Oil dispersants have been employed as a component of marine crude oil spill responses around the world for decades. In spite of their widespread use, however, the published literature exploring the fundamental interfacial science of dispersants' formulation and action remains underdeveloped. The primary aim of our work has been to elucidate the relative influences of initial and dynamic interfacial tensions at the interface between dispersant-treated crude oil and salt water on the dispersion effectivenesses of mixtures of the surfactants Span 80 (sorbitan monooleate), Tween 80 (polyoxyethylenated sorbitan monooleate), and DOSS (dioctyl sodium sulfosuccinate), which are widely used as active agents in oil dispersants around the world. Dispersion effectiveness was measured using a modified version of the Swirling Flask test, currently the standard test protocol used by the U.S. EPA to determine whether a dispersant is "effective" enough for use in U.S. waters. A spinning drop tensiometer was used to measure initial and dynamic interfacial tensions between dispersant-oil mixtures and artificial seawater. Compositional trends in effectiveness were found to be governed by: (1) initial oil-water interfacial tension upon dispersant application; (2) rates of surfactant adsorption to the interface; and (3) rates of surfactant leaching from oil to seawater. These phenomena, in turn, are believed to be controlled by microstructures which are formed by surfactants and water in the oil phase. Such a framework for understanding dispersant behavior is expected to inform future efforts to formulate more effective and/or less toxic dispersants, as well as to facilitate increased understanding of the environmental impact of dispersant-treated oil.