Redesigning the Cutlery Dispensers at Chestnut Dining Hall

Word Count: 1995

1. Introduction

This brief identifies an opportunity in the cutlery dispensing system at Chestnut Residence. It discusses the stakeholders, explores existing solutions, and outlines requirements for a new sustainable design that would improve the health of students. The current dispensers, an array of metal cylinders that separate different metal utensils, are open-air, which promotes bacteria growth and are thus unhygienic. Currently, more hygienic cutlery dispensers are either unsustainable as they are designed solely for single-use plastics or do not have enough capacity for the dining hall traffic. This leads to Chestnut having to prioritize either sustainability or the health of students. Through multiple forms of primary research, including observation, surveys, and interviews, it was found that many students are dissatisfied with the current state of cutlery dispensing. A new design that improves hygiene while aligning with sustainability objectives would not only benefit the U of T community, but the environment as well.

2. Background

This section covers the existing conditions at Chestnut, studies that discuss the impacts of the current design on student health, and DfXs to be considered for potential solutions.

2.1 Existing Conditions

Currently knives, forks, and spoons grouped by type and placed handle up in an array of unlabelled metal cups. The utensils are in contact with each other and are open-air. Notable features include holes in the body of each cup. Each cup is removable from the slanted cup holder. Chestnut uses 4 metal arrays, each holding 8 metal cups in a 2 by 4 array.

Figure 1 - Cutlery dispensing system at Chestnut Dining Hall

2.2 Studies Regarding the Contamination of Cutlery

The design of open-air cutlery dispensers is an issue as “kitchen equipment kept in open baskets or trays in the open air are prone to contamination with bacteria” [4]. Likewise, a study conducted in 2014 by Seoul National University identified traces of bacteria in their cafeterias, both airborne and on the surface of utensils [1]. Data shows that the mean airborne bacteria concentration, a measure of bacteria presence, of over 20 food service operations to be 160.8±164.0 CFU (number of colony-forming units per cubic meter). Staphylococcus aureus, a bacterium that can lead to serious infections, was also detected, indicating a need for improved hygiene in university dining halls [15].

2.3 DfX’s to be Considered

When framing the opportunity, team values were discussed and taken into account to make the brief as meaningful as possible. It was mutually agreed upon that a solution should be made with hygiene, safety, sustainability, and effectiveness in mind as high-level objectives.

2.3.1 Df Hygiene

Design for Hygiene is an approach that centers on the designing and manufacturing of products or systems, which primarily focus on maintaining cleanliness and reducing the risk of contamination. In addition, “the hygienic facility should prevent food from being contaminated with other non-food substances, such as lubricants, coolants, and antimicrobial barrier fluids.” [7]

2.3.2 Df Safety

Safe design involves early integration of hazard identification and risk assessment methods to minimize injury risks throughout the product's life [14]. Four key principles of safe design are minimization, substitution, moderation and simplification.

Minimization: Reducing the exposure to hazards.

Substitution: Replacing one hazard with a lesser one.

Moderation: Using hazardous material under less-hazardous conditions.

Simplification: Underlines eliminating unnecessary complexities. However, nothing can be absolutely safe.

2.3.4 Df Sustainability

A sustainable design meets the needs of customers and shareholders but is also mindful of the life-cycle consequences of the product now and in the future. Specifically, sustainable designs cause minimal solid waste in use [13]. With this in mind, some of the reference designs are more sustainable than others, but none of them meet all the requirements that will be laid out.

2.3.5 Df Effectiveness

ISO 20282-1 defines the effectiveness of everyday products as the "accuracy and completeness with which users achieve specified goals." [8]

3. Stakeholders

The scope of stakeholders for this opportunity was narrowed to individuals who interact with the cutlery dispensers the most frequently, as well as the environment which was considered based on team values.

3.1 U of T Students

The individuals impacted the most are Chestnut residents who use the dining hall and cutlery daily. Students are exposed to contamination the most and thus are the primary stakeholders.

