

SU. Vario_{V.2}

Variable Rate Spray Unit



Introduction

The world has changed dramatically over the past century. Society has become more aware of global Health and economic problems than ever before, and are finding ways in which to correct them. Living, and working standards have improved greatly, but there are many areas within these standards that have been neglected.



The Environment:

Since the introduction of pesticides, over 500 species of insects and mites are reported resistant to particular insecticides. 216 weed species are resistant to at least one or more class of chemical weed killer. This is largely caused by inappropriate spraying methods, inconsistency of spray routines, and lower than ideal spray ratios, allowing plants and insects to develop resistance. Due to this resistance, chemicals are required to be applied at a higher rate and concentration than before, furthering the damage to the environment, and the potential harm to people exposed to these chemicals.



Agricultural workers:

The World Health Organisation (WHO) has estimated 25 million Agricultural workers suffer from pesticide poisoning per year. Third world countries account for %99 of deaths from pesticides, even though it accounts for only %20 of global pesticide sales.

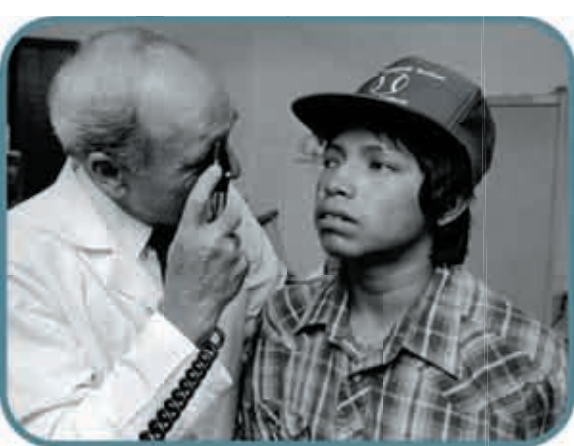
Research has shown that a vast majority of these cases were caused by Inappropriate use of chemical sprayers, inappropriate safety measures, and faulty or poorly designed equipment.

Chemicals used in spraying can be carcinogenic, (Cancer causing) a sensitiser (Causes allergic reactions), or an asphyxiant (reduces oxygen intake). Organophosphate is a commonly used pesticide, and a mild form of neurotoxin.



Global Sales figures of agrochemical products

- (1) After the automotive industry, the chemicals industry is the worlds biggest manufacturer, with annual sales of US\$1.6 trillion. - 2000-2001 Pesticide Market Estimates: Usage.
- (2) In 1998, global sales of agrochemical products topped US\$30.9 billion.
- (3) In an effort to dominate the world agrochemical market, leading transnational corporations (TNC's) have invested billions in new agrochemical products and biotechnology research. One TNC, Aventis, is expected to reach US\$3 billion in research and development.
- (4) Companies such as Monsanto, DuPont, Aventis, Dow Agro-Sciences, have collectively formed an organisation called "RISE" (Responsible Industry for a Sound Environment). In 1996, RISE has spent US\$15 million on lobbyists alone to stratigise a "greener image".
- (5) Leading agrochemical giants invest millions in strategies to promote a "greener" image in an effort to monopolise the world market, thus increasing global sales. The "crop protection market" is expected to become a US\$100 Billion a year industry.



In July 2000, sixteen healthy young farmers in Senegal's Kolda region suddenly fell sick and died. All suffered the same symptoms - severe swelling of the face, limbs and abdomen, heart pains and breathing difficulties - and all were dead within a week. The probable cause: two pesticide powders, Granox TBC and Spinox T, which the victims had used to protect newly planted groundnut seeds against fungus and insects.

- Extract from Rotterdam Convention case study notes



Conventions such as Stockholm, Rotterdam, and Basel, and authorities, such as E.P.A, W.H.O, ILO, and F.A.O, support health, safety, and environmental laws and guidelines for safe work practices and health standards. They closely monitor such things as agrochemical pollution, and health standards in the workplace.



