When designing controllers for large-scale systems, the architectural aspects of the controller such as the placement of actuators, sensors, and the communication links between them can no longer be taken as given. The task of designing this architecture is now as important as the design of the control laws themselves. By interpreting controller synthesis (in a model matching setup) as the solution of a particular linear inverse problem, we view the challenge of obtaining a controller with a desired architecture as one of finding a structured solution to an inverse problem. Building on this conceptual connection, we formulate and analyze a framework called Regularization for Design (RFD), in which we augment the variational formulations of controller synthesis problems with convex penalty functions that induce a desired controller architecture. The resulting regularized formulations are convex optimization problems that can be solved efficiently; these convex programs provide a unified computationally tractable approach for the simultaneous co-design of a structured optimal controller and the actuation, sensing and communication architecture required to implement it. Further, these problems are natural control-theoretic analogs of prominent approaches such as the Lasso, the Group Lasso, the Elastic Net, and others that are employed in structured inference. In analogy to that literature, we show that our approach identifies optimally structured controllers under a suitable condition on a “signal-to-noise” type ratio.