Survey results showed that 84.6% of respondents ranked the cleanliness of the dispensing system to be 3 or below on a scale of 1 to 5, with no respondents ranking it as 5 (see appendix A6). This further supports the need for a new solution. Similarly, the cleanliness of the cutlery itself was ranked a 3 or below by 76.9% of respondents (See appendix A5). When initially asked to describe the cutlery dispensing system, students made comments such as, "they are exposed to air," and, "[they are] just taken by hand," demonstrating their awareness of the unhygienic distribution system. Additionally, “single-use plastic is wrapped in more single-use plastic,” displays that the students recognize the sustainability concern and flaws with the dispensing system (Appendix A1).

3.2 Dining Hall Staff

Other important stakeholders are the dining hall staff. An interview with a staff member revealed that the cup holders are deep cleaned only at the beginning and of each term. It is a tedious task as all the cutlery and cups must be removed and placed in the dishwasher. This infrequent cleaning is due in part to staffing issues; however, the employee revealed that if there were an easier way to clean them, and proper training provided, they would likely be sanitized more frequently. (Appendix A7)

3.3 Environment

One major area of concern is the environment. According to a Forbes article, “Some estimates put the number of individual plastic utensils wasted at 40 billion per year in the United States alone” [10]. According to the dining hall staff, about 15% of students opt for plastic cutlery (Appendix A7). If this is extrapolated to 8 months (2 semesters), with 1000 students eating 2 meals a day, approximately 504 kg of plastic waste will be generated by Chestnut student’s use of single-use cutlery alone.

4. Requirements:

Df Sustainability			
<u>Objective 1</u>: Design should hold various dimensions of cutlery.	<u>Metric:</u> Dimensions of Chestnut cutlery: Forks: 19 x 2.3 x 1.5 cm Knives: 21 x 2 x 0.3 cm Spoons: 17.5 x 4 x 2.5 cm	<u>Constraint</u>: Must fit Chestnut cutlery dimensions	<u>Criteria</u>: More universal is better. Since there is no official standard for cutlery dimensions, the device should accommodate both smaller and larger cutlery than Chestnut’s.

Justification: It is crucial that the design can accommodate various dimensions of cutlery for longevity. If the cutlery is replaced with new sets and the design can't hold them, this would result in it being thrown out, creating unnecessary waste, and not meeting sustainability objectives [13].			
Objective 2: Design for cutlery of various materials.	Metric: Number of different types of materials that design can accommodate.	Constraint: Design must accommodate materials other than plastic.	Criteria: Accommodating more types of material is better (e.g. metal, paper, wood, etc.)
Justification: If designed for reusable cutlery, it would discourage the use of SUP and reduce solid waste in water streams and land, thus aligning with sustainability objectives [13].			

Df Safety			
Objective 3: Design should minimize potential cutting risks for the users of the dining hall who wish to retrieve cutlery	Metric direction in which utensil is dispensed	Constraint Cutlery should be dispensed either handle first or completely flat	Criteria N/A
Justification: It is important that the method of dispensary does not involve the tip of the cutlery being dropped directly into the hand, especially if it is a fork or knife, as this may put users at risk of cuts or punctures. The safest option is to have the user only interact with the handle of the utensil, but if injury does occur, it should be treated according to ICD-10-CM codes. [17]			
Objective 4: Design should be moving at appropriate speeds	Metric Speed of utensil dispensing in [cm/s]	Constraint Cannot be zero	Criteria Lower speed is better
Justification: If designed to have live parts, the speeds of components and, consequently, the speed of the utensil dropped should not be alarming to users. In reference to UL 751, "the factors to be taken into consideration in judging the acceptability of exposed moving parts are: d) The speed of movement of those parts."[16]			

<table>
<tr><td colspan="4">Df Effectiveness</td></tr>
<tr><td><u>Objective 5:</u>
The product should be able to cater to all of the Chestnut students at peak time.</td><td><u>Metric</u>
Amount of cutlery it can hold</td><td><u>Constraint</u>
The product should hold at least 100+50 forks spoons and knives each.</td><td><u>Criteria</u>
The more the better</td></tr>
<tr><td colspan="4"><u>Justification</u>: It is crucial that the system can hold enough cutlery to cater to all of the Chestnut students at peak time. An interview with staff found that at peak times they may cater to 100+ students at once.</td></tr>
<tr><td><u>Objective 6:</u>
Design should be easily operated</td><td><u>Metric</u>
i) Size of labels (font size)

