drug delivery system in the rear.

Several robot manufacturers, including FANUC and Fuji Electric Co., are expected to join the project, together with semiconductor manufacturers such as Hitachi, NEC and Toshiba. And Inagaki says that, although "officially" Ogata projects are totally financed by MITI, industry is expected to contribute "an additional 30 per cent or so".

The project was proposed by a MITI committee of industrialists and academics headed by Naomasa Nakajima of the department of mechanical engineering at Tokyo University. Another member of the committee is Isao Karube of the Research Center for Advanced Science and Technology of the same university, well known for his work on biosensors, such as blood glucose analysers.

Inagaki says that research in the field of micromachines is only about five years old and that the number of researchers worldwide with expertise is very limited. For this reason, MITI officials are hoping to make the project into a joint international effort. But they do not intend to approach potential foreign collaborators until details of the project are finalized.

The project is an amalgamation of proposals and includes plans to develop microrobots for the maintenance and repair of nuclear power plants, chemical plants, gas and water pipes and aircraft engines. And MITI foresees a day when microrobots will be able to patrol the piping of nuclear power plants and carry out repairs "whenever an abnormality is detected", avoiding expensive shut-downs for maintenance and repair.

One likely addition to the project is the development of robots for use in space, already being investigated under another Ogata project.

MITI's budget proposal will no doubt be trimmed down in negotiations with the Ministry of Finance. And it remains to be seen if the Ministry of Health and Welfare will remain silent while MITI launches a project that delves deeply into the realms of medicine and drugs. But MITI will probably disguise and alter the project in such a way as to avoid objections.

David Swinbanks

CHEMICAL WEAPONS

Heated argument in prospect

Sydney & Boston

CRITICISM of the US Army's programme to incinerate chemical weapons on Johnston Island in the Pacific has come from several quarters in recent weeks, even though the incineration programme is already fully operational and more US chemical weapons are on their way to the island from bases in Germany. The debate, both in the United States and in the South Pacific countries, has caused a split between environmentalists and arms control advocates, but now seems unlikely to affect the fate of the Johnston Island programme. Nevertheless, it may well have an impact on the long-term prospects for incineration as a way for the superpowers to dispose of their vast and ageing stockpiles of chemical weapons.

At a meeting of the South Pacific Forum, held earlier this month in the small Pacific nation of Vanuatu, some participants continued to criticize the US chemical weapons incineration plant on Johnston Island as "another example of the Pacific being used by major weapons-producing states as an experimental area". Of the forum nations, only Australia and New Zealand supported the Johnston Atoll Chemical Agents Disposal System (JACADS), which began operation on 30 June (see *Nature* **346**, 5; 5 July 1990). A communique released by the island nations opposing the plant complained about the "significant uncertainties and risks" posed by the project.

Nor were the forum participants reassured by three scientific reports presented by Australia's Prime Minister, Bob Hawke, in support of US claims that the weapons destruction methods include adequate environmental safeguards. According to the US Department of Defense, workers at the JACADS incineration facility have already safely destroyed more than 800 artillery shells and some 2 tons of nerve agent. By now, Johnston Island, 1300 km southwest of Hawaii, has accumulated some 300,000 weapons ready for incineration, including mustard and nerve gas shells. Another 100,000 US shells consisting of 400 tons of Sarin and VX nerve gas are in transit from Clausen, West Germany.

The environmental advocacy group Greenpeace continues to be one of the most vocal opponents of JACADS, claiming that the high-temperature incineration process produces toxic bioaccumulative chemicals such as polychlorinated dioxins and furans. According to Paul Johnston, Greenpeace International spokesman on chemical weapons, there are four safer alternatives: chemical neutralization; photodegradation; electrochemical procedures and biodegradation.

These methods, Greenpeace argues, have the advantage over incineration that they would be done in closed systems, and would not "result in huge volumes of gases being pumped into the atmosphere". A recent Greenpeace technical review* of the JACADS programme reviewed the prospects and current status of each of these alternative methods. Johnston says that these alternatives could be developed into working techniques within 18 months if the US Army were to conduct accelerated research on them.

But Trevor Findlay, senior research fellow at the Peace Research Centre of the Australian National University in Canberra, does not believe that the alternatives offered by Greenpeace are totally safe either. As with incineration, Findlay points out, all four proposed alternatives require the lethal chemical agents to be taken out of their shells. The possibility of spills and accidents, he says, poses a safety and environmental threat from almost any proposed method.

Now that US Defense Secretary Dick Cheney and congressional committees have agreed in principle to cancel the US binary chemical weapons modernization programme, arms control advocates in the United States are heartened by US actions and see JACADS as "a big step forward" in the effort to live up to an agreement, reached with the Soviet Union last spring, that at least 80 per cent of both superpowers' chemical stockpiles should be destroyed. Many other countries, even some Pacific nations, have supported the demilitarization effort despite the potential environmental threat posed by chemical weapon destruction.

Australia, for instance, has supported JACADS as part of a push towards an international chemical weapons treaty (*Nature* **341**, 271; 1989). Unless it destroys its own stockpile, the United States is seen to be in no position to push other countries into signing a treaty.

But, environmentalists point out, even with the addition of the US chemical weapons from Germany, only some 7 per cent of the US stockpile will be destroyed at the Johnston Island facility. The Soviet Union's stockpile, none of which has yet been destroyed, is believed to be larger still. Thus the fate of most of the superpowers' chemical arsenals remains uncertain, and the environmental stakes are high. The Soviet's plans are unclear, although they too are working on incineration methods and are committed to collaborating with the United States in the weapons' destruction.

The remainder of the US chemical weapons arsenal is marked for incineration at eight domestic facilities, yet to be built.

Environmentalists say that they will fight the plan and push for more research into alternative methods. "Our fight at Johnston Island is not over yet and our serious concerns continue about the environmental damage caused by incineration", says US Greenpeace spokesperson Sebia Hawkins; "the larger fight in the United States is just beginning".

Tania Ewing & Seth Shulman

* Greenpeace Review of Johnston Atoll Chemical Agent Disposal System (JACADS), July 9, 1990.