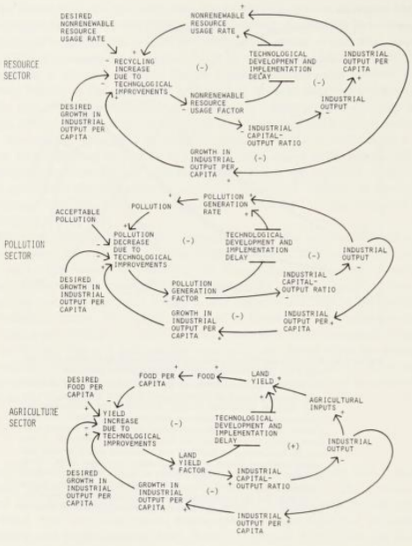

Figure 7-33 Structural additions for adaptive technological policies with a bias toward growth in industrial output per capita

Run 7-22 after the year 2000. Because few new resource recycling technologies are implemented after the year 2000 in Run 7-23, resource usage begins to grow with the rising population POP and industrial output per capita IOPC. As the nonrenewable resource fraction remaining NRFR declines below 0.2 in the year 2070, the fraction of capital that must be allocated to obtaining resources FCAOR rises sharply. Since more capital must be allocated to obtaining resources, industrial output per capita IOPC declines after the year 2070.

When the technological advances necessary to offset the negative effects of

growth involve substantial costs, one might expect a reluctance to incur those costs, especially if the costs of the protective technologies interfere with industrial growth. Run 7-23 shows that, if the goal of the policy maker is continued growth, a policy of sacrificing the development of protective technologies in favor of continued growth is successful only in the short run. Industrial output per capita IOPC grows 50 more years in Run 7-23 than in Run 7-22, where protective technologies were continually developed despite their costs. In the long run, however, the choice not to develop these protective technologies in favor of continued growth leads to overshoot and decline as a result of the negative effects of growth. The overall behavior of Run 7-23 is similar to that of reference run (Figure 7-7). Rising resource costs due to resource depletion cause industrial output per capita IOPC to decline in 2070, which eventually limits the growth in population POP after the year 2090.

The technological policies represented here have all been directed at two of the four basic dynamic properties of the world system. Their goal was to raise the physical limits to growth and reduce the mechanisms that might erode those limits (such as pollution or resource depletion). If one is willing to assume that technologies can be developed to accomplish those goals with no delays and no physical costs anywhere in the system, then technological policies are an acceptable way to overcome the instability represented in the overshoot behavior mode (see, for example, Run 7-18 or Run 7-19). If one believes that improved technologies can be achieved only with real physical costs and implementation delays, then the overshoot mode of behavior still prevails (Runs 7-21, 7-22, and 7-23). Physical growth has not been checked, system delays still exist (and in fact new ones have been introduced), and physical limits to growth remain. However, a new dimension was added to these physical limits. In the last three technological runs growth may be stopped either by the natural physical limits included in the model or by devoting so much output to avoiding those limits that intolerable costs are incurred in the economic sector. In either case, the delays in the system and the positive forces favoring physical growth bring about the overshoot of sustainable physical levels of output and subsequent decline.

7.6 SOCIAL POLICIES

In the preceding section we presented the effects of policies that would require major new technological changes before they could be implemented. In this section we test a number of policies that would require major changes in the social value structure of the world system. The majority of the technological policies were directed at relieving the negative pressures that limit growth, but these social policies are aimed primarily at reducing the positive pressures that promote continued growth. For these policies, basic value changes would presumably have to be supplemented by technological changes, but we believe the initiation of these "social policies" comes from significant changes in social value structures. The following runs test the effects of value changes on the model's behavior as shown in the reference run (Figure 7-7).