Title of invention: STEM, MD Inc.

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PART I: PATENT DISCLOSURE

Abstract

Developing countries do not possess substantial health care facilities to serve the needs of their population. Specifically, many hospitals lack sophisticated diagnostic and medical equipment causing inefficiencies to the system. To decentralize the role of the hospitals in education and healthcare, we've created a series of Medical Device kits that introduce seven different medical devices to children, and that directly train local technicians. The Medical Device kits teach children how to think like an engineer by creating imitation medical devices comprised of simple components. For hospitals and clinics, we will provide an assemblage of functioning medical device components where the local technicians must put together the components to use the product. By creating a "do-it-yourself" method of learning engineering techniques, developing areas will have the opportunity to have a self-sustained future in healthcare diagnostics with the creation of a new generation of Medical Device technicians.

Background of the Invention

Many health care systems in developing countries are inadequate to serve the needs of their people. Facilities lack medical supplies, diagnostic equipment, proper medical waste disposal and ample staff resulting in adverse consequences. For example, the majority of deaths caused in Tanzania come from late diagnosis; the leading cancer for females is cervical cancer, accounting for 40% of all cancer cases (Kibatala, 2007). Given the proper tools, this statistic could be much lower. In addition to the physical lack of supplies, many of these health care facilities lack the proper education to function as efficiently as possible.

Providing these developing health care facilities with the proper medical supplies can be expensive, especially when considering the more sophisticated devices such as diagnostic equipment. However, these tools give doctors and health care workers the ability to deliver a higher quality of care to their patients. Programs such as Brother's Brother in Pittsburgh or Project C.U.R.E. (Commision on Urgent Relief and Equipment) aim to address the problem of inadequate medical supplies. The companies collect donated medical supplies and send them to rural areas across the world. However, much of the functioning equipment shipped to areas of need break on site due to age and/or extended use, rendering the equipment useless. A study of seven hospitals in Haiti found 30% of 115 pieces of donated medical equipment could not be repaired (Dzwonczyk & Riha, 2012). In addition, the World Health Organization (WHO) estimated of the 80% of donated medical equipment worldwide, only 10-30% of the donations are operational. As a response, WHO has installed guidelines for Good Donation Practice to avoid the accumulation of non-functioning equipment in rural hospitals, but still stresses the need for training rather than more equipment. By providing equipment training to rural workers, it increases the likelihood of restoration of a previously donated machine that might already exist in the hospital.

Training individuals on how to operate such sophisticated equipment and supplies can be a challenge, especially when a language barrier exists. In 2009, Engineering World Health (EWH) sent workers to Rwanda to train hospital technicians. This reduced the amount of out-of-service equipment by half and increased the technician's' productivity. However, sending a trained professional to educate workers in rural areas can be costly as well and is not a perfect solution. Thus, a better system must exist to provide struggling areas with adequate medical supplies. Our proposed solution is STEM, MD Inc.

STEM, MD Inc. has three aims. The first aim is to provide ample medical supplies to developing areas, specifically the more expensive diagnostic and medical equipment. The second aim is to educate medical workers on how the equipment works on a component level. And the third aim is to instill STEM education to the children of the same rural areas receiving our medical equipment.

Education of these devices is provided through the assembly of the machines on site. The medical equipment sent to the underdeveloped countries is refurbished back to its functioning state, but the machine itself is packaged in pieces. A step-by-step image assembly diagram comes with the kit of machine parts forcing the medical worker to construct the equipment themselves. Ultimately through the machine's assembly, the technician learns how the machine works on a component level, thus if the machine breaks in the future, the technician will be more likely to fix it having this prior experience of assemblage.

In addition to medical worker education, medical device assemblage will be introduced to local schools with the installment of our Children's Medical Device Learning Kits. These "pseudo medical device" kits mimic the end product of a medical device, such as the cathode of an X-ray machine, but do not actually make a functioning device. Instead, by using cheaper imitation parts, children will learn the fundamental physics of the cathode through its construction. Thus, by the time these children are old enough to make societal contributions, they could work in the medical field specializing in medical equipment assembly/assessment.

STEM, MD Inc. addresses some fundamental problems with health care in developing areas including lack of medical supplies, waste reduction and education. With the implementation of our proposed educational and distribution system, developing areas will have the opportunity of a self-sustained future.

Prior Art

Brother's Brother

Brother's Brother is a gift-to-kind charity that brings medical devices to underdeveloped countries, based out of Pittsburgh, PA (http://brothersbrother.org/about/). Medtech companies with a surplus of devices donate their technologies to Brother's Brother (http://brothersbrother.org/about/). Brother's Brother utilizes mission trips and partner organizations to deliver the medical donations, which include medicine, supplies and equipment, textbooks and educational supplies (http://brothersbrother.org/about/). Their strategy has disrupted healthcare status quo and brought medical supplies and educational opportunities to several underdeveloped countries. For example, Brother's Brother has donated 95,000,000 to over 25 million children, and 17,000 tons of medicine (https://www.youtube.com/watch?time_continue=103&v=c12DQaVlp5U).

Brother's Brother is one of the top five largest shippers of donated pharmaceuticals and medical supplies in the United States (https://www.youtube.com/watch?time_continue=103&v=c12DQaVlp5U). But, what happens once the supplies are donated? Are they ever used, and what happens if they break? The hospitals and clinics that the items are donated to do not specialize in using these devices, or repairing them. Therefore, many of the medical devices are left unused. Therefore, while Brother's Brother is effective in bringing donated medical supplies directly to the locations they are needed, they are not effective in training their users on what to do with the supplies.

