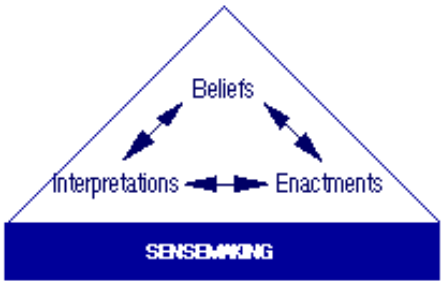
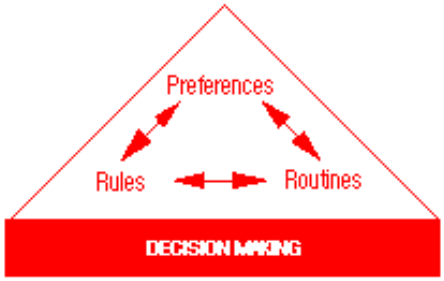
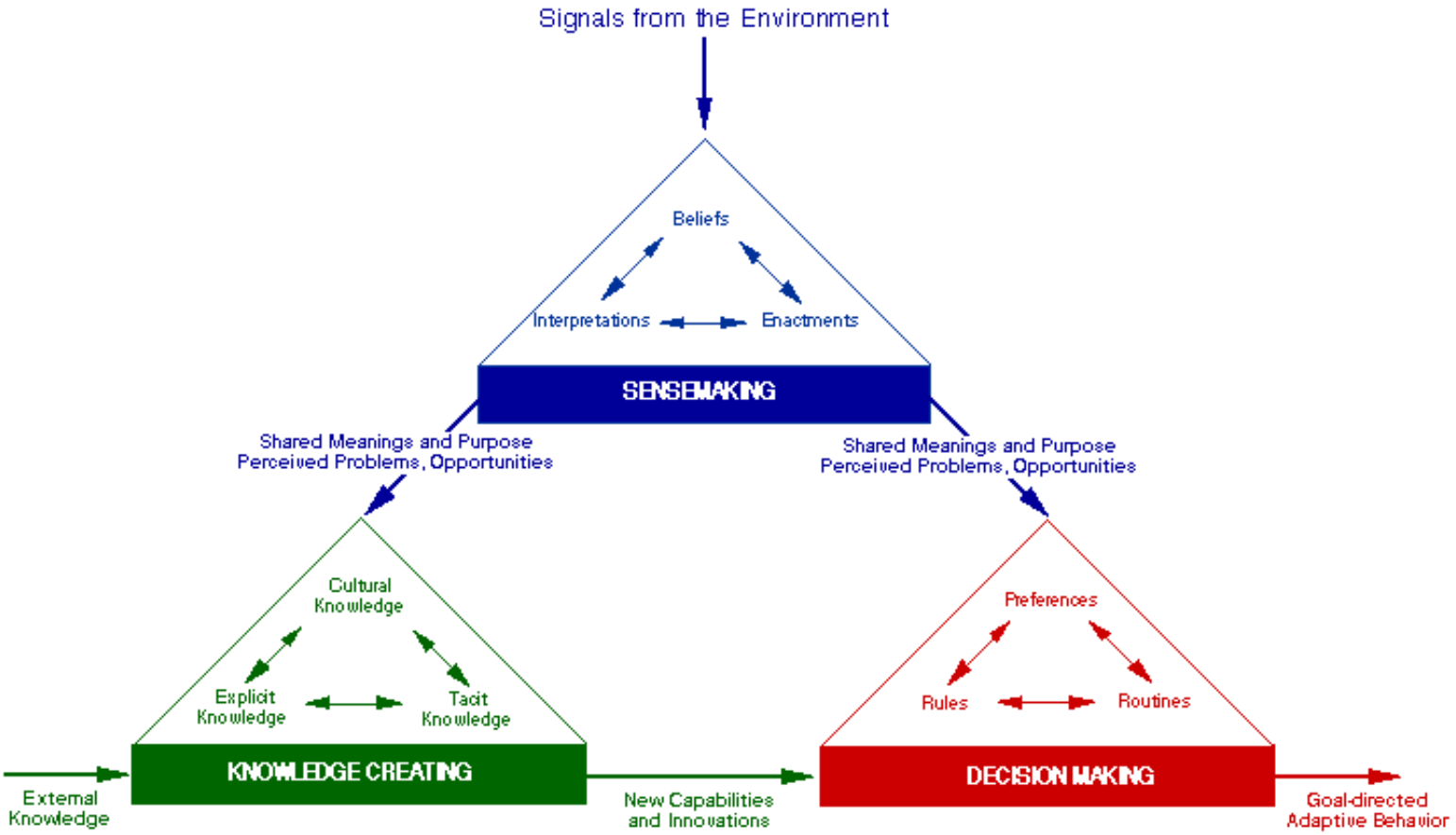