ii) Time it takes to retrieve cutlery (seconds)</td><td><u>Constraint</u>
Must not take more than 3 seconds per utensil.</td><td><u>Criteria</u>
i) Larger labels are better

ii) Less time is better</td></tr>
<tr><td colspan="4"><u>Justification</u>: The current dispensing system is considered easier to use than alternative designs by students, where 38.5% ranked it first when asked to comparatively rank it to reference designs (see appendix A). However the system still has problems as summarized by the following quote, “It takes a lot of time to take out cutlery, there are no labels and I don’t want the ones that everyone’s touched.” For a busy cafeteria, an intuitive design is required so that users can efficiently take their cutlery. ISO 20282 [8] describes ease of operations as a task being completed within an acceptable task time. By observation, 3 seconds per utensil should suffice.</td></tr>
</table>

<table>
<tr><td colspan="4">DF Hygiene</td></tr>
<tr><td><u>Objective 7:</u>
The interior of the utensil dispenser must not be exposed to air.</td><td><u>Metric</u>
Area of opening [cm^2]</td><td><u>Constraint</u>
Must not leave the whole utensil open-air</td><td><u>Criteria</u>
The smaller the better.</td></tr>
<tr><td colspan="4"><u>Justification</u>: A sanitized utensil storage environment is essential. The utensils should not be exposed as passersby breathe, talk, and cough regularly. Therefore, leaving utensils open-air prompts the growth/transmission of bacteria. This would impact the health of students using the cutlery.</td></tr>
<tr><td><u>Objective 8:</u></td><td><u>Metric</u></td><td><u>Constraint</u></td><td><u>Criteria</u></td></tr>
</table>

The utensil dispenser should be easily cleanable.	Average amount of time to clean the surface and interior of the utensil dispenser.	Must be able to be disassembled and cleanable.	The quicker the better.
Justification: According to NSF/ANSI 2 “Food equipment”(IAPMO standard)[9]. Food zones for which IPC CIP is intended shall be designed and manufactured so that cleaning and sanitizing solutions may be circulated throughout the fixed system. Exact standard also applies for utensil dispensers since it can be regarded as a type of food equipment.			

5. Reference designs

5.1 - “Closed-Air” Dispensers

Figure 2 - Mind Reader Foundation Collection, 3-Compartment Utensil Dispenser [3]

This is perhaps the most hygienic method of cutlery dispensing. It is both enclosed and only allows for one utensil to be touched at a time. Although it meets objective 8, it fails to meet objective 2. This dispenser, and similar products, are designed to fit solely single-use plastic cutlery which generates unnecessary waste [3].

5.2 - “Sustainable” dispenser

Figure 3 - ANBOUXIT Utensil Holder for Spoons and Forks [2]

Although this design holds many types of cutlery, therefore meeting objectives 1 and 2, it fails to meet effectiveness objectives. The capacity of this dispenser and similar products is too small for the Chestnut dining hall. This design holds 108 utensils in total [8], but objective 6 states that the product should hold at least 150 utensils. Moreover, this design is open air which fails to meet objective 8.

6. Conclusion

In summary, the cutlery dispensing system at Chestnut dining hall is not as sustainable, effective, and hygienic as it could be. Existing alternatives are either sustainable or hygienic, but not both. This opportunity calls for a design that can fulfill the requirements laid out which would benefit the U of T community.

7. References

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S. Park *et al.*, "A Study on Bacterial Contamination of Cooking Environments of Food Service Operations at University of Seoul," *Journal of Environmental Health Sciences*, vol. 40, no. 2, pp. 88–97, 2014, doi: https://doi.org/10.5668/JEHS.2014.40.2.88.

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"ANBOUXIT Utensil Holder for Spoons and Forks, Cutlery Caddy with 3 Compartment, Kitchen Utensil Dispenser, Bamboo Cutlery Organizer Countertop, Plastic Cutlery Dispenser for Party, Wedding, Breakroom : Amazon.ca: Home," *www.amazon.ca*. https://www.amazon.ca/Compartment-Dispenser-Organizer-Countertop-Breakroom/dp/B0BRK5NPKX/ref=sr_1_1_sspa?crid=11HR9IH0ISKCL&keywords=cutlery+dispenser&qid=1697854167&s=kitchen&sprefix=cutlery+dispenser%2Ckitchen%2C115&sr=1-1-spons&sp_csd=d2lkZ2V0TmFtZT1zcF9hdGY&psc=1 (accessed Oct. 21, 2023).