IMEC (International Medical Equipment Corporation)

IMEC provides equipment, tools, and supplies to underdeveloped countries based out of Boston, MA. They focus on three areas of development: medical, agricultural, and educational programs (http://imecamerica.org/about.html). One way that they ensure that hospitals are properly equipped is by bringing "Hospital Suites" to the hospitals and clinics. They replicate what a hospital suite in an average hospital in the United States would have - hospital beds, blood pressure devices, heart rate monitor, etc. Then, they package these "Hospital Suites" in a 40 foot shipping container, which is then brought to the hospital or clinic in the underdeveloped countries. The "Hospital Suites" can directly installed next to the hospital, and the patient is treated the same way they would be treated in America (http://imecamerica.org/healthcare.html). They have several different programs where professionals will come and train local communities. For example, they have Biomedical Training and Supply Chain Consulting programs. For the Biomedical Training program, trained faculty go to the hospital or clinic in the underdeveloped country and access their current state of resources. They develop a three year training plan, and work with the individuals to learn how to use and repair equipment (http://imecamerica.org/Biomedical-Training.html). For the Supply Chain Consulting program, experts in Supply Chain management in under resourced communities develop strategic improvement plans (http://imecamerica.org/Supply-Chain-Consulting.html).

Multi-component learning kit

This invention requires that the user completes physical experiments/exercises in order to complete a problem. The user is given a problem to solve, and must solve it using "experimental hardware, regents, and procedures provided in the kit" (https://www.google.com/patents/US20100248202?dq=engineering+kit+experiment&hl=en&sa=X&ved=0ahUKEwioneTY7drJAhUCSiYKHULcAPQQ6AEITjAH). The goal of the engineering kit is to teach the user about the Applied Sciences and how to problem solve.

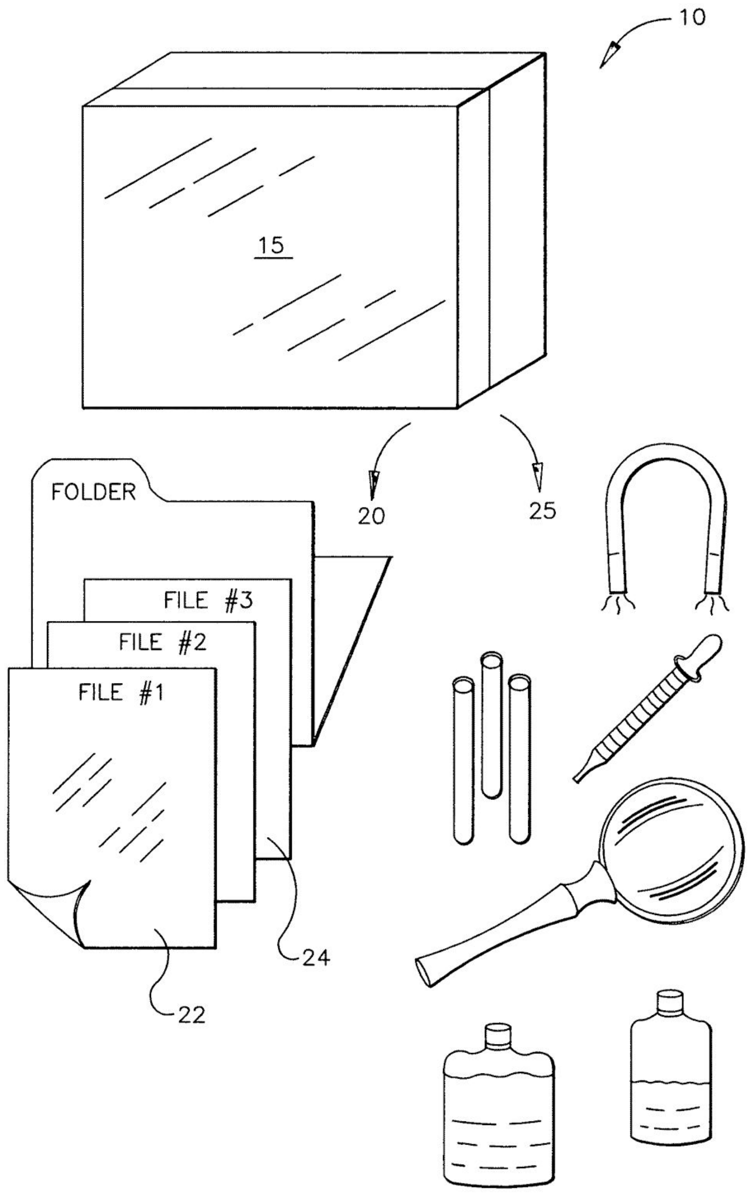

Figure 1. Inside the box are different cards with different problems, and the kit is equipped with different hardware.

Figures

For the purpose of this assignment, we will only include one diagram of the children's medical device learning kit, which is the X-Ray tube diagram. However, in a more complete version of this proposed process, we would include diagrams for x-ray machines, ultrasounds, autoclaves, mass spectrometers, endoscopes, centrifuges, and blood pressure dopplers.

