS,GO_1,GO_2	1	1	0.864	0.586	0.649	0.700
DEEPCROSS,GO_1,GO_2	0	0	0.839	0.591	0.662	0.697
DEEPCROSS,GO_1,GO_2	1	0	0.857	0.582	0.645	0.695
DEEPCROSS,GO_2,GO_3	1	1	0.801	0.658	0.572	0.677
DEEPCROSS,GO_1,GO_1	0	1	0.854	0.583	0.583	0.673
DEEPCROSS,GO_2,GO_3	0	1	0.814	0.643	0.561	0.673
DEEPCROSS,GO_2,GO_3	1	0	0.796	0.656	0.566	0.672

The Play



Analysis

Deep Cross + double Go, what's new?

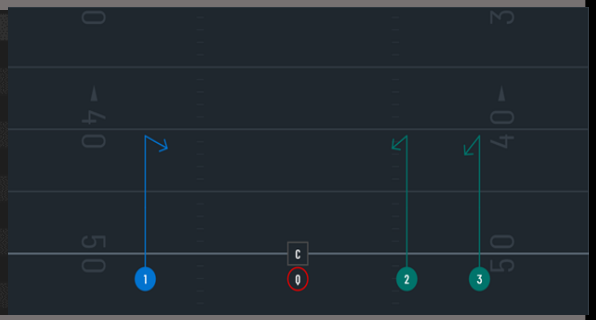
Exploring other variables

Target on Farside	Add Rollout	Target is WR	Add Shotgun	Add Play Action
-0.009781	-0.023585	0.011363	-0.048339	0.000180

Top Three-Man Concepts

Routes	Tar side1	Tar side2	tar1 Score	tar2 Score	tar3 Score	Avg. Score
HITCH_3,HITCH_3,HITCH_3	0	1	0.768	0.768	0.768	0.768
HITCH_3,HITCH_3,HITCH_3	0	0	0.766	0.766	0.766	0.766
HITCH_2,HITCH_3,HITCH_3	0	0	0.768	0.757	0.757	0.761
HITCH_2,HITCH_3,HITCH_3	0	1	0.768	0.757	0.757	0.761
HITCH_2,HITCH_2,HITCH_3	0	0	0.743	0.743	0.740	0.742
HITCH_2,HITCH_2,HITCH_3	0	1	0.743	0.743	0.738	0.741
GO,HITCH_3,HITCH_3	0	0	0.654	0.776	0.776	0.735
FLAT,HITCH_3,HITCH_3	0	0	0.651	0.774	0.774	0.733
GO,HITCH_3,HITCH_3	0	1	0.652	0.773	0.773	0.733
FLAT,HITCH_2,HITCH_3	0	0	0.647	0.760	0.778	0.728

The Play



Analysis

All Hitches to get the first down – I see a common theme here.

Exploring other variables

Target on Farside	Add Rollout	Target is WR	Add Shotgun	Add Play Action
0.006350	-0.031460	-0.011306	0.036322	-0.000404

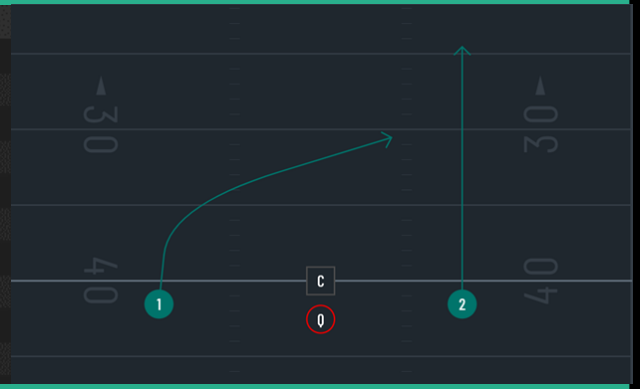
Cover 4

Scenario 1: "Seeking High Upside"

Top Two-Man Concepts

Routes	On Target side	tar1 Score	tar2 Score	Avg. Score
DEEPCROSS,GO	0	0.820	0.511	0.665
DEEPCROSS,GO	1	0.817	0.511	0.664
CORNER,DEEPCROSS	0	0.543	0.760	0.651
CORNER,DEEPCROSS	1	0.547	0.755	0.651
DEEPCROSS,DIG	0	0.770	0.506	0.638
DEEPCROSS,DIG	1	0.767	0.506	0.636
SLANT_1,SLANT_1	0	0.627	0.627	0.627
DEEPCROSS,POST	1	0.749	0.497	0.623
DEEPCROSS,POST	0	0.752	0.493	0.623
DEEPCROSS,HITCH	1	0.753	0.490	0.621

The Play



Analysis

Deep Cross + Go – you could have guessed it.