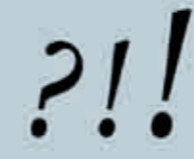
F.A.O (Food and Agriculture Organisation)

Research Survey Key Points: Knapsack Spray applications

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| Malaysia | 44% of knapsack sprayers had a functional performance efficiency of less than 75%. |
| Pakistan | With an agrochemical market of around US\$28 million, studies have shown that almost 50% of this is wasted as a result of poor performance of application equipment. |
| Philippines | Knapsack sprayers have an annual demand for about 100,000. The state of equipment and lack of training caused applicators face a high level of pesticide exposure, particularly dermal. |
| Vietnam | A survey of 1,500 farmers in 16 provinces in South Vietnam showed that only 39% use a mouth and nose cover (simple tissue mask or handkerchief) for spray protection; 37% wore trousers and long-sleeved shirts. |

Brief

Design an improved Knapsack Sprayer that benefits the user through the development of physical and cognitive ergonomics, whilst addressing health and safety concerns regarding knapsack sprayer function and spray chemical application.



Concerns & Existing Issues.

- (1) Knapsacks are required to be flushed out and cleaned after every application to prevent chemical buildup, and chemical cross-contamination. This is often neglected.
- (2) Mixing and measurement of chemicals can be inconvenient and confusing. Mixed solutions are often too dilute to be effective, resulting in the need for unnecessary re-application, and potentially allow plants and insects to develop chemical resistance.
- (3) Highly concentrated chemical solutions contribute to pollution, and cost, and have no extra benefit to spray effectiveness.
- (4) Incorrectly mixed chemical solutions result in fluctuations of chemical concentration during spraying. This causes blockages in the system and makes it difficult to flush out remaining chemicals after use to avoid cross-contamination of chemicals.
- (5) Even when proper safety gear is worn, users often do not wear proper protective clothing during the initial preparation stages of spraying. Paradoxically; this is the time when the chemical is in its most harmful state.
- (6) Leaking from typical sprayers are common. This poses a problem, particularly considering how close to the body the leaking area occurs.
- (7) Existing designs do not allow for ventilation between the user's back and the unit, which can cause workers to become hot and uncomfortable.



Opportunities

- (1) products on the market generally remain unchallenged, with no particular brand offering better performance than current competing manufacturers.
- (2) Designs currently on the market generally fail to address health and safety issues, particularly in regard to safe chemical management. This leaves an opening in the market for a product that can resolve these issues.
- (3) Agrochemical companies such as Aventis and DuPont could benefit from marketing a product-reliant sprayer, and in return, collaborate in the promotion of the sprayer through cross-marketing.
- (4) The development of a non-motorised sprayer is much more feasible for developing counties, that fail to meet general health and safety requirements.

Specifications

- (1) Design a Knapsack sprayer that effectively reduces the degree of chemical contact the user is faced with when spraying potentially harmful chemicals.
- (2) Provide an easier, safer, and faster method of applying accurate chemical spray ratios.
- (3) Prevent chemical cross-contamination when alternating between two or more different types of sprays.
- (4) Reduce the likelihood of over-spraying, overconcentration, or dumping of spray chemicals through better design of the product 'system'
- (5) Address product usability and safety through application of physical and cognitive ergonomics.

The design is to be marketable as an easier, more effective method of commercial and general Knapsack spraying.



Phase 1: Incorporate an injection system

The design went through several stages with prototyping, initially focusing on venturi technology, moving to piston configuration, and finally, developing an effective method of chemical ratio adjustment.

Potential Benefits

- (1) Removes the need to pre-mix and measure chemicals during filling the tank.
- (2) Prevents the cross-contamination of different chemicals, and contamination of soil and waterways. After spraying is finished, the chemical container is removed and the remaining water in the reservoir is tipped out. Emptying of the unit is safe to the environment as chemicals never enter the sprayer's water reservoir,
- (3) Vastly reduces the amount of contact the user has with the chemicals, both in its raw, and diluted form.
- (4) Allows for increased accuracy with water to chemical ratios. This minimises waste product, and preventing soil from being over-sprayed and chemically contaminated.
- (5) Makes Knapsack Spraying easier and more effective for the user through the introduction of cognitive ergonomics.

Venturi System

Creates a pressure difference in water flow to draw another liquid into the line.