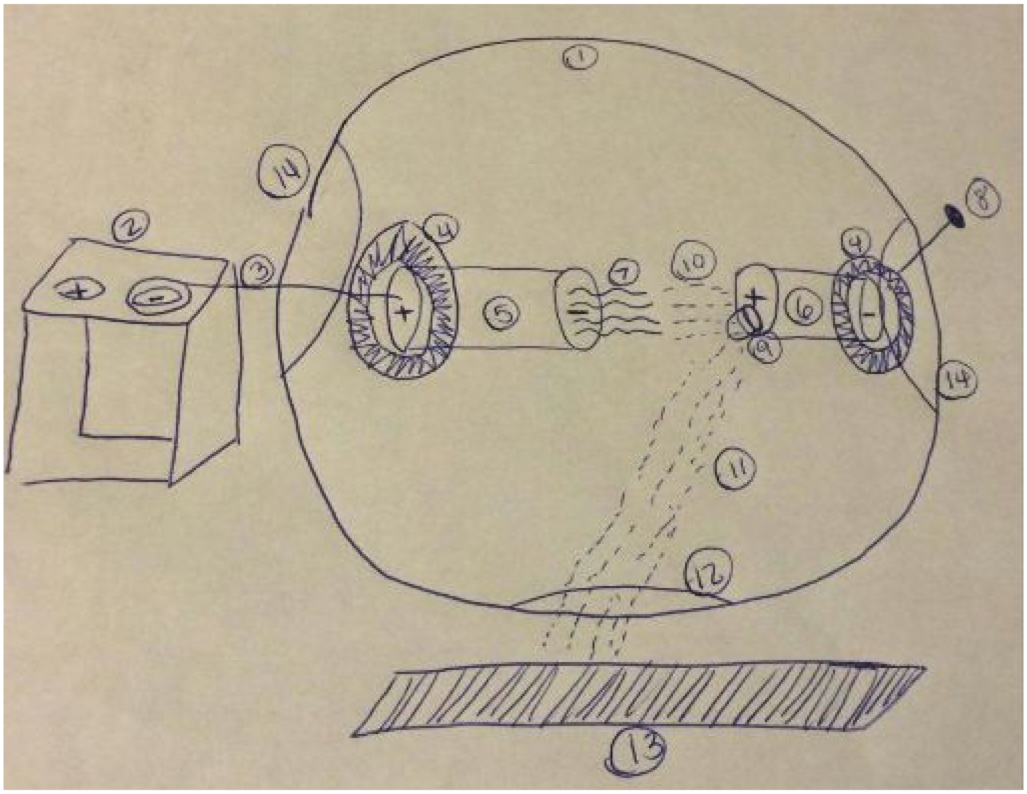

Figure 2. X-Ray Tube for Children's Medical Device Kit

1. The X-Ray Tube vessel
2. Voltage source, a used battery
3. A copper wire attached to the negative (-) end of the battery in (2.)
4. A plastic casing that surrounds the cathode and anode
5. The cathode, a used battery
6. The anode, a used battery
7. Metal filaments to transmit the electrons, made out of paperclips
8. A handle attached to the plastic casing of the anode that allows the user to rotate the battery
9. The metal, attached to the anode, where the photons collect, made out of a metal thimble
10. Electron flow from the cathode (transmitted by the filaments)
11. X-ray flow from the thimble
12. Window that the X-Rays flow through
13. X-Rays collect on a black piece of paper, representing thin film sheets
14. Holes are cut in the X-Ray tube vessel to allow the user to insert the internal

components

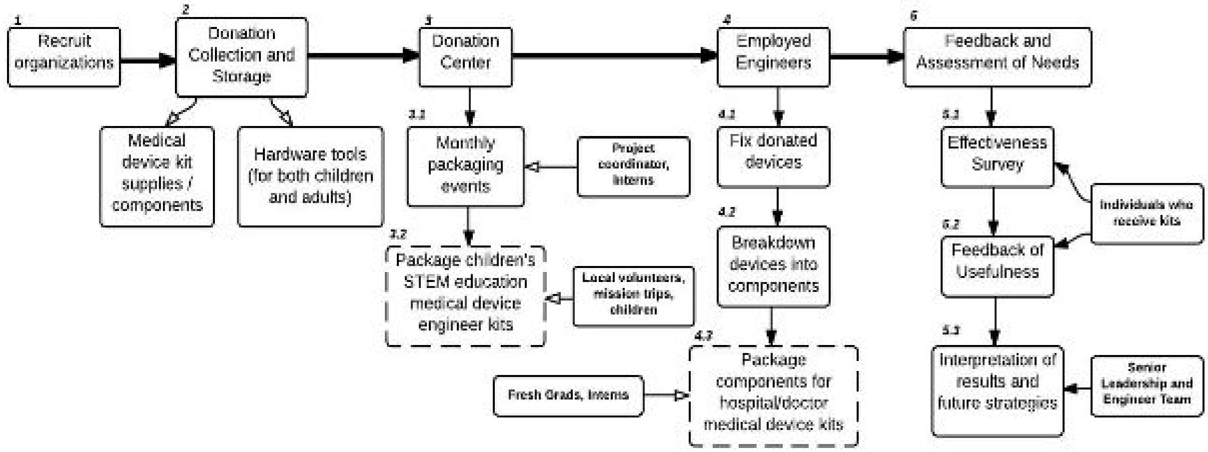

Figure 3. Process Flowchart for both Children and Adult Medical Device Kits

1. Recruit organizations
2. Donation Collection and Storage, including Medical device kit supplies/components and hardware tools (for both children and adults)
3. Donation centers
    3.1. Monthly packaging events, completed by project coordinator and interns
    3.2. Package children's STEM education medical device engineer kit, completed by local volunteers, mission trips, children
4. Employed engineers
    4.1. Fix donated devices
    4.2. Breakdown devices into components
    4.3. Package components for hospital/doctor medical device kits, completed by fresh graduates and interns
5. Feedback and Assessment of Needs
    5.1. Effectiveness Survey, completed by the individuals who receive the kits
    5.2. Feedback of Usefulness, completed by the individuals who receive the kits
    5.3. Interpretation of results and future strategies, completed by the Senior Leadership of STEM, MD, Inc., and the Engineer team

Description of Invention (Specification)