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8. Appendix A: Primary Research

A1 Qualitative Survey Data

Survey Link:
https://docs.google.com/forms/d/e/1FAIpQLScxQSUQDETl4EC3NjVZSeDaaCeQ4cFa_aVKJdRaGt_TB0UKbw/viewform?usp=sf_link

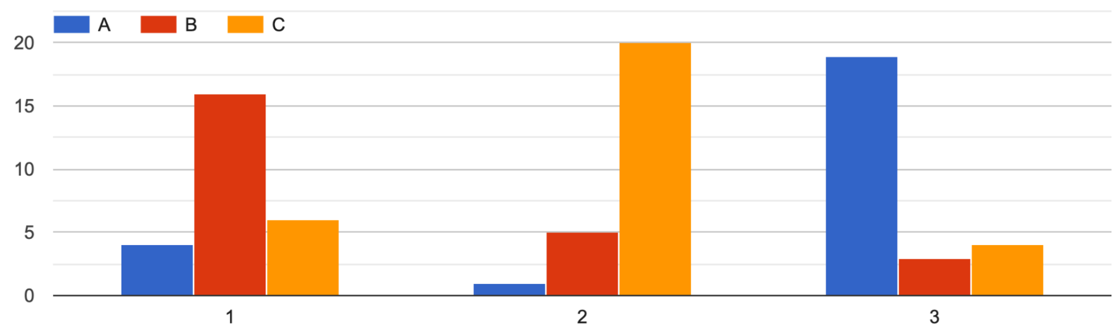
Year of Study	***Places they have eaten***	***Types of cutlery observed***	***Additional comments***
Year 1	Chestnut	Stainless Steel, Wood/bamboo, Single Use Plastic	

Year 1	Chestnut, New College, Robarts, Victoria College, Sid Smith, Med Sci Building	Stainless Steel, Wood/bamboo, Single Use Plastic	
Year 1	Chestnut	Stainless Steel	They are exposed to air
Year 1	Chestnut	Stainless Steel	
Year 2	New College, Campus One	Stainless Steel, Reusable Plastic, Single Use Plastic	By hand
Year 1	New College, Med Sci Building	Stainless Steel	
Year 1	Chestnut, Med Sci Building	Stainless Steel, Reusable Plastic	
Year 3	Robarts, Sid Smith	Stainless Steel, Reusable Plastic, Single Use Plastic	
Year 1	Chestnut, New College, Med Sci Building	Wood/bamboo, Reusable Plastic	
Year 1	Med Sci Building	Single Use Plastic	
Year 1	Campus One	Stainless Steel, Wood/bamboo, Reusable Plastic, Single Use Plastic	
Year 1	Chestnut, New College, Robarts, Campus One, Sid Smith, Med Sci Building	Stainless Steel, Wood/bamboo, Single Use Plastic	
Year 1	Chestnut, New College, Robarts, Sid Smith, Med Sci Building, Hard Hat Cafe	Stainless Steel, Wood/bamboo, Single Use Plastic	Places that could easily use reusable cutleries does not use reusable cutleries
Year 1	Chestnut, New College, Med Sci Building	Stainless Steel	They’re very bendy
Year 1	Chestnut, New College, Sid Smith, Med Sci Building	Stainless Steel, Single Use Plastic	single use plastic is wrapped in more single use plastic, people may be stealing some of the stainless steel cutlery at chestnut (it just seems like there’s less)