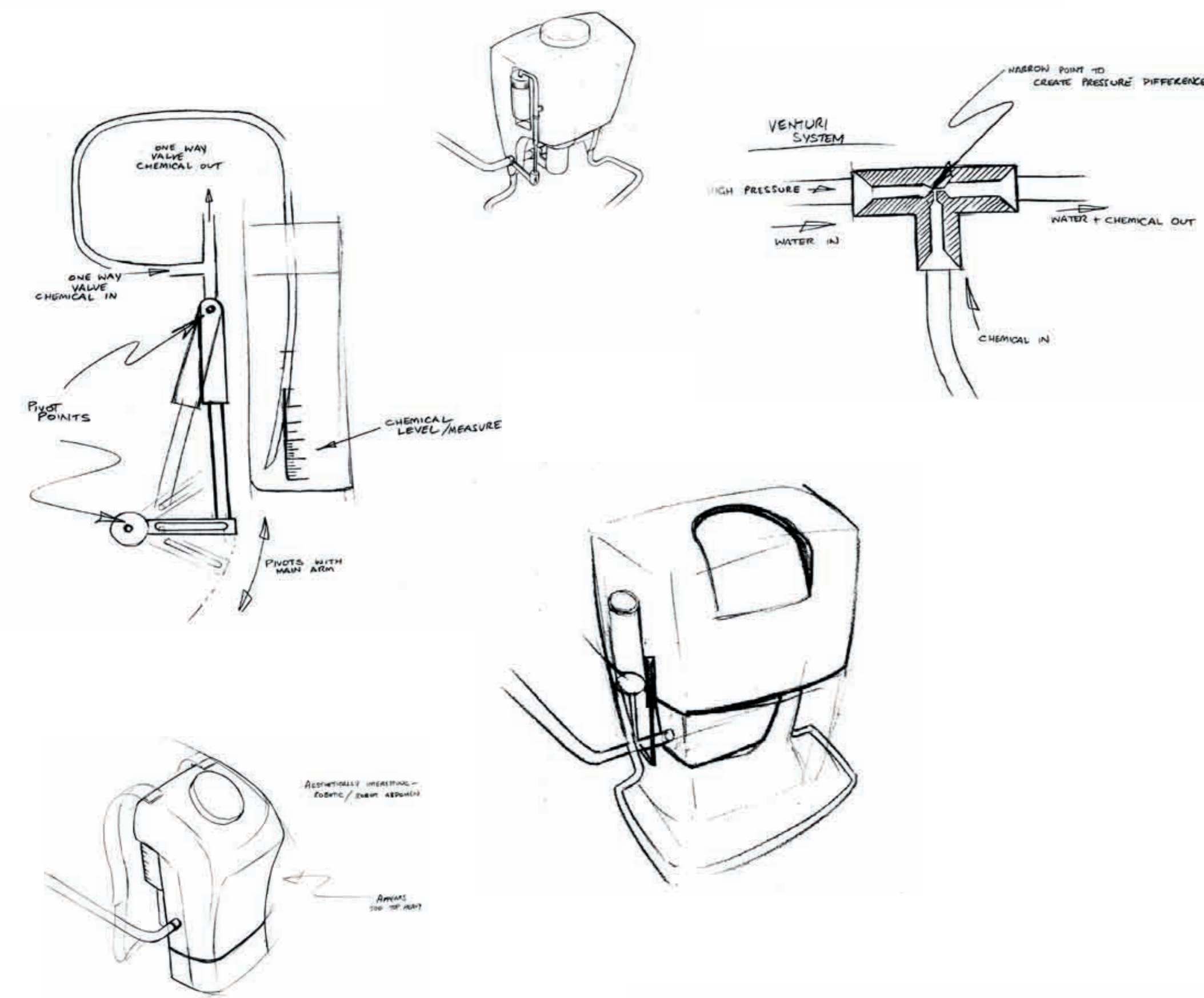