Children's Medical Device Learning Kit: X-Ray Description

The X-Ray Tube is comprised of internal and external components. The internal components are inserted within the X-Ray Tube vessel (1). It is important that there is a vacuum inside the X-Ray Tube vessel, and the X-Ray Tube vessel is made out of glass. However, for the purpose of modeling the system for children, the X-Ray Tube vessel can be made out of any type of material and does not need to establish a vacuum. The X-Ray Tube vessel will have 3 holes: one to insert the cathode (5), another to insert the anode (6), and a third to direct the X-Rays directed by the anode (6). Inside the X-Ray Tube vessel is the cathode (5) and anode (6), which are surrounded by the a plastic casing (4), which establishes the concept that there must be a closed system in a real X-Ray Tube. The cathode (5) and anode (6) are made out of used batteries and cannot generate actual electron flow, but in a real X-Ray tube, there would be an electron flow (10) from the cathode to the anode The cathode (5) is attached to the voltage source, which is a used battery (2), but the battery cannot produce any voltage in this model. A copper wire (3) is attached to the positive end of the cathode and the negative end of the voltage source, which connects the voltage source to the cathode. Coming off the negative end of the cathode are metal filaments which transmit the electrons, represented by paperclips (7) that the use attaches to the battery with Krazy Glue. The anode collects the electron flow (10) from the cathode (5) on a metal platform, which is a metal thimble (9) in this model and acts as a focal spot. In a normal X-Ray tube, the metal platform is typically made of tungsten. A handle (8) is attached to the plastic coating (4) of the anode (6) to allow the user to rotate the anode to avoid it from heating up from the electron flow. The photons are transmitted as X-rays from the thimble (11) and flow through the window (12) of the X-Ray Tube vessel (1). The X-Rays collect on the a black piece of paper (13), which represents the thin film that an analog X-Ray device collects the X-Rays on.

Process Flowchart for both Children and Adult Medical Device Kits Description

Figure 3 demonstrates the flow of goods and information within our company as it reaches developing countries. Component 1, "Recruit Organizations", represents the different organizations we collect used medical equipment from. Organizations, such medical device manufacturers, hospitals, private medical offices, fall under this category. These organizations donate machinery, including x-ray machines, ultrasounds, autoclaves, mass spectrometers, endoscopes, centrifuges, and blood pressure dopplers. In addition, these recruited organizations donate other recycled items to complete the component-based medical device kits and children learning kits, such as hardware tool kits and Krazy Glue.

Component 2, "Donation Collection and Storage", represents the process of recruiting organizations for donations, as well as collecting the goods. Collected goods within Component 2 includes "Medical device kit supplies / components", comprising of the stated machines in Component 1 as well as replacement parts for restoration of donated medical equipment. "Hardware tools (for both children and adults)" also falls under Component 2 and is comprised of donated tools such as hammers, screw drivers or general assembly tools to be included in assembly kits for the component-based medical device kits and the children learning kits.

Component 3, "Donation Centers", refers to the physical warehouse used to house all the donated supplies from Components 1 and 2. Organizations can distribute their goods at the donation center or employees can bring goods directly. Component 3.2, "Monthly Packaging Events", included under Component 3, represents events held run by Project coordinators and interns. During these events, new children kit ideas will be proposed as well as assembled represented in Component 3.2, which is executed by local volunteers, mission trips, and children. "Project Coordinators / Interns" will be required to make Component 3.1 operational. They will lead discussions and ultimately delegate "Local volunteers, mission trips and children" of Component 3.2 through the packing process during the meetings.

"Employed Engineers" of Component 4 will take donated medical equipment from Component 3, "Donation Centers", and assess their functionality. If the medical equipment is functional as donated, the engineers move to Component 4.2, if the medical equipment is not functional, the engineers move to Component 4.1, "Fix donated devices". Engineers gather the necessary parts from the donation centers to restore the medical equipment to its former functioning state. Both functioning and restored medical devices move to Component 4.2, "Breakdown devices into components", where engineers physically take apart the functioning machine for reassembly in a new location. Engineers are also responsible for generating an image-dependent assembly guide to include with the medical device kit. Finally, Component 4.3. "Package components for hospital / doctor medical device kits", is the final assemblage of the medical device for shipment. Crucial to Component 4.3 are the "Fresh graduates and interns". Because these medical device kits include expensive parts, we need trained individuals to handle them with care during the packaging process, but must allocate resources of the employed engineers carefully. Once an assembled medical device kit is complete, it is ready for shipment to the country in need.

Component 5, "Feedback and Assessment of Needs," will consist of feedback from the individuals in the developing country who received the kits, including the hospitals/clinics and the teachers/children, and the reaction of STEM, MD Inc. to improve our system. First, the individuals who received the kits will complete an effectiveness survey (6.1.), which will provide information to the team on how effective the medical device kits actually were at improving their status quo. Second, they will provide feedback of usefulness (6.2.), which will include how the medical device kits were actually used and statements on the impact of the kits. Third, STEM, MD Inc., including the Senior Leadership and Engineering Team, will interpret the results of 6.1. and 6.2. and determine future strategies for the company.

Claims

1. A component-based medical device kit comprising
    a. refurbished components of previously used medical devices, including 7 different types: x-ray machine, ultrasound, autoclave, mass spectrometer, endoscope, centrifuge, and blood pressure doppler;
    b. tool kit with donated hardware tools specific for each medical device kit type mentioned in 1a;
    c. image-dependent assembly guide for construction of each medical device kit type mentioned in 1a.
2. A children's learning kit for creating a medical device comprising
    a. recycled components to construct 7 different medical device learning kits, including: x-ray machine, ultrasound, autoclave, mass spectrometer, endoscope, centrifuge, and blood pressure doppler;
    b. tool kit with donated tools specific for each medical device learning kit type mentioned in 2a that are safe for children, such as safety scissors, non-toxic glue, etc.;
    c. videos for each medical device learning kit mentioned in 2a demonstrating the importance of each component in the learning kit and how it relates to the

components in the actual device, as well as the applied science for each component, with the vocal track in different language and available in vhs/dvd/mp3;

d. image-dependent assembly guide for construction of each medical device learning kit type mentioned in 2a.

