fleeing into sterile mathematics does not solve anything. The relevance of such work is just as hard to judge. Nor does such work necessarily make the best preparation for a student's career.

We therefore have to create a climate in which such work can flourish. We also need to create a basis of financial support for it. Research on servomechanisms is supported by NASA and DOT, but real process control, just as most research on process design, has no home either at NSF or any other agency and very meager industrial support. This is again purely a question of the intellectual climate. The needs and potential for significant improvements in process control are at least as big as those in many areas which have ample support.

Let me make one thing clear. I do not want to imply that what I outlined is the only research or even the main research control engineers should do. In process control we suffer already far too much from preconceived notions of what the only present thing to do is, and I do not want to add to this. Sound rigorous theoretical work and well-conceived experimentation can make significant contributions to modern control. But the nature of the problem is such that, unless we obtain a better understanding of the design process itself, many of the most valuable units of our work will remain useless, and some of our theoretical work will go into directions where no real need exists. We therefore have to create an interface between the industrial practitioner and the rigorous researcher, and the only way I can see it is to start working on the fundamentals of our profession—trying to obtain an understanding of the design process itself, which never really is algorithmic but rather interactive and intuitive and strongly relying on informed judgment. It will be a difficult but interesting and gratifying task.

Let me finish with another story relevant to the present state of research in the engineering profession. I read once a strategic analysis of the Maccabean War, an important event of Jewish history. The analyst showed that Judah, the Maccabean, was a military genius, the inventor of guerilla warfare, the first to be able to handle the Greek phalanx. But having beaten the Greeks in a historic battle, he forgot his lesson. He really dreamed of becoming a Greek general leading his army in a phalanx. Doing that he was sadly beaten. His brothers followed his first lessons, which led to final victory. I do not want to elaborate on this example. □

NOTATION

α_t = white noise variable
B = backward shift operator
$G_p(B)$ = plant discrete transfer function
$G_p(s)$ = plant continuous transfer function
k = defined by $\theta = k \cdot T + c \cdot T$ (k is an integer)
δ = defined by $e^{-T}{}_t$
λ = noise parameter
X_t = state vector
Y_t = output
τ = filter time constant [Eq. (1)]
θ = time delay [Eq. (1)]
ϵ_t = deviation of output from setpoint
u_t = control action at time t
T = sampling period
$W_0 = 1 - \delta^{1-\lambda c}$
$W_1 = \delta - \delta^{1-\lambda c}$
$c = \theta/T - k$

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TWENTY LECTURES ON THERMODYNAMICS

By H. A. Buchdahl, Pergamon Press, 1975

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