Exploring other variables

Target on Farside	Add Rollout	Target is WR	Add Shotgun	Add Play Action
-0.002694	-0.016529	-0.066748	-0.062868	-0.010844

Scenario 2: "Seeking The Sticks"

Top Two-Man Concepts

Routes	On Target side	tar1 Score	tar2 Score	Avg. Score
OUT_3,OUT_3	0	0.799	0.799	0.799
OUT_2,OUT_3	1	0.677	0.814	0.745
OUT_2,OUT_3	0	0.675	0.812	0.743
DRAG_3,DRAG_3	0	0.734	0.734	0.734
SLANT_1,SLANT_1	0	0.699	0.699	0.699
OUT_2,OUT_2	0	0.696	0.696	0.696
OUT_1,OUT_3	1	0.566	0.809	0.688
OUT_1,OUT_3	0	0.564	0.807	0.686
DIG,OUT	1	0.579	0.713	0.646
DIG,OUT	0	0.578	0.710	0.644

The Play

Analysis

If you're lucky enough to have a defense run Cover 4 on 3rd and short - Dual Out routes from opposite slots appear optimal in many variations – with the double drag close by.

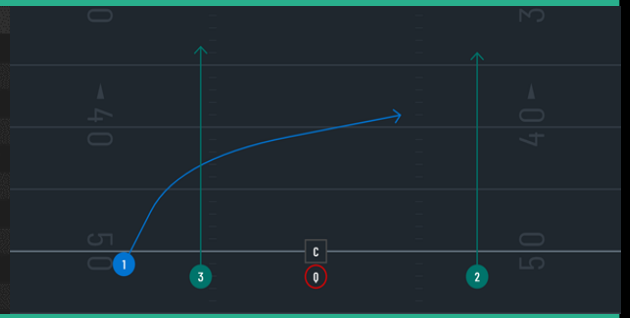
Exploring other variables

Target on Farside	Add Rollout	Target is WR	Add Shotgun	Add Play Action
-0.000565	-0.057037	-0.019632	-0.014513	0.018151

Top Three-Man Concepts

Routes	Tar side1	Tar side2	tar1 Score	tar2 Score	tar3 Score	Avg. Score
DEEPCROSS,GO_2,GO_2	0	1	0.808	0.654	0.654	0.705
DEEPCROSS,GO_1,GO_2	0	1	0.817	0.616	0.675	0.703
DEEPCROSS,GO_1,GO_2	1	1	0.825	0.609	0.665	0.700
DEEPCROSS,GO_2,GO_2	0	0	0.800	0.649	0.649	0.699
DEEPCROSS,GO_1,GO_2	0	0	0.811	0.611	0.669	0.697
DEEPCROSS,GO_1,GO_2	1	0	0.817	0.604	0.660	0.694
DEEPCROSS,GO_1,GO_1	0	1	0.822	0.611	0.611	0.682
DEEPCROSS,GO_1,GO_1	0	0	0.818	0.606	0.606	0.676
DEEPCROSS,GO_1,GO_3	1	1	0.811	0.612	0.573	0.665
DEEPCROSS,GO_2,GO_3	1	1	0.775	0.659	0.560	0.665

The Play



Analysis

Just crown the Deep Cross + double Go combination – appears to be optimal in many different scenarios.