Year 1	Chestnut, New College, Robarts, Sid Smith, Med Sci Building, Hard Hat Cafe	Stainless Steel, Single Use Plastic	
Year 1	Chestnut, New College, Med Sci Building	Stainless Steel, Wood/bamboo, Single Use Plastic	
Year 1	Chestnut	Stainless Steel	
Year 1	Chestnut	Reusable Plastic	
Year 1	Chestnut, New College, Med Sci Building, Hard Hat Cafe	Stainless Steel, Wood/bamboo, Reusable Plastic	
Year 1	Chestnut	Stainless Steel, Wood/bamboo	
Year 1	New College, Robarts, Sid Smith	Stainless Steel, Single Use Plastic	
Year 1	Chestnut, New College, Sid Smith, Med Sci Building	Stainless Steel, Wood/bamboo, Single Use Plastic	
Year 1	Chestnut, Campus One, Sid Smith, Med Sci Building	Stainless Steel, Wood/bamboo, Single Use Plastic	
Year 1	Chestnut, New College, Med Sci Building	Metal, Wood/bamboo, Single Use Plastic	
Year 1	Chestnut, New College, Med Sci Building	Metal, Wood/bamboo, Single Use Plastic	

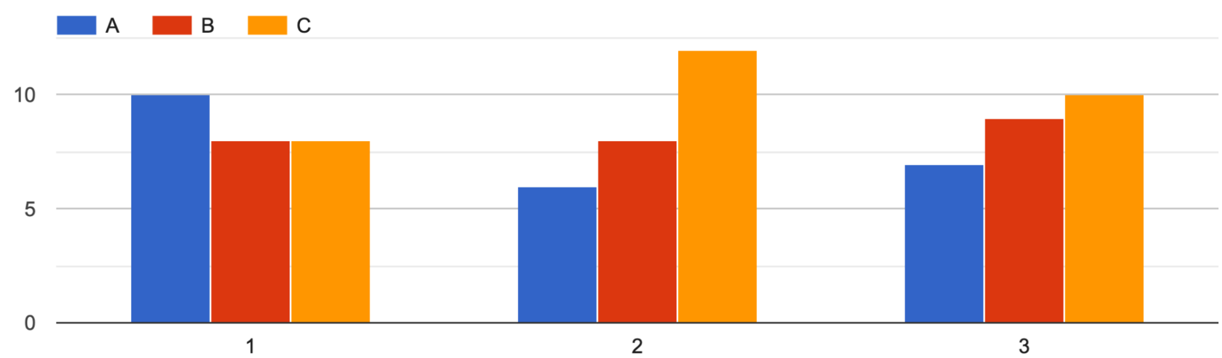
Appendix A2: Rank the Cutlery Dispensing System

Please rank the images of the cutlery dispensing systems on cleanliness



Appendix A3: Rank by Perceived cleanliness

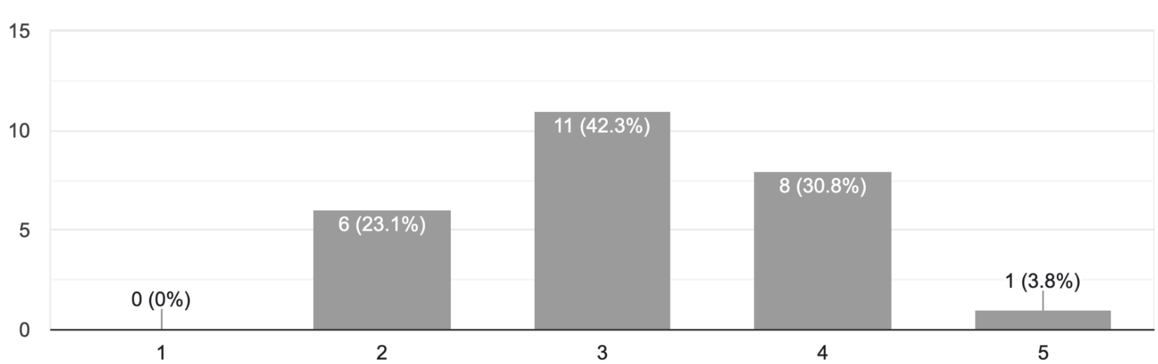
Please rank the dispensing systems on ease of use