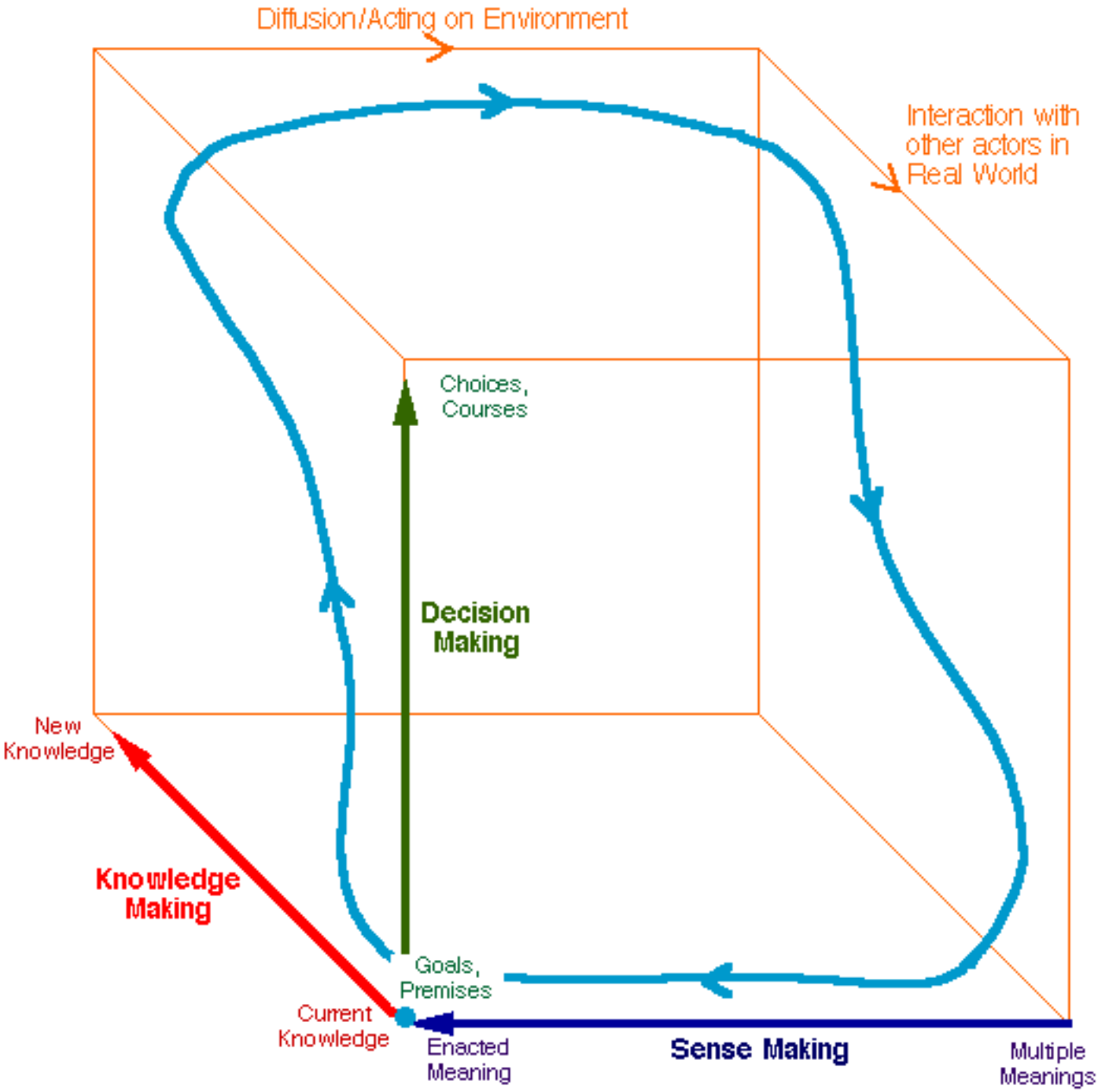
Three Modes of Organizational Information Use