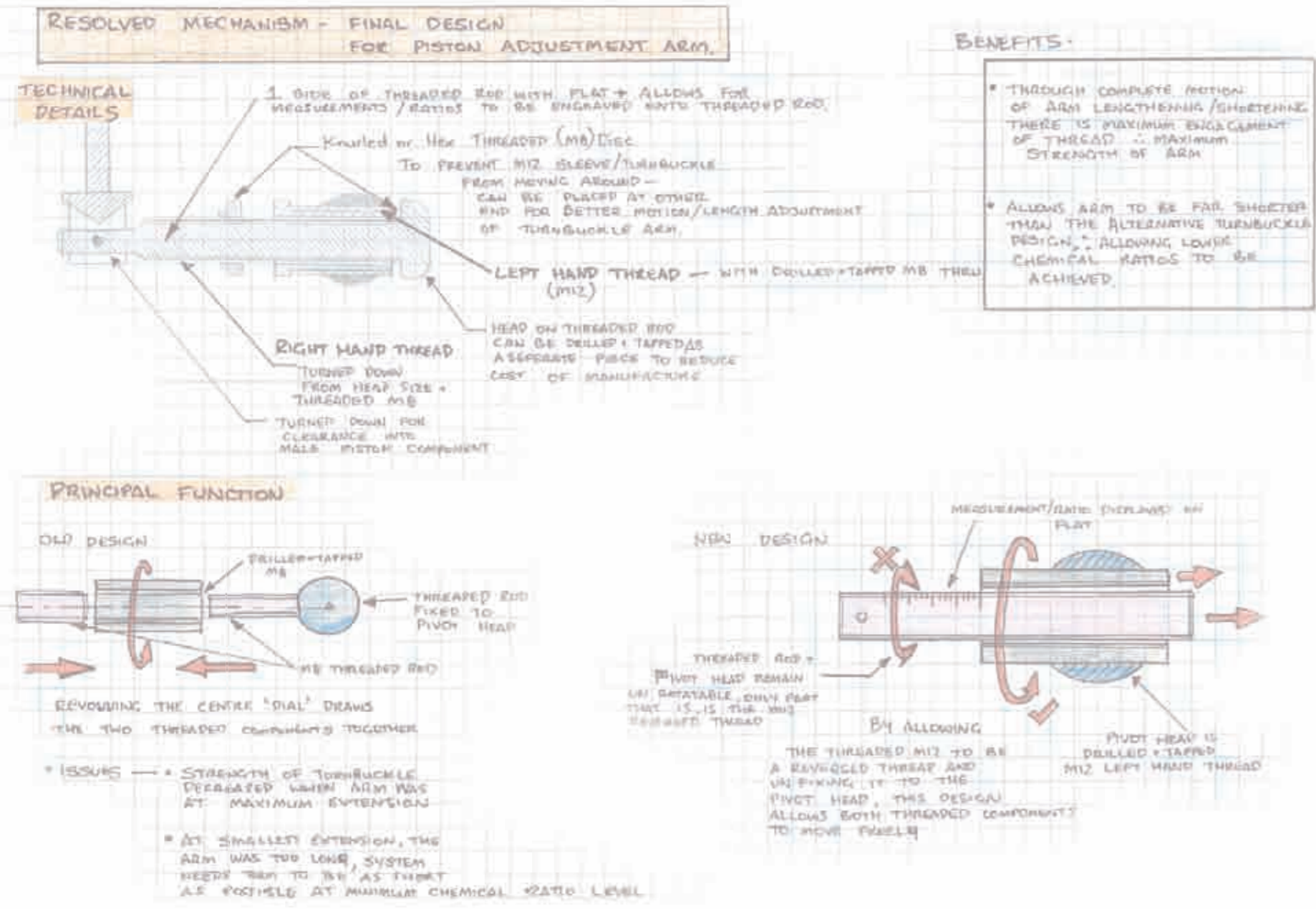
Results:

