

Development of an Excel-Based Software Solution to Collegiate EMS Shift Scheduling & Placement

David Gordon^{1,2}, EMT; Ezra Brooks¹, EMT; Donavon Sandoval¹, EMT; Kaitlyn Boyle¹, EMT

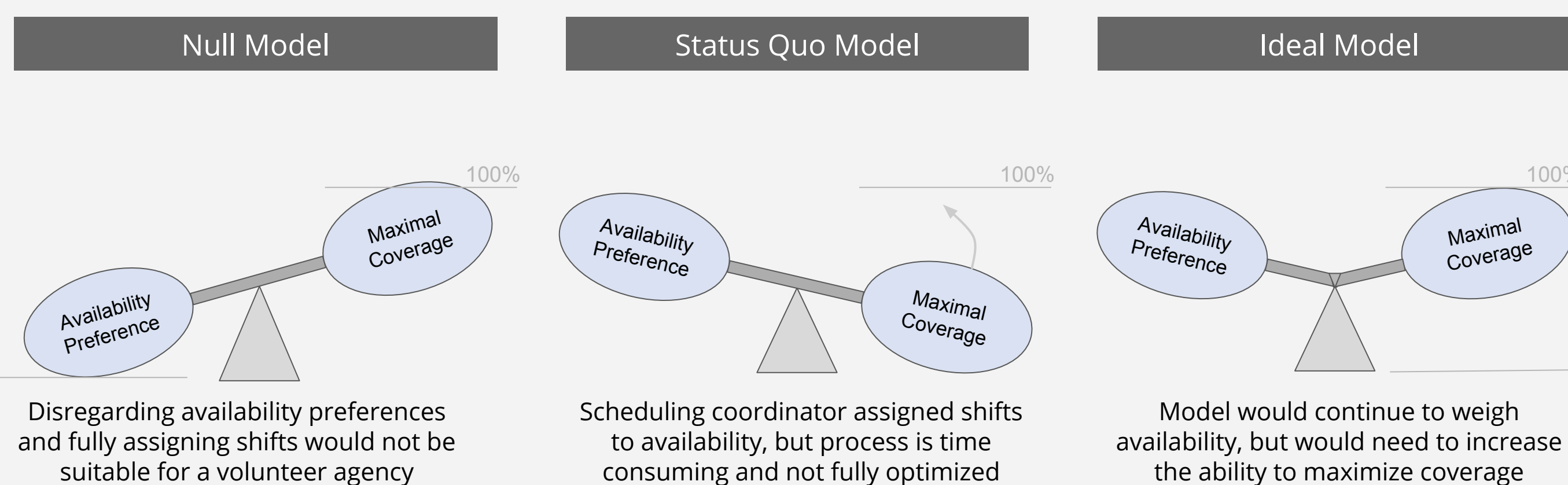
¹ University of Pennsylvania, Medical Emergency Response Team
² Lewisboro Volunteer Ambulance Corps



Introduction

Weekly, MERT's scheduling coordinator aggregates 50 volunteer EMTs' availability to maximize coverage for 18 shifts and special events

Shift Assignment Models & Tradeoffs



MERT Scheduling Cycle

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Day 1	2	3	4	5	6	7
Availability Submission Open						
	Availability Opens for Following Week		Reminder to complete availability	Availability Closes for Following Week @ 17:00; schedule is assembled and released in evening		
8	9	10	11	12	13	14
Scheduled Shifts						

- EMTs complete an availability form for the following week, which is open from Tuesday until Friday
- When availability is complete, the Scheduling Coordinator assembles the schedule and releases to MERT EMTs
- Throughout the week, the Scheduling Coordinator updates the schedule as more shifts are filled and trades occur