Model	Process	Modes	Interactions / Resources
SENSE-MAKING	Environmental change—> Enactment, selection, retention —> Enacted interpretations "Looking backward": Retrospective sensemaking	• Belief-driven processes • Action-driven processes	
KNOWLEDGE CREATING	Knowledge-gap situation —> Tacit, explicit, cultural knowledge —> Knowledge conversion, building, linking —> New knowledge "Looking across many levels": Multilevel learning from individuals, groups, organizations	• Knowledge conversion • Knowledge building • Knowledge linking	
DECISION MAKING	Choice situation —> Alternatives, outcomes, preferences —> Rules, routines —> Decisions "Looking ahead": Goal-directed, future-oriented	• Rational • Process • Political • Anarchic	

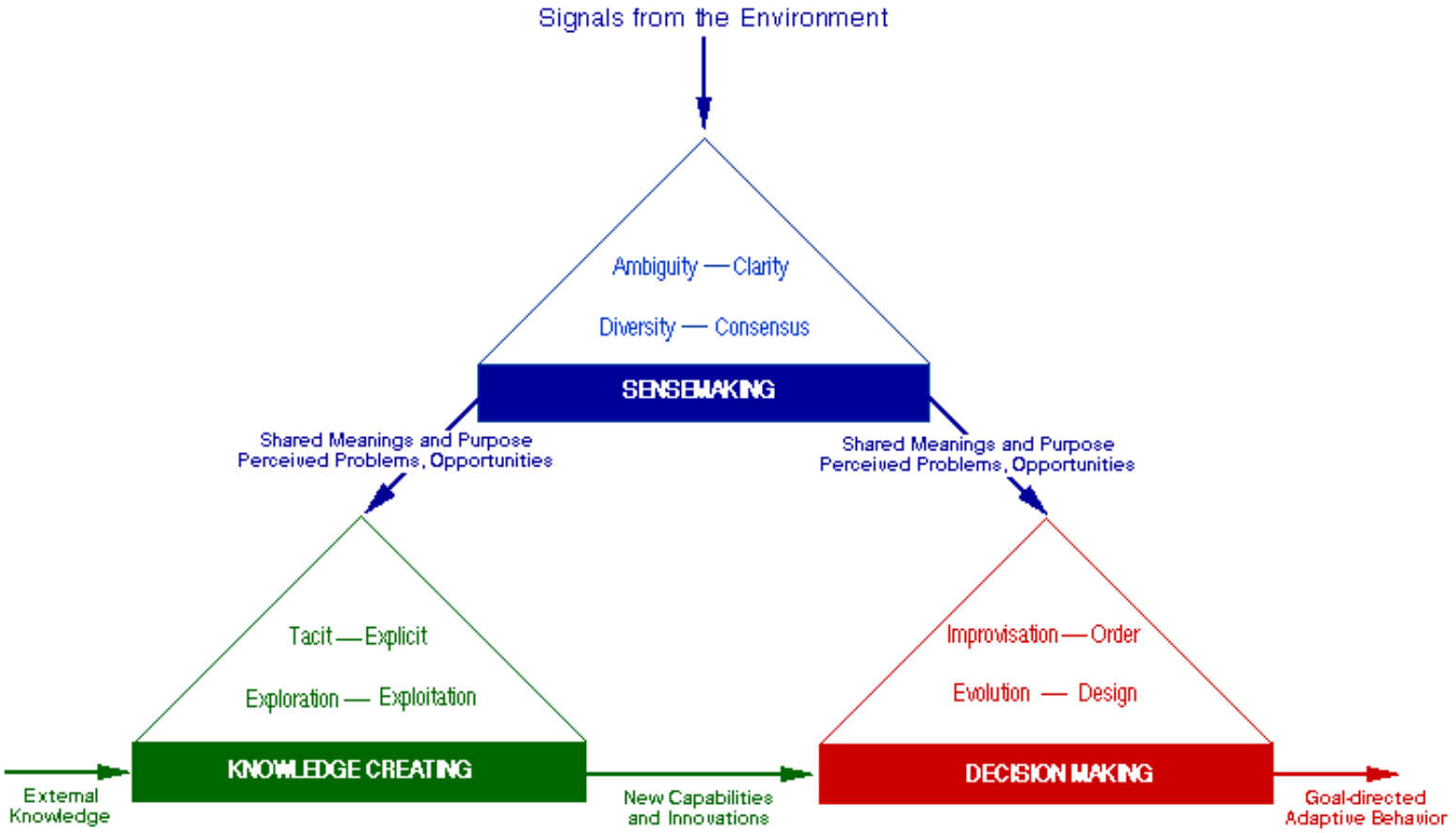
Organizational Knowing Cycle



Organizational Knowing Cycle (2) -- Moving through Information Space



Tensions in Organizational Knowing



The World Health Organization Smallpox Eradication Programme

Smallpox is the only major human disease to have been eradicated. Epidemics of smallpox had inflicted mankind throughout history, and as recently as 1967, some 10-15 million cases were still occuring annually in more than 30 endemic countries (Fenner et al 1988). Of these some two million died and millions of survivors were left disfigured or even blind. There is no treatment for smallpox once it has been contracted. The more serious strain of the smallpox virus (variola major) causes fatality of 20-40 percent among unvaccinated persons.

On January 1, 1967, the World Health Organization launched the Intensified Smallpox Eradication Programme. At that time the plan was to rely entirely on mass vaccination of susceptible persons in endemic countries -- the problem was defined as one of **mass vaccination**. The mass vaccination strategy had successfully eradicated smallpox in programs in Western Europe, North America, Japan and other areas. The WHO Expert Committee on Smallpox in 1964 had recommended that the goal should be to vaccinate 100% of the population, based on the observation in India that smallpox persisted in some areas despite vaccinations reported to be 80% or more of the population (80% was then assumed to be the acceptable target of a well-conducted vaccination program). In hindsight, one might have asked whether the sample size of successful vaccination campaigns was adequate, whether results obtained in insulated areas (such as tests on the island of Tonga) could be replicated