The topic of this project is the theoretical analysis of dissipative quantum engineering, i.e., the generation, coherent control, and detection of quantum states in quantum nonlinear systems allowing for losses and gain. We focus on both fundamental aspects and implementations of such open quantum system dynamics. The latter is related to quantum technologies of the second generation, which process quantum information using quantum phenomena. Decay mechanisms, which are present in open systems and, thus, in all real devices, deteriorate the performance of quantum technologies. However, our preliminary results show that it is possible to find cases where the decay is desirable and useful in quantum information processing. We will try to find new ways to fully compensate for destructive effects of the decay or even to make the decay mechanisms playing a constructive role in quantum state engineering. Our approach is focused on dissipation-controlled quantum engineering of quantum analogs of standard (semiclassical) exceptional points (EPs), i.e., degeneracies of Hamiltonians describing non-Hermitian or PT-symmetric systems including the effect of quantum jumps (instantaneous switching between the energy levels of the system). EPs have been attracting increasing interest, both theoretical and experimental, in diverse fields of physical research. EPs are considered the basis for novel enhanced sensing apparatus and are relevant to describe dynamical phase transitions and in the characterization of topological phases of matter in open systems. However, it seems that the research community interested in PT-symmetric systems and EPs for quantum sensing ignores the effect of quantum jumps. In addition to including quantum jumps, we propose to define quantum EPs as degeneracies of Liouvillian superoperators. To our knowledge analyzing eigenspectra of Liouvillians in the contexts of the standard EPs, EP sensing, and PT-symmetric systems is a largely unexplored field of research. Quantum state engineering with dissipative nonlinear systems is a challenging problem also because such systems are often non-integrable. In this case it is useful to develop an algorithmic approach to dynamics in which one focuses not on equations of motion and notions like energy or momentum, but on iterative update rules and operational notions like change or translation. Thus, we will consider a concept of quantum cellular automata to simulate dynamics of dissipative quantum systems. Due to our collaborations with experimental physicists, who already implemented similar systems in their laboratories, we hope to experimentally verify at least some of our ideas.