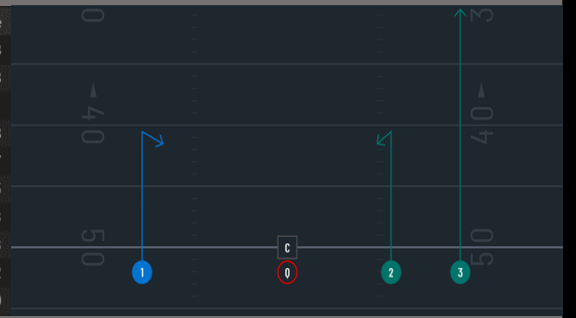
Exploring other variables

Target on Farside	Add Rollout	Target is WR	Add Shotgun	Add Play Action
-0.007468	-0.018389	-0.016033	-0.040593	0.000469

Top Three-Man Concepts

Routes	Tar side1	Tar side2	tar1 Score	tar2 Score	tar3 Score	Avg. Score
GO,HITCH_3,HITCH_3	0	0	0.705	0.754	0.754	0.738
DRAG,GO,OUT	1	0	0.672	0.772	0.770	0.738
DRAG,GO,OUT	0	0	0.664	0.763	0.768	0.731
HITCH_3,HITCH_3,HITCH_3	0	0	0.728	0.728	0.728	0.728
GO,HITCH,OUT	1	0	0.698	0.718	0.765	0.727
GO,HITCH_3,HITCH_3	0	1	0.693	0.742	0.742	0.725
DRAG,GO,OUT	1	1	0.657	0.759	0.753	0.723
HITCH_3,HITCH_3,HITCH_3	0	1	0.723	0.723	0.723	0.723
DIG,GO,OUT	1	0	0.651	0.773	0.741	0.722
HITCH_2,HITCH_3,HITCH_3	0	0	0.708	0.726	0.726	0.720

The Play

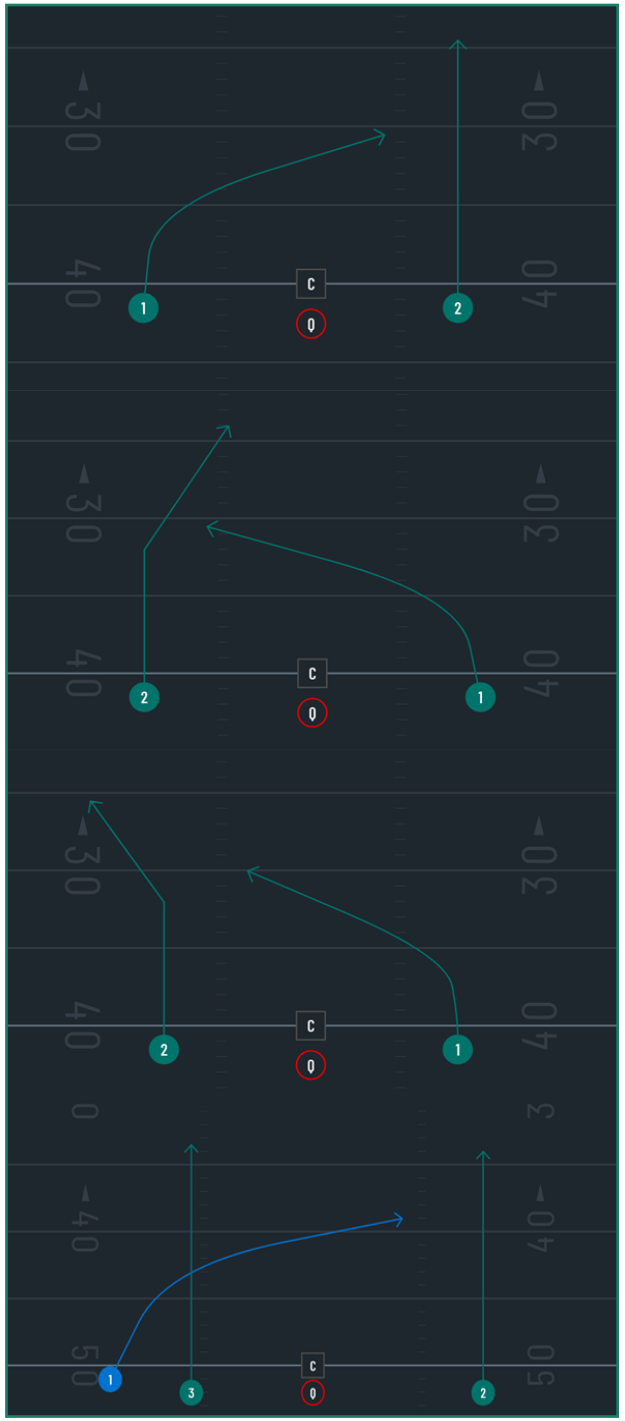


Analysis

Go, Hitch, Hitch – Interesting wrinkle compared to other short-yardage 3-man concepts.