PART II: INVENTION PROCEDURE

Background

Problem Statement

In underdeveloped countries, there is a lack of medical equipment and of people who are trained on how to use and/or fix it. Also, there is little emphasis on STEM education in primary and secondary schools, and little encouragement for building engineers/technicians.

- Lack of education on how to use medical diagnostic equipment/donated equipment
- Lack of engineering/technician teachers
    - http://www.scientificamerican.com/article/medical-equipment-donated-developing-nations-junk-heap/
- Not enough functional diagnostic equipment to service hospital
    - http://www.who.int/medical_devices/03_medical_device_needs_pascience_kibatala.pdf
- STEM education of children
    - The start of emphasis has been seen in developed countries (Belgium, Canada, South Korea, US etc.) but has not been implemented into developing countries.
    - http://www.iteea.org/Conference/PATT/PATT28/Fan%20Ritz.pdf

Description of the System

The System:

- Hospitals, and primary and secondary schools in developing countries

Cause of problems:

- Lack of funding in developed countries
- Lack of STEM education exposure at a young age
- Over donated medical equipment that is broken
    - Results in accumulation of medical waste in developing countries

Consequences if the problem is not solved:

- Continued poor health care
- Developing countries relying on developed countries to provide them with resources

Existing Solutions

- Brothers and Brothers - http://brothersbrother.org/education-charity/
    - Collects donated medical equipment, medications, supplies etc. and ships the donations to areas of need across the world

- Peace Corp. - http://www.peacecorps.gov/resources/faf/fafhealth/
  - Volunteers help train medical workers on site about medical techniques, waste management → provides education to workers
- Project C.U.R.E. (Commission of Urgent and Relief Equipment) - https://projectcure.org/about/history
  - Collects donated medical equipment, medications, supplies etc. and ships the donations to areas of need across the world
- World Health Organization (WHO): Principles for Good Donation - http://www.who.int/hac/techguidance/pht/1_equipment%20donationbuletin82WHO.pdf
  - 1. Healthcare care equipment donations should benefit the recipient to the maximum extent possible
  - 2. Donations should be given with due respect for the wishes and authority of the recipient, and in conformity with government policies and administrative arrangements of recipient country.
  - 3. There should be no double standard in quality. If the quality of an item is unacceptable in the donor country, it is also unacceptable as a donation
  - 4. There should be effective communication between the donor and the recipient, with all donations made according to a plan formulated by both parties.
- Engineering World Health (EWH) - http://www.scientificamerican.com/article/medical-equipment-donated-developing-nations-junk-heap/
  - Sends trained professionals to developing countries to train public hospital technicians, with training emphasis on medical equipment and how to make repairs

Additional References:

Kibatala, K. “Medical Device Needs in a Developing Country”. Ministry of Health and Social Welfare, Tanzania. 2007. http://www.who.int/medical_devices/03_medical_device_needs_pascience_kibatala.pdf

Dzwonczyk R & Riha C. “Medical equipment donations in Haiti: flaws in the donation process”. Rev Panam Salud Publica. 2012 31(4):345-348.

World Health Organization (WHO). “Medical device donations: considerations for solicitation and provision: WHO Medical device technical series.” 2011. http://apps.who.int/iris/bitstream/10665/44568/1/9789241501408_eng.pdf

Contradiction Diagram

Figure 4. Contradiction Diagram for "Lack of Technical Education"

Contradictions:

1. Poor healthcare produces cheap health insurance and cheap supplies, but also produces higher death rate, less diagnostic equipment, higher rate of infection, fewer trained doctors.
2. Cheap supplies produces low costs for hospitals, but also produces fewer supplies available.
3. Cheaper labor produces cheap health insurance, but also produces fewer specialized professionals
4. Fewer factories produces less waste and less pollution, but also produces less export/international presence and less income/GDP
5. Lack of technical education produces fewer factories, more farmers/agriculture, cheaper labor and a low need for STEM teachers, but also produces fewer specialized professionals, a poor healthcare system, and a lack of enthusiasm for lifelong learning

Resources

1. Substance resources
    a. Refurbished medical equipment
    b. Recycled materials
        i. bottles
        ii. batteries
        iii. hardware tools

iv. scrap metal
v. light bulbs
vi. wiring
vii. magnets
viii. any medical device spare parts

c. Packaging material
    i. Packing peanuts
    ii. Bubble wrap
    iii. Packaging tape
    iv. Box cutters
    v. Boxes
d. Diagram creation software (ie. Adobe illustrator)

2. Field resources
    a. Vacuum in lightbulbs
    b. Electrical current between wires
    c. Magnetism
    d. Radiation
    e. X-Rays / Ultrasound / The electromagnetic spectrum
    f. Visible light spectrum
    g. Chemical reactions
3. Space resources
    a. Hospitals
    b. Factories
    c. Offices
    d. Classrooms
    e. Shipping crates
4. Time resources
    a. Patients' life expectancies
    b. Shipping time
    c. Assembly time at the site of assembly (United States/Pittsburgh, PA), and at the donation site (Underdeveloped country)
    d. Time spent in the classroom/in science class