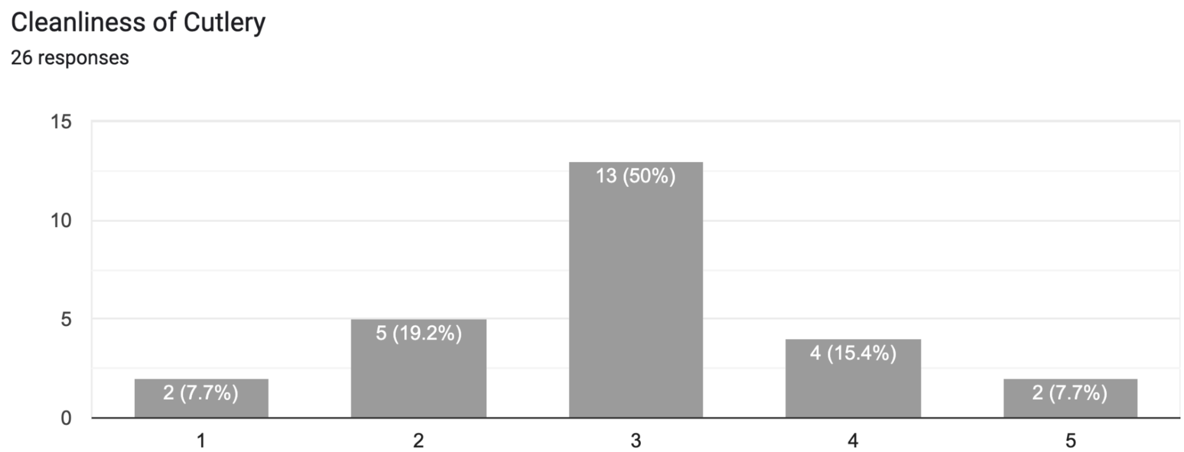
Appendix A4: experience eating at dining halls

Experience Eating at Dining Halls

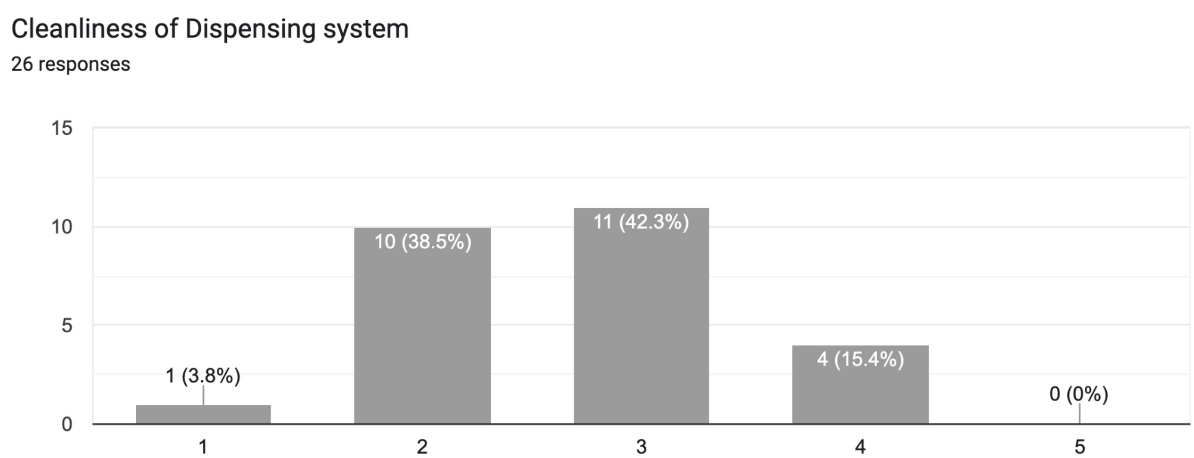
26 responses



Appendix A5: Cleanliness of cutlery



Appendix A6: Cleanliness of Dispensing system



Appendix A7: Interview with Staff

Interview with a dining hall staff member who wished to remain anonymous:

Question 1: What percentage of students opt for plastic cutlery?

Response: About 15%

Question 2: How easy is the cutlery holder to maintain? How often is it maintained?