Exploring other variables

Target on Farside	Add Rollout	Target is WR	Add Shotgun	Add Play Action
0.003050	-0.021294	-0.004322	0.020597	0.003349



The Deep Cross

You saw it, the Deep Cross showed up as the optimal target in many variations – against all defensive coverages.

The Deep Cross - EPOE

If you're still not sold – we can use a simple metric called EPAOE to further confirm that the Deep Cross is the most effective route.

EPAOE = EPA on the play – (Average EPA the offensive team generally produces)

Compared to all targeted routes on 2-man concepts – the Deep Cross had the highest EPAOE/play by nearly .13 over the next closest!

tar_route	mean	count
DEEPCROSS	0.206244	649
HITCH	0.076886	2409
SLANT	0.068898	1099
OVERBALL	0.058828	258
ANGLE	0.032149	98
DIG	0.021140	1080
OUT	0.004431	1707
POST	-0.006087	370
GO	-0.011591	1071
WHIP	-0.014930	259
WHEEL	-0.023012	69
DRAG	-0.025554	871
COMEBACK	-0.044941	36
CORNER	-0.061795	365
BENEATH	-0.113056	207
FLAT	-0.164599	2148

Top EPOE 2-Man concepts

Routes	mean	count
DEEPCROSS,POST	0.485902	123
GO,POST	0.380578	118
CORNER,DEEPCROSS	0.305604	69
DEEPCROSS,HITCH	0.293588	184
DIG,WHIP	0.171846	68
DEEPCROSS,OUT	0.155614	155
DRAG,HITCH	0.122767	214
DEEPCROSS,DRAG	0.114342	107
DEEPCROSS,DIG	0.111886	130
GO,OUT	0.111811	398

The Deep Cross + Post had shown to be the best Cover 1 beater in my model, now we confirm its effectiveness with the highest EPAOE per play.

The Deep Cross route appears in 6/10 of the top EPAOE combinations.

Deep Cross + Post

Who's running this foolproof optimal 2-man concept? Let's look at the top 10 teams.

PlayerTeam	mean	count
Jets	0.147651	14
Bills	1.021466	10
Lions	0.208568	7
Bengals	1.071401	6
Panthers	1.130541	5
Bears	0.810447	5
Patriots	0.292978	5
Ravens	2.240403	5
Cowboys	0.212865	5
Vikings	0.130243	5

What're the odds that the top 10 teams that run this concept all have a positive EPAOE/play? What if I told you the Jets are on the forefront of this combination?

With a sample size of 123, I would love to see that number larger, but this stands out given the data we have.

Findings

“Seeking High Upside”

- Nearly all optimal “Seeking High Upside” combinations incorporated a Deep Cross, and then complimented it with a deep route - Post, Go or Corner. Intuitively, the success of this play makes sense, as it forces the target side safety to make a choice – and he will most likely take on the deeper route, leaving the Deep Cross open. The jury is still out for the Deep Cross as we wait for a larger sample size, but preliminary results appear positive.

“Seeking The Sticks”

- The optimal short yardage play appeared to be running dual opposing Drag routes from the slot in obvious man-to-man situations like Cover 0 or Cover 1. The dual Drag make sense, as crossing routes are very popular against man-to-man. Another optimal combination would be running dual Hitches from opposing slots. Running Hitches from the slot is a great way to find open spaces in the middle of the field – a very simple, yet effective concept.

Limitations & Future work

Limitations & Future Work

- The obvious limitation is not enough data – small sample sizes will always be a challenge. As the sample increases, the picture will become clearer.
- Tracking data – having the ability to use spatial data throughout the play would vastly improve this research. Evaluating route combinations based on spacing and separation would be optimal.
- Time – Increased research time will improve the quality of work, perhaps 2-3 months as opposed to 1 month. Combinatorial analysis is a daunting task, especially with so many confounding variables.

Sources

Sources

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