5. Informational resources
    a. Diagnostic results
    b. Assembly guides
    c. Videos on VHS/DVS with instruction guide
    d. Company - Developing country relationship/communication
        i. Effectiveness surveys
        ii. Language needs
6. Functional resources
    a. Medical Device Engineers
    b. Volunteers
    c. Interns
    d. New graduates
7. Financial resources
    a. Charity donations of medical supplies
    b. Financial donations from charities
    c. Developing/Developed countries government spending
8. Human resources
    a. Doctors
    b. Medical workers
    c. Medical assistants
    d. Technicians
    e. Peace Corp. Volunteers
    f. Local Volunteers
    g. Professionals sent to developing countries to train local healthcare workers

Constraints and Limitations

Hospitals

- Hospitals must be permanent. Their establishment provides a centralized place for patients to come and receive the best care possible and a place for doctors to see has many patients as possible in one day. They also allow doctors to practice higher quality medicine. For health care to advance and evolve, hospitals must remain.
- In some cases, the hospital can be removed where the doctor travels to different locations, but the level of care drops inherently.

Doctors, medical workers, medical assistants

- Health care workers cannot be removed from the system. They are the people responsible for providing healthcare to all the patients in need. To improve health care as a whole, the productivity of health care workers much increase.

Patients

- People in need of medical assistance will always exist. From the smallest injury to the a life threatening disease, people need healthcare to live longer lives.

Aging, Wear and Tear

- Medical equipment and facilities will always be subject to wear and tear the more they are used. Thus, there will always be a need for repairs and replacements.

Success Criteria

The Ultimate Objection: Success of STEM, MD Inc.

Success of our invention would include accomplishing three aims. First, success would include providing health care facilities in developing countries with necessary diagnostic equipment and medical equipment. Second, success would include the ability to education medical workers in developing countries about the functionality of medical equipment in the absence of a formal system for training technicians to use and fix medical devices. Third, success would include the ability to education children in developing countries in STEM topics, especially Engineering, and specifically medical device equipment in the absence of a formal system for training teachers or students in medical device assembly.

Objective Tree

Figure 5. The Objective Tree for Stem, MD Inc.

Measurements to Define Ideality

1. Thorough technical training of medical equipment repair for medical workers/technicians.
2. Developing countries provide requests and feedback on medical equipment received.
3. STEM, MD Inc. responds to requests in a timely manner and is adaptable to requests.
4. Provide developing countries with the necessary medical equipment.
5. Integration of STEM education in developing world schools.
6. The creation of future engineers, technological workers in developing areas.
7. The reduction of medical waste and broken medical equipment.

Ideal Final Result (IFR)

A health care system in any country, developed or developing, that is self-sustained. Each country has enough resources to provide the health care facilities with ample supplies, proper waste disposal, updated medical equipment and maintains the highest educational training available without outside intervention from another country.

Conceptual solutions

Directions of Innovation

1. Find a way to eliminate, reduce, or prevent Lack of technical education in order to avoid Fewer specialized professions, Less enthusiasm for lifelong learning and Poor healthcare

system.

2. Resolve the contradiction:Lack of technical education shouldn't exist to avoid harmful results Fewer specialized professions, Less enthusiasm for lifelong learning and Poor healthcare system and should exist to provide Cheaper labor, Low need for STEM teachers, Fewer factories and More farmers/agriculture.

3. Find an alternative way to obtain Cheaper labor that offers the following: provides or enhances Cheap health insurance does not cause Fewer specialized professions does not require Lack of technical education.

4. Resolve the contradiction: Cheaper labor should be provided to produce Cheap health insurance and shouldn't be provided to avoid Fewer specialized professions.

5. Find an alternative way to obtain Low need for STEM teachers that offers the following: does not cause Less skilled population and Fewer specialized professions does not require Lack of technical education.

6. Resolve the contradiction: Low need for STEM teachers shouldn't be provided to avoid Less skilled population and Fewer specialized professions.

7. Find an alternative way to obtain Fewer factories that offers the following: provides or enhances Less pollution and Less waste does not cause Less income/GDP and Less export/international presence does not require Lack of technical education.

8. Resolve the contradiction: Fewer factories should be provided to produce Less pollution and Less waste and shouldn't be provided to avoid Less income/GDP and Less export/international presence.

9. Find an alternative way to obtain Less pollution that does not require Fewer factories.

10. Find an alternative way to obtain Less waste that offers the following: does not require Fewer factories is not influenced by Poor waste disposal.

11. Find a way to eliminate, reduce, or prevent Less income/GDP under the conditions of Fewer factories.

12. Find a way to eliminate, reduce, or prevent Less export/international presence under the conditions of Fewer factories.

13. Find a way to eliminate, reduce, or prevent Less skilled population under the conditions of Low need for STEM teachers.

14. Find a way to eliminate, reduce, or prevent Fewer specialized professions under the conditions of Cheaper labor, Low need for STEM teachers and Lack of technical education.

15. Find a way to eliminate, reduce, or prevent Less enthusiasm for lifelong learning in order to avoid No use of scientific method in community culture under the conditions of Lack of technical education.

16. Find a way to eliminate, reduce, or prevent No use of scientific method in community culture under the conditions of Less enthusiasm for lifelong learning.

17. Find an alternative way to obtain More farmers/agriculture that offers the following: provides or enhances More food does not require Lack of technical education.

18. Find an alternative way to obtain More food that offers the following: eliminates, reduces, or prevents Higher death rate does not require More farmers/agriculture.

19. Find a way to eliminate, reduce, or prevent Poor health care system in order to avoid Unsanitary conditions, Higher death rate, Less diagnostic equipment, Higher rate of infection and Fewer trained doctors under the conditions of Lack of technical education.