elsewhere, and to what extent campaigns in Europe and North America were helped by better controlled conditions (Hopkins 1989). A review of the programmes conducted after 1967 suggests that mass vaccination alone could have eliminated smallpox in South America and most African countries, but not in the densely populated countries of Bangladesh, India, Indonesia, and Pakistan (Fenner et al 1988).

A 1966 outbreak in Nigeria started the evolution of a new strategy. In Western Nigeria, where over 90 percent of the population had been vaccinated, another smallpox outbreak had occurred, apparently originating in a religious group which had resisted vaccination. Vaccine supplies were delayed, forcing program staff to quickly locate new cases and isolate infected villages which could then be vaccinated with the limited supplies. A reporting network using the available radio facilities was established to locate new cases. Containment teams moved swiftly to isolate infected persons and to vaccinate susceptible villages. The Nigerian experience demonstrated that an alternative strategy of surveillance and containment could break the transmission chain of smallpox, even when less than half the population was eventually vaccinated (Hopkins 1989).

In 1970, a major epidemic had begun in the Gulbarga district of Karnataka in southwestern India, claiming over 1,300 victims (including 123 deaths) in more than 1,000 villages and

five municipalities. To prevent the epidemic from spreading to more populated areas, "prompt detection of all cases in an area of two million people was required. All available health personnel, not just smallpox health workers, were mobilized for a weeklong, house-to-house search of the area. By carefully focusing containment vaccination around each newly discovered case, they eliminated smallpox from the district within weeks." (Brilliant 1985, p. 27) The Gulbarga experience was India's first real success with surveillance-containment, and showed that it could work even in a densely populated country. The new strategy evolved gradually and were accepted slowly as local campaigns controlled outbreaks with their own variations of surveillance-containment. In India for example, when a village-by-village search in Uttar Pradesh and Bihar in 1973 identified 10,000 new cases, surveillance first shifted to a house-to-house search, and then to market surveillance: smallpox disappeared in some 19 months before the strategy was ever fully worked out (Hopkins 1989).