Typical Week of MERT Shifts

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Typically no Day Shifts / Events	Typically no Day Shifts / Events	Typically no Day Shifts / Events	Typically no Day Shifts / Events	Typically no Day Shifts / Events	1000-1330 1-2 Shift Lead EMT(s) 2-3 Additional EMTs	1000-1330 1-2 Shift Lead EMT(s) 2-3 Additional EMTs
					1330-1700 1-2 Shift Lead EMT(s) 2-3 Additional EMTs	1330-1700 1-2 Shift Lead EMT(s) 2-3 Additional EMTs
1700-2300 1-2 Shift Lead EMT(s) 2-3 Additional EMTs	1700-2300 1-2 Shift Lead EMT(s) 2-3 Additional EMTs	1700-2300 1-2 Shift Lead EMT(s) 2-3 Additional EMTs	1700-2300 1-2 Shift Lead EMT(s) 2-3 Additional EMTs	1700-2300 1-2 Shift Lead EMT(s) 2-3 Additional EMTs	1700-2300 1-2 Shift Lead EMT(s) 2-3 Additional EMTs	1700-2300 1-2 Shift Lead EMT(s) 2-3 Additional EMTs
2300-0700* 1-2 Shift Lead EMT(s) 2-3 Additional EMTs	2300-0700* 1-2 Shift Lead EMT(s) 2-3 Additional EMTs	2300-0700* 1-2 Shift Lead EMT(s) 2-3 Additional EMTs	2300-0700* 1-2 Shift Lead EMT(s) 2-3 Additional EMTs	2300-1000* 1-2 Shift Lead EMT(s) 2-3 Additional EMTs	2300-1000* 1-2 Shift Lead EMT(s) 2-3 Additional EMTs	2300-0700* 1-2 Shift Lead EMT(s) 2-3 Additional EMTs
Poss. Standby & Athletics Events 1 Shift Lead EMT 1 Additional EMT	Poss. Standby & Athletics Events 1 Shift Lead EMT 1 Additional EMT	Poss. Standby & Athletics Events 1 Shift Lead EMT 1 Additional EMT	Poss. Standby & Athletics Events 1 Shift Lead EMT 1 Additional EMT	Poss. Standby & Athletics Events 1 Shift Lead EMT 1 Additional EMT	Poss. Standby & Athletics Events 1 Shift Lead EMT 1 Additional EMT	Poss. Standby & Athletics Events 1 Shift Lead EMT 1 Additional EMT

* indicates shift ends on following day

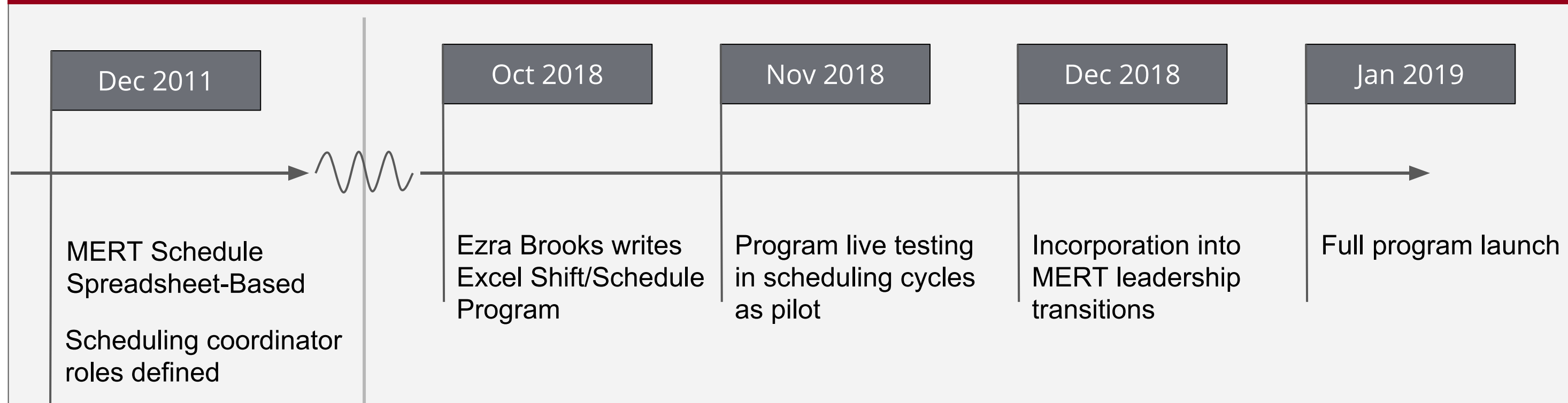
- MERT EMTs are sent the schedule on Friday evening for the following week
- Schedule is stored at the same Google Sheet link every week
 - EMTs check the same spot when schedule is released for continuity
 - EMTs reach out directly to scheduling coordinator with changes to schedule