Failed to draw chemical effectively into the main line. The system required an exceedingly high amount of pressure to operate effectively. Areas of the flow line needed to be less than 0.8mm in Diameter to give the desired Water: chemical ratio. This would be ineffective with powder-based chemical products, that would eventually block the flow line.

Conclusion:

There were too many variables within the system for the venturi to function effectively. Venturis are designed to work with a constant flow of water. Hand powered sprayers have an intermittent flow, thereby interrupting the venturi effect.

The venturi system would not deliver the required pressure output. Appeared effective under pressures greater than 50Psi. Incorporated with a fuel-powered system, a venturi with correct configuration may work effectively.



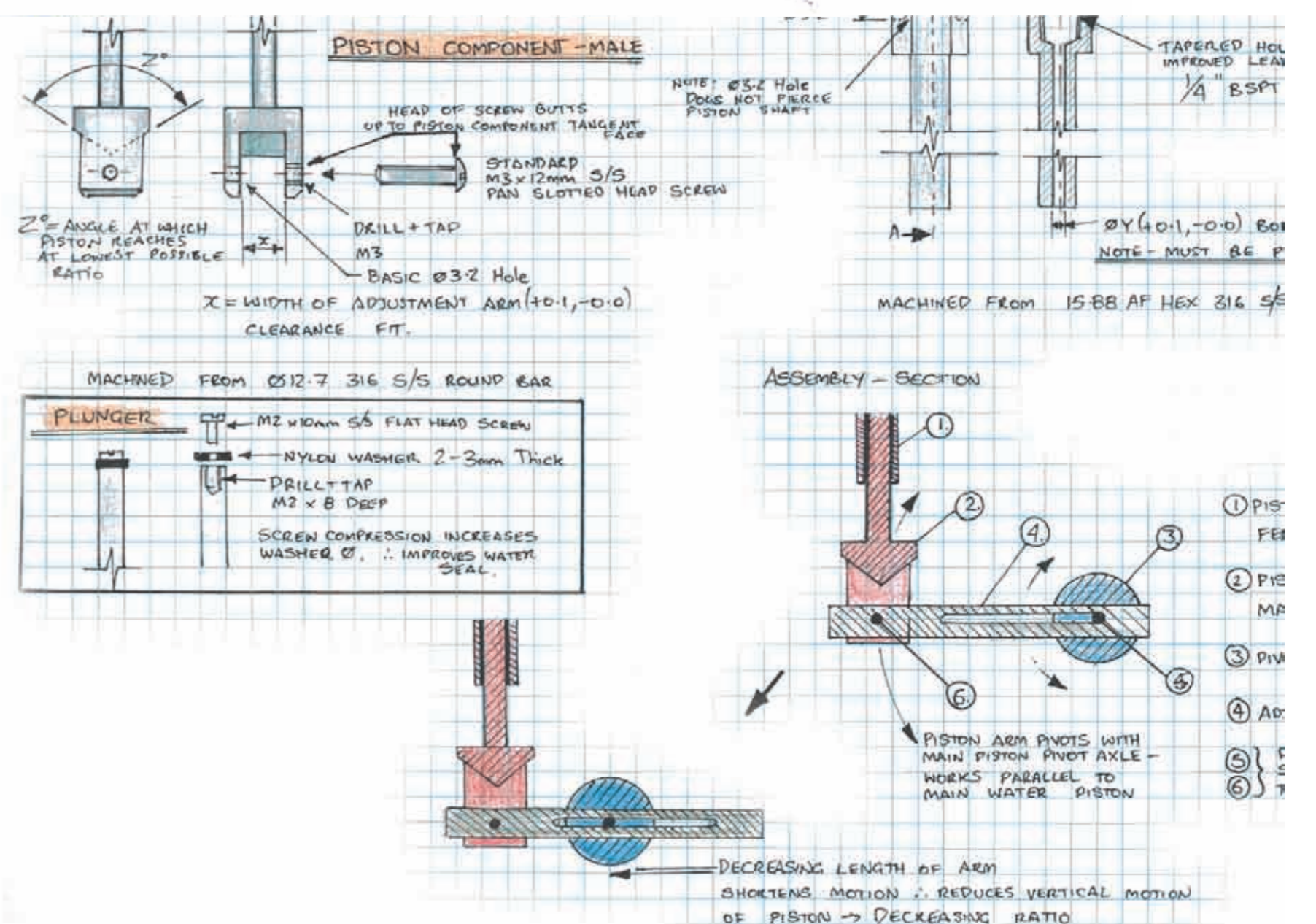
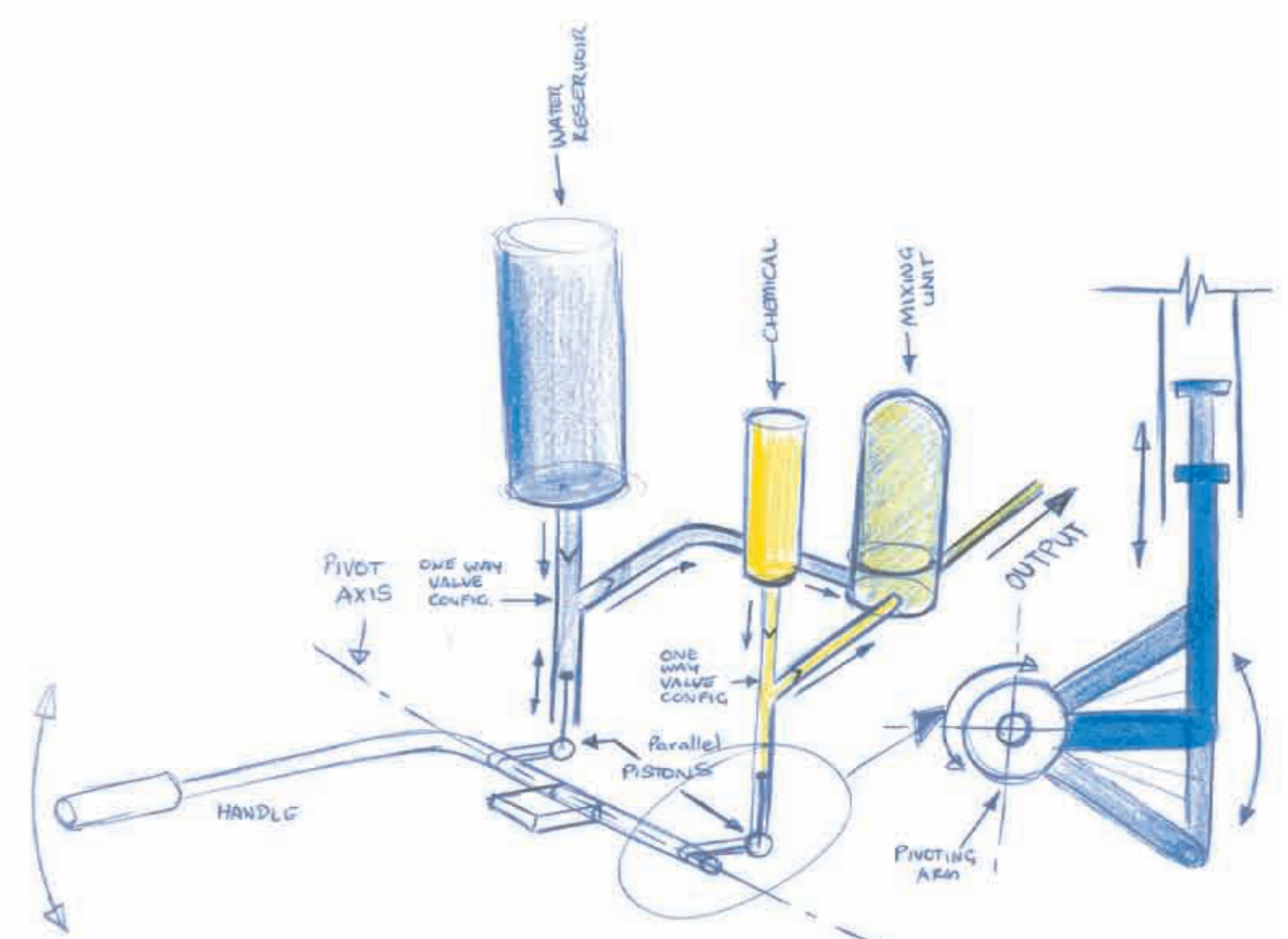
Delivery System

How it works:

The system uses the existing hand-powered energy source that drives the existing water piston to drive an external parallel piston.

Benefits:

- 1/ Remains constant with main flow line: Because the piston is being driven parallel to the main piston, changes in pressure and flow (inevitable with the inconsistency of hand powered spraying), do not alter the chemical to water mix.
- 2/ Easily adjustable ratio: Displacing the piston arm from the pivot point changes the depth of the piston stroke, allowing for chemical ratio adjustment.
- 3/ Low Maintenance: The simple design of this unit allows it to be easily disassembled for repair or replacement.
- 4/ Pre-mixes the chemical and water: The added chemical enters the Pressure Bomb proportionally with the water (device used to allow only smaller area of the tank to be pressurised, rather than the entire unit). Water turbulence within the pressure bomb acts as a mixer for the solution.



Su. Vario_{V.2}

Variable Rate Spray Unit

✓ Ergonomic

✓ Environmental

✓ Efficient

✓ Effective



Su. Vario removes the need for horticulturists to pre-mix and measure dangerous chemicals prior to spray application.

Through the introduction of an innovative delivery system, **Su. Vario** makes knapsack spraying more easier, safer, effective, and more environmentally responsible than any other knapsack currently on the world market.