20. Resolve the contradiction:Poor healthcare system shouldn't exist to avoid harmful results Unsanitary conditions, Higher death rate, Less diagnostic equipment, Higher rate of infection and Fewer trained doctors and should exist to provide Cheap health insurance and Cheap supplies.

21. Find an alternative way to obtain Cheap health insurance that does not require Poor healthcare system and Cheaper labor.

22. Find a way to eliminate, reduce, or prevent Unsanitary conditions under the conditions of Poor healthcare system and Poor waste disposal.

23. Find a way to eliminate, reduce, or prevent Poor waste disposal in order to avoid Unsanitary conditions.

24. Find a way to eliminate, reduce, or prevent Higher death rate under the conditions of Poor healthcare system.

25. Find a way to eliminate, reduce, or prevent Fewer trained doctors under the conditions of Poor healthcare system.

26. Find a way to eliminate, reduce, or prevent Higher rate of infection under the conditions of Poor healthcare system.

27. Find a way to eliminate, reduce, or prevent Less diagnostic equipment under the conditions of Poor healthcare system.

28. Find an alternative way to obtain Cheap supplies that offers the following: provides or enhances Low costs for hospitals does not cause Fewer supplies available does not require Poor healthcare system.

29. Resolve the contradiction: Cheap supplies should be provided to produce Low costs for hospitals and shouldn't be provided to avoid Fewer supplies available.

30. Find an alternative way to obtain Low costs for hospitals that does not require Cheap supplies.

31. Find a way to eliminate, reduce, or prevent Fewer supplies available under the conditions of Cheap supplies.

9 Directions of Innovation for Consideration

Find an alternative way to obtain Low need for STEM teachers that offers the following: does not cause Less skilled population and Fewer specialized professions does not require Lack of technical education.

- By using several inventive principles, including partial or overdone action; self service; cushion in advance; segmentation; and combining, children at the elementary level, and technicians in hospitals/clinics, can become skilled and specialized professionals without the need of STEM teachers. To accomplish this, users can use a “kit” comprised of different components, and a guide that can walk them through using the components, to learn how a device or system works, without the need for a teacher.

Find an alternative way to obtain Less pollution that does not require Fewer factories.

- In order to obtain less pollution without effecting factory productivity, use a pneumatic construction, such as a wind turbine or solar power, to provide energy to the factory, instead of gas or oil, which is the main contributor of pollution.

Find a way to eliminate, reduce, or prevent Less income/GDP under the conditions of Fewer factories.

- Replacing an expensive material with a cheap, inexpensive copy eliminates the reduction of income/GDP without lowering the number of factories in decreasing productivity.

Find a way to eliminate, reduce, or prevent Less export/international presence under the conditions of Fewer factories.

- In order to reduce the lack of export and international presence due to fewer factories, use Mediator to create a market of customer service, which only requires office buildings and consists of people who aid in help customers with devices created in other countries.

Find an alternative way to obtain More farmers/agriculture that offers the following: provides or enhances More food does not require Lack of technical education.

- By transforming the chemical state the food grown to include genetically modified organisms, it enhances food, creates more food and does not require a lack of technical education.

Find an alternative way to obtain Cheap health insurance that does not require Poor healthcare system and Cheaper labor.

- In order to obtain cheap health insurance without requiring a poor healthcare or cheap labor, use an inexpensive short-lived object instead of an expensive, durable one, such as creating mobile hospitals that provide care rather than requiring the patient to go to an expensive and static hospital location. This will reduce the cost, as the cost to run one hospital will be broken into multiple mobile hospitals.

Find a way to eliminate, reduce, or prevent Poor waste disposal in order to avoid Unsanitary conditions.

- By moving a new dimension, unsanitary conditions due to poor waste disposal can be eliminated. Mini-incinerators will be brought to individual hospitals where the facilities can eliminate their waste on site eliminating the unsanitary conditions before they start.

Find a way to eliminate, reduce, or prevent Less diagnostic equipment under the conditions of Poor healthcare system.

- To prevent limited diagnostic equipment supply in a poor healthcare system, use the continuity of a useful action, where the action is medical device donations, and the continuity is using the different parts of the broken medical device equipment to create new ones.

Find an alternative way to obtain Low costs for hospitals that does not require Cheap supplies.

- This contradiction can be solved with local quality. Government donations will fund the supplies need to obtain lost costs to the hospitals, thus placing each part of the system under conditions most favorable.

Test for Novelty:

After performing a patent search to test for novelty, we found that there is no patented process or object that is similar to our idea.

