1116-52-2006 **Zachary Abel*** (zabel@math.mit.edu), **Erik D. Demaine**, **Martin L. Demaine**, **Sarah Eisenstat**, **Jason Lynch** and **Tao B. Schardl**. *Who Needs Crossings? Hardness of Plane Graph Rigidity.* Preliminary report.

Despite initial motivation from mechanical linkages such as those used to power steam engines, Kempe's celebrated Universality Theorem—informally, "there is a linkage to sign your name"—does not account for bar intersections in the linkages it describes. Indeed, all known constructions for this Theorem (and its various strengthenings) critically rely on allowing bars to cross each other. What is lost by forbidding crossings? Noncrossing linkages can be physically realized without concern for extraneous obstructions, e.g., with edge-hinged panels as in rigid origami or pop-up cards. But are linkages as expressive when crossing is disallowed?

We settle this problem in the affirmative, by follow the spirit of Kempe's original proof of the Universality Theorem but with several new, delicately designed modular gadgets to forbid crossing between or within gadgets. As a consequence of our construction (and some additional techniques), we also exactly settle the complexity of several graph-rigidity problems: The problems of testing rigidity or global rigidity of noncrossing linkages, or testing the rigidity of equilateral (but possibly crossing) linkages, are all complete for co-$\exists\mathbb{R}$, the complement of the class obtained from the Existential Theory of the Reals. (Received September 21, 2015)