The initial definition of the problem as mass vaccination was a classic symptom of a confusion between ends and means. The goal of the program was the complete eradication of smallpox, and mass vaccination was a means to achieve that end. With the epidemiological experience available in 1966, the choice of mass vaccination as a strategy appeared rational. National governments also favored mass vaccination partly because it was a highly visible display of government action, and partly because of the substantial investments already made in creating the vaccination infrastructure (including jobs and salaries). Fortunately, the smallpox campaign learned quickly from its experiences in Nigeria, India and elsewhere and was able to recast the problem and evolve a new surveillance-containment strategy through experimentation and innovation in the field.

The process of institutional learning and local adaptation was central to the campaign's success: "Indeed, that process, more than any other element in the campaign, is the key explanatory factor of the ultimate success of the program." (Hopkins 1989, p. 74, italics in original.) The surveillance and containment strategy was not a single policy deliberately planned for or even envisioned by WHO. Instead, it comprised a broad array of measures that emerged over time from the local practices of field teams who had to invent procedures that not only blended with local customs and conditions, but were also genuinely effective in providing early detection and enforcing isolation and control. What eventually eliminated smallpox was the combined approach of using mass vaccination to reduce disease incidence so that detection and containment could eliminate the remaining endemic foci (Brilliant 1985).

To achieve the large-scale vaccination in the program required the high volume production of potent, reliable vaccines and an efficient, inexpensive means of delivering the vaccine. Three major technological innovations greatly facilitated the smallpox eradication program by addressing these needs. Perhaps the most significant was the development of the capacity to mass produce high quality **freeze-dried vaccine** in many countries. Edward Jenner had discovered as long ago as 1796 that humans inoculated with cowpox became

immune to smallpox. An earlier 1959 WHO smallpox program had depended on a liquid vaccine that had to be used within 48 hours and was easily contaminated. The new freeze-dried vaccine, which had the potency and stability needed for mass vaccination, was developed mainly at the Lister Institute in London using modest resources. The first apparatus for heat-sealing the ampoules of freeze dried vaccine on a production scale was built from a child's toy construction kit (Hopkins 1989). The final production method was subsequently made freely available. Since the quality of the vaccine was crucial, WHO established two regional vaccine reference centers in Canada and the Netherlands to test vaccine quality. Within a few years, several countries achieved self-sufficiency in vaccine production.

Apart from the vaccine, the program also had to solve the problem of developing an efficient technique of introducing the smallpox vaccine into humans. The traditional vaccination technique was to scatch a drop of the vaccine into the superficial skin layers, employing a rotary lancet or a needle, which sometimes resulted in serious wounds. The scratch method was clearly inadequate for large-scale vaccinations that were to be accomplished in compressed time frames. Starting in 1963, the US National Communicable Disease Center tested a hydraulic-powered **jet injector** that could do over 1,000 vaccinations in an hour. The jet injector proved too expensive for house-to-house vaccination in densely populated countries.

The third major technological innovation was the **bifurcated needle**. The new freeze-dried vaccine required a different method of presenting single doses of the vaccine. Because the vaccine had to be reconstituted each time and dispensed in tiny quantities, the traditional method of storing liquid vaccine in capillaries was no longer tenable. In developing a new solution, Benjamin Rubin of Wyeth Laboratories worked with Gus Chakros of the then Reading Textile Machine Company in needle design. It occurred to Rubin that a prolonged needle with a loop would provide both the capillarity activity and the scarification action required (Hopkins 1989). He suggested the use of a sewing needle in which the loop end was ground into a prolonged fork, creating two bifurcated prongs. A piece of wire suspended between the prongs was designed to hold a constant amount of vaccine by capillarity. By 1968, the bifurcated needle had replaced traditional methods in most countries, and by 1970 it was in use everywhere.