Reduce Idea to Practice with Function-Means Diagram

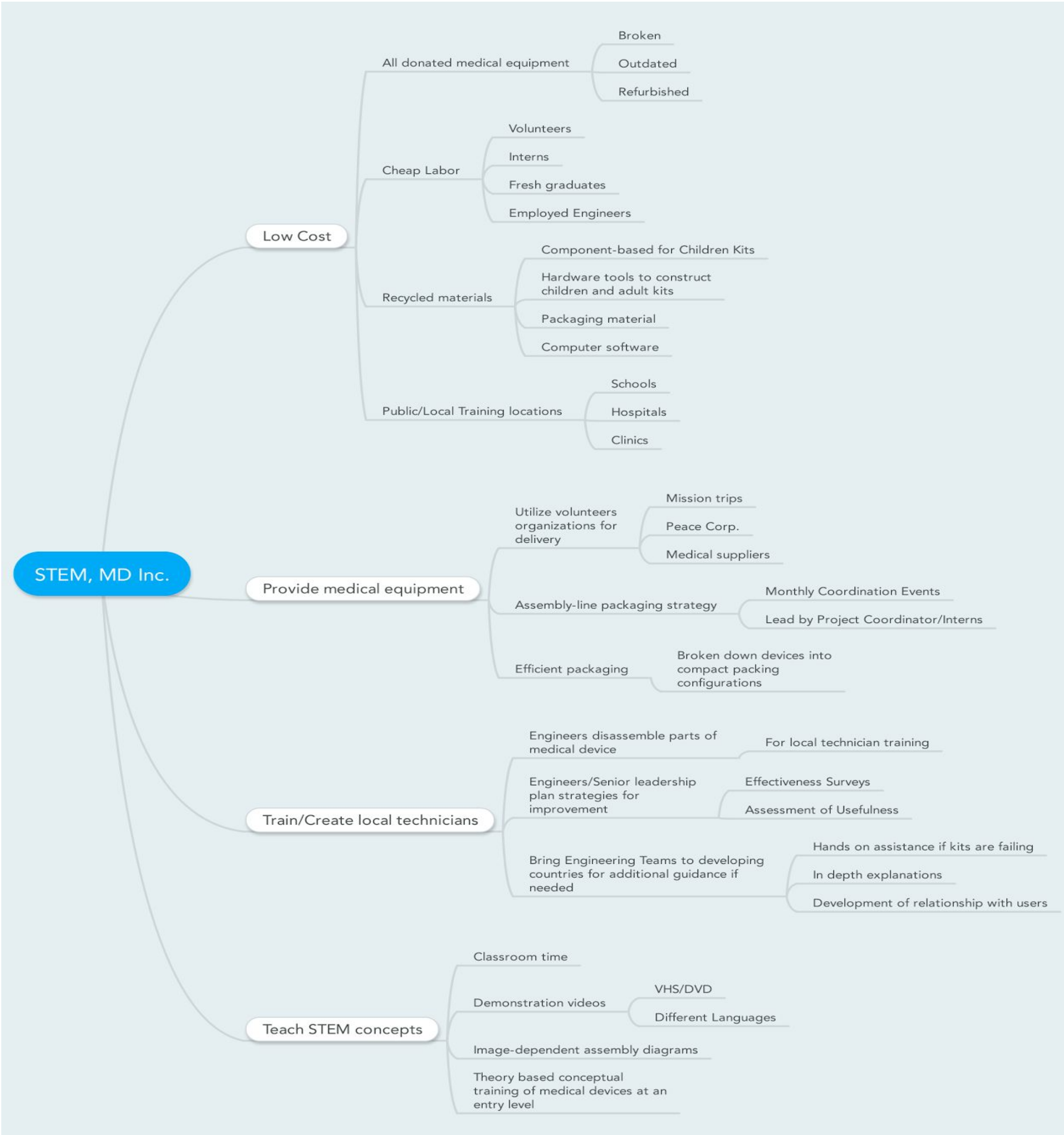

Figure 6. The Function-Means Diagram for STEM, MD Inc.

Failure Analysis

- The user is unable to reassemble functioning machines after the disassembly process
- The kits are left unused resulting in material wasted

- The material in the Medical Device Learning kits is toxic to children
- The materials are broken when shipped
- STEM, MD Inc. turns into a “for-profit” organization
- The workers are unable to understand the picture diagram and cannot assemble the medical devices
- There’s not enough willing medical device engineers to hire or volunteers committed to the work
- The assembly guides could be separated from the medical device kit resulting in no instructions to assemble device
- Medical devices could not work once they are constructed in the hospital
- The recycled materials could be poor quality
- The refurbished medical equipment could be toxic
- The packaging material could fail and result in broken material that is shipped overseas,
- The hospitals or classrooms could not be conducive for learning or allocate time to the employees for training
- The diagnosis could be improperly misinterpreted and the patient could be misdiagnosed, especially if the devices do not work properly
- The individuals who receive the kits could abuse STEM, MD Inc. and try to sell their kits for profit by filling out the effectiveness and usefulness surveys improperly
- The human resources, such as the doctors or people who deliver the supplies to the hard-to-reach regions, could not be supportive of the mission.

Final Assessment

STEM, MD Inc. disrupts the prevailing solution, which brings in trained professionals to fix and install broken devices. It teaches developing countries how to build and fix their own products without having to outsource to developed countries. The medical kits result in a new generation of medical device technicians by teaching children the components of different medical devices at a young age.

Envision the Future

Evolution with matching and mismatching elements:

Instead of providing developing countries with new, expensive medical equipment, STEM, MD Inc. provides donated machines. In addition, many of these machines are restored to their functioning state by taking different parts for different sources or even different models of the machine.

Evolution toward increased complexity followed by simplification (reduction):

The prevailing status quo involves donating medical supplies and devices to developing countries and outsourcing to other countries to fix the medical devices when they are broken. In the future, there will be a “do-it-yourself,” culture in the developing countries. They will understand the components of medical devices and learn how to create medical devices from resources they have available in their own country to create devices that accomplish the same goals as the devices that developed countries use more expensive material to create.

Evolution toward micro-levels:

The medical devices commonly installed in hospitals are bulky and require expert technicians to use. The diagnostic results are specific to each device, and require rigorous training to be able to interpret. Already today, medical devices are becoming smaller and more mobile. In the future, the medical devices in hospitals will be smaller and stationary, and less complicated.

Evolution toward decreased human involvement:

The installation of STEM education of the youth in developing countries is dependent on the medical device learning kits. Instead of sending a trained professional to separate developing countries to educate the children, the learning kits replace the need for human involvement. Instead of verbally teaching the children, the the process of building the devices in the learning kits provides the teaching aspect.