Objective

Develop a scheduling solution to optimize EMT availability to maximize shift coverage that integrates seamlessly into MERT's operations

Development & Implementation

Program Timeline



Old Process

EMTs Submit Availability

Name: _____
Rank: _ EMT
_ Shift Lead

Availability
Monday, February 25
_ 1700-2300
_ 2300-0700*
_ 1700-0700*
_ Other: _____
_ Unavailable

- Availability completed via Google Form
- EMTs can indicate full, partial, or no availability for each shift

Coordinator Assembles Schedule

- All availability set-up completed manually
- Coordinator needs to optimize, but without advanced tools to do so

New Process

EMTs Submit Availability

Name: _____
Rank: _ EMT
_ Shift Lead

Monday, February 25 1700-2300
_ Available
Monday, February 25 2300-0700*
_ Available

- Form was modified to prompt availability as Y/N
- Availability now a binary variable

Coordinator Assembles Schedule

- Availability completed using Excel functions
- **New program is used within excel to generate schedule with highest number of placements fulfilled**

Shift Assignment Model Framework

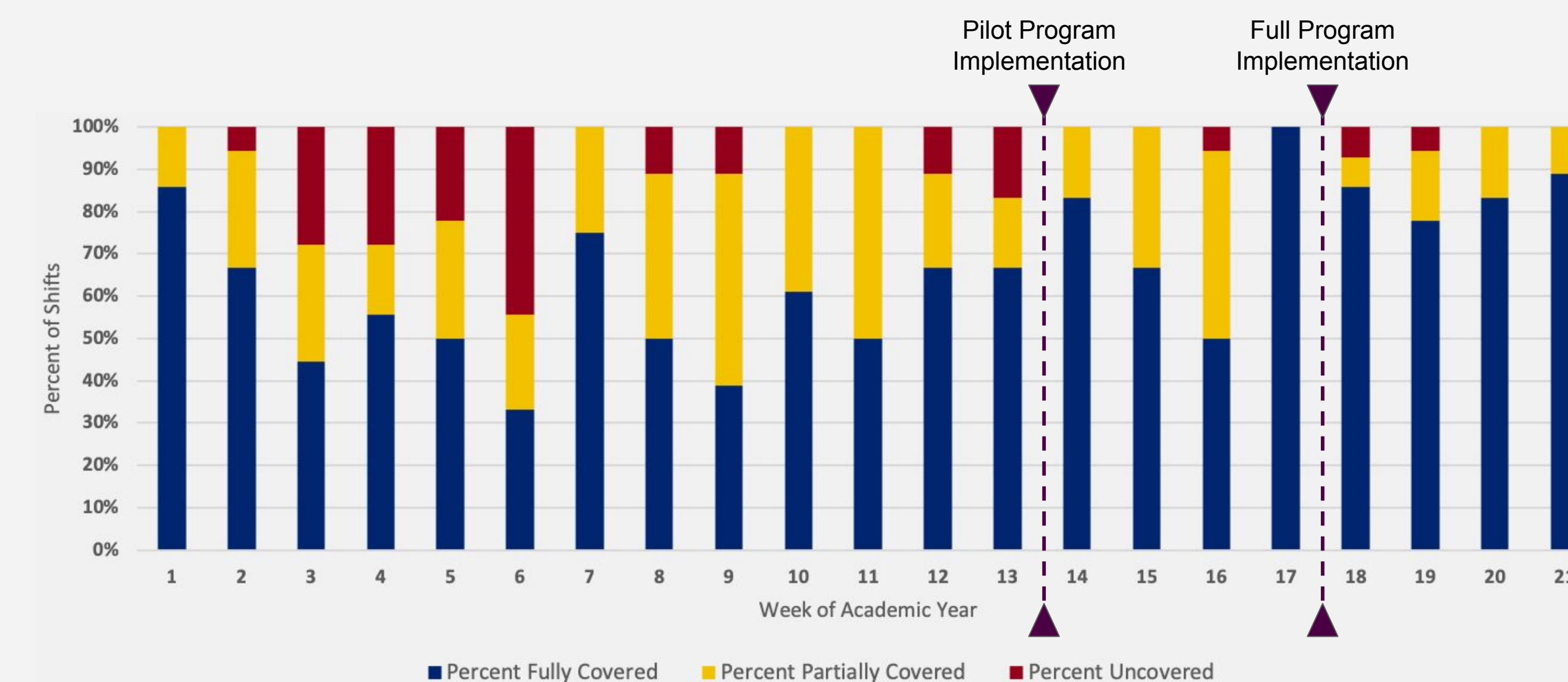
	Shift_1	Shift_2	Shift_3	Shift_4	Max Shifts
(*) EMT_1	1	1	0	0	1
(*) EMT_2	1	0	1	1	2
EMT_3	0	1	1	1	2
EMT_4	1	0	0	1	1
EMT_5	1	0	0	0	1
EMT_6	1	0	1	0	1
EMTs Needed	2	2	2	2	