Although the development of the freeze-dried vaccine, the jet injector, and the bifurcated needle were milestones in the smallpox campaign, the program would not have succeeded without the ingenuity and creativity with which the field staff surmounted a host of local problems. Important innovations such as smallpox recognition cards, watchguards, rewards, rumor registers, and containment books all came from fieldworkers (Brilliant 1985). Managers and supervisors encouraged the creative solving of problems as they arose, and adopted an attitude of supporting problem-oriented practical experimentation in the field. New techniques or improvements of existing procedures were then disseminated through surveillance newsletters and periodic review meetings.

Staff training was another major component of the campaign. Epidemiologists from various backgrounds and nationalities, including academic epidemiologists, had typically never worked in rural villages, and so required special training. In India, part of the training program included two simulation exercises. The first was a hypothetical outbreak that required the trainee to trace the source of infection, locate all contacts, and carry out containment operations. An example scenario involved an infectious disease hospital as a source of infection. Academic epidemiologists were incredulous, but realized when they reached the field that poorly guarded hospitals were notorious for spreading the disease they were trying to control. In the second exercise, the trainee played the role of the chief of a state smallpox program who had to watch against infection from neighbouring areas, investigate sources of infection, and make sense of conflicting reports. Following the exercises, the entire training group then went out to a nearby village with a chickenpox outbreak and proceeded to vaccinate and contain the infection. The field training was highly practical and was conducted not by a ranking administrator but by a junior paramedical assistant who had intimate knowledge of village-level epidemiology.

At the strategy level, the smallpox eradication programme of 1966 was guided by a plan that embraced two complementary approaches: mass vaccination campaigns which employed freeze-dried vaccine of assured quality to substantially reduce the incidence of smallpox in endemic areas, and surveillance systems which detected and reported cases early enough to permit the containment of outbreaks and the analysis of occurence patterns so that appropriate vaccination and surveillance activities could be taken. The WHO program functioned in a collegial structure of many independent national programs, each developing its own administrative traditions and adapting to local social and cultural conditions. As a result, programs differed greatly from one country to another, as well as from one time period to another.

Unambiguous standards of performance were stipulated from the outset and refined as the program advanced. Mass vaccination campaigns were expected to result in more than 80% of the population in each area having a vaccination scar. Independent assessment teams could easily ascertain the proportion of the population with such a scar. From 1974, standards for surveillance and containment were added: 75% of outbreaks should be discovered within 2 weeks of the onset of the first case, and that containment of the outbreak should begin within 48 hours of its discovery and that no new cases should occur more than 17 days after containment had begun. Fenner et al (1988) concluded that "the various standards were of the greatest value when the data were promptly collected, analysed and used as management guides for programme action. The knowledge by those collecting the information that their data were being promptly put to use contributed greatly to the development of the system and to better performance." (p. 1354)

Each national program developed its own set of standard operating procedures that were tuned to the local task environment. In India, **Operation Smallpox Zero** was launched in

1975 with a closely specified set of rules and procedures (Brilliant 1985). Village-by-village searches were changed to house-to-house. In one state capital room-to-room searches were done to prevent an epidemic from spreading. Every case of rash with fever was recorded, monitored, and treated as smallpox until proven otherwise. A rumor register was maintained at the Primary Health Center. Uncertain diagnoses were followed with containment by default. Four watchguards were posted at infected homes. All villages within 10 miles of a case of known or suspected smallpox were searched. Everyone inside a one-mile radius was vaccinated. Market searches were intensified. Medical officers were posted to live in infected villages. The stringent procedures paid off. The average size of an outbreak fell to fewer than 5 cases from 7 six months before. The number of infected villages fell by 40% each month.