Response:

- It is only cleaned at the beginning and end of the term.
- It is put through the dishwasher to be cleaned.
- There is not enough staff to deep clean the metal cup every time
- If there is an easier way to clean and it is explained properly they might do it more frequently

9. Appendix B: Source Extracts

Appendix B1: Df Safety Handbook[14]

Nothing can be made absolutely safe. There will always be risks involved in every task, whether at a drilling rig, out on an offshore platform, at a processing facility, or even at home. There comes a point, however, when the perceived benefits associated with an activity outweighs the risks associated with that activity. Acceptable risk is the level of potential consequences of some action or process that is deemed by the individuals or society to be tolerable given the benefits of the action or process. In the 1960s the Californian community, through the state government, accepted the risks of drilling off the southern California coast to tap into the oil reserves that lay in relatively shallow waters. Following the Santa Barbara oil spill of 1969, however, the community voiced its concern over the environmental consequences of an oil spill, and legalisation was passed to ban future oil drilling in that area. Thus, what had been deemed to be an acceptable risk by the community's representatives became unacceptable in the light of the accident.

12.3 Inherently Safe Design

In the 1970s and 1980s the design philosophy of inherently safe design emerged as a result of a number of incidents in the process industries. The philosophy is equally applicable to a number of aspects of petroleum engineering operations. The design of either a process, a facility or a procedure will be inherently safer if it avoids hazards completely rather than just seeking to control them. The key principles of inherently safe design are minimisation, substitution, moderation and simplification.

Minimisation: Reduce the exposure to a hazard by, for example, reducing the amount of hazardous material stored on site. As Kletz noted in 1978, "what you don't have can't leak". [5] Oil produced from a well should be moved away from the well as quickly as possible.

Substitution: Replace one hazard with another lesser one. This might be achieved by replacing a more hazardous material with one that is more environmental friendly.

Moderation: Moderation involves using hazardous material under less-hazardous conditions, or moderating the operation to reduce the hazard. Noisy flow lines and equipment might receive an acoustical treatment to muffle the noise. The road layout at an onshore drilling site might be designed so that trucks making deliveries of drill and casing joints do not have to drive through the operations area to make their delivery.

Simplification: Making a design as simple as possible, eliminating unnecessary complexities. This principle can be applied to the development of operational procedures by eliminating complex instructions, replacing them with clearer, simpler words that are unambiguous. Computer interfaces used by the operators to monitor and control any process, such as the drilling of a well should be designed to be easy to use, displaying all the required information clearly and unambiguously. Furthermore, all sites should be kept clean and free of clutter and unnecessary items.

Appendix B2: Df Hygiene Handbook [9]:

5.1.3 *Food zones shall be readily accessible and easily cleanable or shall be designed for clean-in-place ~~cleaning (IPC)~~ (CIP) when a readily accessible design is not feasible.*

5.1.4 *Food zones for which ~~IPC~~ CIP is intended shall be designed and manufactured so that cleaning and sanitizing solutions may be circulated or passed throughout the fixed system. The design shall ensure that cleaning and sanitizing solutions contact all food contact surfaces. The system shall be self-draining or capable of being completely evacuated. Equipment and appurtenances designed for CIP shall have a section of the cleaned area accessible for inspection or shall provide for other acceptable inspection methods. The manufacturer shall provide written instructions for the cleaning and sanitizing of all food zone surfaces for which ~~IPC~~ CIP is intended. The type and concentration of sanitizing agent recommended in the instructions by the manufacturer shall comply with 40 CFR §180.940.*

Appendix B3: Df Efficiency Handbook [8]:

4 Ease of operation

In this part of ISO 20282, ease of operation is defined as "the usability of the user interface of an everyday product when used by the intended users to achieve the main goal(s) supported by the product". The focus on user interfaces is to reflect the situation that, while there are many factors that may have important effects on usability, all interactive products will have a user interface, and the quality of the user interface can have significant positive and negative effects that facilitate or hamper the usage of the product and thereby its adoption.

Ease of operation means that users should be able to achieve their main goals

— with a high success rate (effectiveness of operation),

— within acceptable task times (efficiency of operation), and

— with an acceptable level of satisfaction with operation.

In order to achieve ease of operation, the crucial factor is effectiveness of operation. This is because the tasks associated with achieving the main goal of use of an everyday product involving the user interface are generally fast and of low complexity, and so improvements in efficiency or satisfaction will not usually be of practical importance.

When designing for ease of operation, it is important to achieve high levels of success for first-time users, because users must be successful in using the product the first time before they can use it continuously.