* indicates shift lead

- Availability interpreted as binary variable matrix within Excel
- Variables for maximum shifts, EMT needed, and agency requirements per shift added
- Excel OpenSolver add-on interprets binary variable
- Linear model matches providers to shift to preferentially fill shifts
 - Accounts for shift leads
- Model interpreted as an array function
- Conditional formatting formats schedule
 - EMT 1 & 2 Shift Leads

Evaluation

Shift Coverage When Schedule Is Released



Model Implementation Summary

	Old Scheduling Model	New Scheduling Model
Schedule Cycles Assessed	8/20/18 - 11/12/18	11/19/18 - 2/10/19
n Shifts	220	112
Shifts Fully Covered @ Schedule Release	56% (123)	76% (85)
Shifts Partially Covered @ Schedule Release	30% (65)	21% (24)
Overall Shifts Matched to Providers @ Schedule Release	85% (188)	97% (109)
Shifts Where Coverage Was Solicited Throughout Week	15% (32)	3% (3)
Shifts Lapsed without Coverage	0% (0)	0% (0)

- Models assessed using proportion of shifts covered when schedule is released
 - Shifts where providers volunteered to cover open shifts were arranged by scheduling coordinator
 - All shifts were eventually covered
- New model implementation significantly increased the rate of full schedule coverage (p<0.03, Mann-Whitney Test)
- New model implementation decreased rate of partial coverage (p<0.05, Mann-Whitney Test)
- New model implementation decreased rate of shifts uncovered when schedule was released

Conclusions

- A similar model could be utilized by other collegiate EMS organizations
 - The model could be tweaked for operational plan for other organizations
- The OpenSolver Excel-based model is an effective solution for MERT
 - No additional cost beyond Excel program
 - No third party service or platform
- Model allows scheduling coordinator to optimize availability and maximize coverage
- Increasing scheduled shifts minimizes burden on scheduling coordinator to find coverage

References & Acknowledgements

References

- Microsoft Corporation, Excel 16.0.6769.2017 (2016)
- OpenSolver for Excel 2.9.0[Computer software] (2018), retrieved from: <https://opensolver.org/>
- University of Pennsylvania Medical Emergency Response Team. (mod 2019). *Operating Guidelines*. Philadelphia, PA

Acknowledgements

The Penn Division of Public Safety, University Administration, and MERT Advisory Team are instrumental in supporting the MERT program:

Maureen Rush, Vice President for Public Safety & Chief of Police, **Gene Janda**, Chief, Fire and Emergency Services, **Mike Fink**, Deputy Chief of Tactical & Emergency Readiness, **Josh Glick**, Penn MERT Medical Director, **Val Swain Cade McCullum**, Vice Provost of University Life, **Erika Gross**, Chief Operating Officer For Wellness, **Benoit Dube**, Chief Executive Officer for Wellness & Associate Vice-Provost, **Ben Evans**, Executive Director of Risk Management & Insurance, **Wendy White**, Senior Vice President and General Counsel of the University of Pennsylvania and Penn Medicine, **Joe Tierney**, Executive Director, Robert A. Fox Leadership Program, **Noelle Melartin**, Director for the Office of Alcohol and Other Drug Program

Contact

Please direct correspondence to:

David Gordon
davgor@sas.upenn.edu

MERT Leadership Team
chief@penmert.org