An important innovation which preceded Operation Smallpox Zero was the use of the infected rural village or urban neighborhood as an assessment index, and in effect, as a decision premise for allocating resources. A village in which any case of smallpox was recent enough to be potentially infective was labelled a 'pending outbreak' and placed on the pending lists of active outbreaks maintained at the smallpox control offices. If no new cases were found at the end of the pending outbreak period (4-6 weeks), the outbreak was removed from the lists with fanfare. By specifying a standard complement of resources for each incident (jeep, vaccine, gasoline, staff), pending outbreaks were an ideal tool for resource allocation, invariably the most pressing management decision when an outbreak was first identified.

Throughout the program, the pursuance of clear and stringent rules and standards concerning vaccination, detection and containment, was matched by an equally fervent spirit of innovation and experimentation in the implementation of those procedures. Many people in WHO today believe that the program had bent many rules, and indeed, many at WHO viewed the smallpox program negatively because it ran outside the regular WHO system. Hopkins (1989) recounts how one WHO official commented that if the India campaign were successful, he would "eat a tire off a jeep." When the last case was reported, Donald Henderson, director of the smallpox program, sent that person a jeep tire.

There were many instances of cutting corners. Obtaining cash for the program required voluminous paperwork, and often cash flowed simply on the director's assurance that funds would be forthcoming. The regional finance officer in India often had to cover such advances, but considered them as "an act of faith well justified." In Bangladesh, traditional steps in the health service hierarchy were bypassed when the mobile surveillance teams drew personnel from their other regular assignments and gave them authority and powers that exceeded their service ranks. In India, relations in the joint WHO-government of India central command became characterized by an open, informal atmosphere developed from months of working closely in the field and office. Junior staff frequently leaped over formal hierarchical levels in order to expedite action, so much so that nearly every senior Indian health official cited 'level jumping' as one of the reasons for the program's success.

At the core of the campaign in India (as well as many other countries) was a logic of learning by experimenting and sharing that learning quickly.

WHO had recognized early on the critical role of concurrently evaluating the performance of the various campaigns by independent teams so that deficiencies could be discovered and remedied while the campaigns were still active. Evaluation and assessment procedures constantly evolved in response to new experience and lessons learned from the field. Evaluation measures were kept flexible so that they could be changed to fit each local environment. Initial output-based measures such as the number of people vaccinated proved unuseful and were replaced by outcome-based measures such as trends in the incidence of smallpox. More specific indicators were used at lower levels. In India for example, attention shifted to pending outbreaks in 1974; the focus then changed to the outcome of surveillance searches in 1975; and finally search efficiency was stressed in the closing years of the campaign. A sensitive feedback and control system was thus established, relying on the extensive, accurate and rapid collection of data from the field. Field data were rapidly analyzed and acted upon in order to influence the campaigns while they were still in progress. The smallpox program excelled in careful planning and administration, creating hierarchical levels of control and reporting systems that were nevertheless simple enough for the field teams to understand. Regular feedback was provided through periodic review meetings at all levels and through special publications and research papers.

In 1977, the last case of smallpox was reported in Somalia. For the first time, a major disease has been completely vanquished. Dr H. Mahler, WHO director-general, described the smallpox program as "a triumph of management, not of medicine." It is said that at a meeting in Kenya in 1978 the then director-general, on announcing the end of smallpox, had turned to Donald Henderson who had directed the smallpox program, and asked him which was the next disease to be eradicated. Henderson reached for the microphone and said that the next disease that needs to be eradicated is bad management (Hopkins 1989).

Discussion Questions

0. **In the Nigerian vaccine shortage situation, how did the program staff enact the environment in order to make sense of it?**
   What was the final outcome of this "enacted sensemaking"?

1. **What major knowledge-gaps were faced by the Smallpox program?**
   How were they addressed?

2. **Why did the program use many rules and routines to guide decision making?**

What were the effects?

