

# Industrial and Systems Engineering Seminar

## *The Role of Fixed Costs in the Design of Optimal Transportation Hub Networks*

**Wednesday, December 4**

3:15 PM – Refreshments before the Seminar

**3:30 PM – Graduate Seminar**



### **Professor Morton O'Kelly**

Professor

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Hubs are extremely important nodes in operational networks, including express delivery systems, and air passenger systems. As a result of over 25 years of collective work in the area (Campbell and O'Kelly, 2012), it is now widely recognized that this problem is both interesting and challenging. Hub models evolved as variants on well-known location models. Hubs are similar to medians, yet differ in one important respect – hubs are facilities through which flows are connected and are therefore tied together by paths through the network. The interesting fact is that by combining spatial interaction with facility location, the strong interdependence between location and transport is brought to the fore. The presentation summarizes work in progress with my colleague James Campbell. This paper formulates a model to analyze the role of fixed costs in the design of optimal transportation hub networks. The analysis allows particular versions of hub networks to emerge from the cost structure, rather than by imposing a rigid pre-defined connectivity protocol. The paper integrates modeling approaches from an environmental hub location model (O'Kelly, 2012) with the 3-index formulation of Ernst and Krishnamoorthy (1996) to produce a hub location model with fixed and variable costs for all arcs. The goal is to demonstrate how the inclusion of a richer cost model in transportation hub location can generate a wide range of different network types, depending on the relative magnitudes of the cost elements. While the existence of special case network solutions is well known and has been exploited (Contreras and Fernandez, 2012) in optimization, the current research provides added insight to the cost of flow in a more or less connected hub network. All eight prototype networks identified in O'Kelly and Miller (1994) can be derived as special cases. Some additional unanticipated networks also emerge.

**Bio:** Morton O'Kelly is Director of the Center for Urban and Regional Analysis. Dr. O'Kelly works on network analysis, location theory, and Geographic Information Systems and spatial analysis. His current research interests include the application of network analysis to specific accessibility problems, especially in the study of hub networks, urban transportation, and accessibility. Dr. O'Kelly is also working to measure the degree of efficiency in urban commuting patterns in comparison to particular benchmarks from the point of view of optimization.

<http://www.geography.osu.edu/faculty/okelly/>