3. **Did the program learn and adapt over time?**

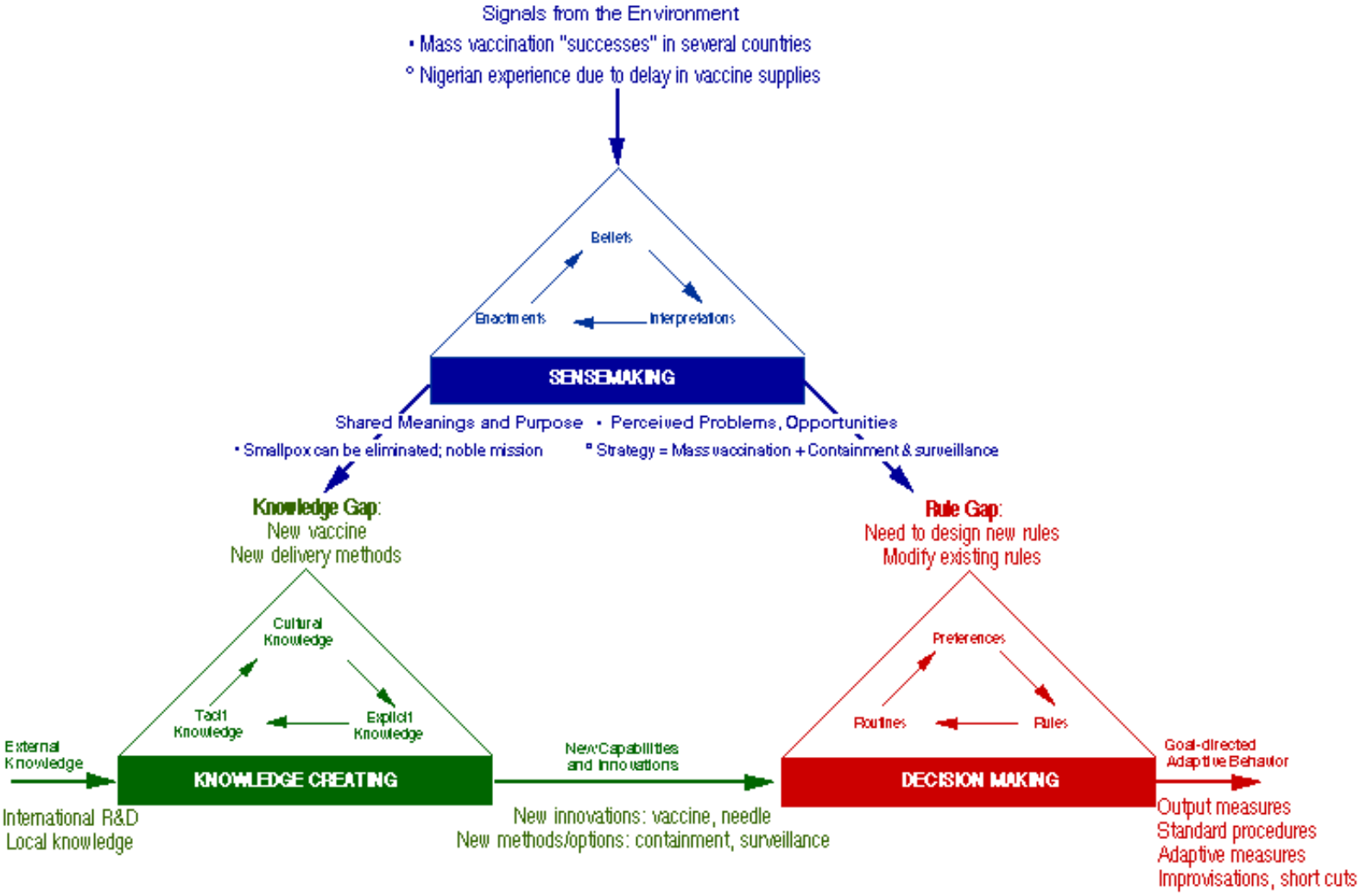
Sources:

Hopkins, Jack W. 1989. The Eradication of Smallpox: Organizational Learning and Innovation in International Health. Boulder, CO: Westview Press.

Brilliant, Lawrence B. 1985. The Management of Smallpox Eradication in India. Ann Arbor, MI: University of Michigan Press.

Fenner, F., D. A. Henderon, I. Arita, Z. Jezek, and I. D. Ladnyi. 1988. Smallpox and Its Eradication. Geneva: World Health Organization.

Organizational Knowing in the WHO Smallpox Program



Information Management in the WHO Smallpox Program