Appendix B4: Df Sustainability [13]:

Attributes of a Sustainable Design

A sustainable design:

- Efficiently incorporates environmentally preferred materials and finishes
- Requires a minimal consumption of resources in all stages of the product life cycle, including energy, water, and other resources in manufacturing; consumables in use; and natural footprint (such as land for disposal) at the end of life
- Minimizes the material content in products
- Uses green chemistry-based materials and avoids materials that upset the ecosystem in production and use
- Uses recycled material and refurbished assemblies and components
- Minimizes the use of dissimilar materials
- Allows its components to be reused and its materials of construction to be separated and recycled at the end of a product's life (recycling technology is rapidly advancing, and design engineers must be aware of best practices and the possibilities of recycling)
- Causes minimal solid, liquid, and gaseous discharge into the atmosphere, water streams, and land in manufacturing and in use
- Has a long life, is repairable, and is efficient in use (requiring the least amount of energy and other consumables without harmful emissions)
- Can be upgraded to extend the product's life
- Has high reliability and maintainability with low cost of repair
- Is in harmony with people and nature at the point of use
- Is optimized across time and space by using LCA to assess the product's environmental impact and to prioritize design decisions
- Both sustainability and commercial viability criteria are used in design decisions to ensure that the product enhances customer's well-being

Appendix B4 - "Bacterial contamination of crockery and cutlery within the kiosks' restaurants of the Federal University of Technology, Yola,": [4]

Table 3a. Determination of TBC (cfu/ml) of different samples.

Equipments	A	B	C	D	E	F	G
Plates	1.2×10^4	2.5×10^6	1.4×10^4	4.3×10^5	1.1×10^5	1.1×10^4	1.4×10^4
Spoons	4.5×10^4	1.0×10^4	3.0×10^5	4.7×10^5	1.4×10^5	1.5×10^4	3.3×10^4
Forks	3.0×10^4	7.0×10^4	5.2×10^4	2.2×10^4	1.6×10^5	1.8×10^5	5.0×10^4
Knives	1.0×10^4	9.5×10^4	3.3×10^5	3.3×10^4	2.0×10^4	1.3×10^5	2.5×10^5
Cups	1.1×10^5	1.0×10^4	2.5×10^5	3.0×10^5	1.0×10^5	4.1×10^4	1.1×10^4
Washing pots	1.5×10^4	1.4×10^5	3.0×10^5	1.0×10^5	4.7×10^4	4.5×10^4	1.5×10^4

Key:-A – Restaurant 1; B – Restaurant 2; C – Restaurant 3; D – Restaurant 4; E – Restaurant 5; F – Restaurant 6; G – Restaurant 7.

improvement in the hygienic condition of the restaurant cannot be over emphasized. Towels provide an ideal environment for bacteria to grow and habour. Wet towels can habour potentially harmful organisms and become breeding grounds for bacteria (www.foodsafetymatters.gov.au, 2004). The use of towels in a kitchen can cause the spread of bacteria to hands, equipment, crockery and cutlery (www.foodsafetymatters.gov.au, 2004). Harmful organisms can not only survive, but continue to grow in contaminated towels which remain damp. *E. coli, P. vulgaris, Klebseilla* sp. and *Shigella* sp. are bacteria that were most frequently isolated from the restaurants (Steward, 1976) with no or low hygiene, some of them like *Klebseilla* sp and *Proteus vulgaris* are frequent causes of urinary tract infections, though they are usually associated with some underlying predisposing factors in the urinary tract (Nester et al., 2004)

The total values of bacterial count (TBC), cfu/ml of the samples were in the range of 1.1×10^4 - 3.0×10^5 for cups, 2.2×10^4 -1.6×10^5 for forks, 1.0×10^4 -3.3×10^5 for knives, 1.2×10^4 - 2.5×10^5 for plates and 1.5×10^4 - 4.7×10^5 for spoons cfu/ml (Table 3a). The TBC values are significantly different as the items (spoons, forks, Knives, cups, plates, washings of pot) vary in each restaurant (Table 3b). The TBC values are also significantly different for the items among the restaurants (Tables 3c, d, e and f). According to Collins and Patricia (1979), standard for crockery and utensils in the U.S.A., Public Health Service requires counts of not more than 5.0×10^4 and 2.5×10^5 cfu/ml per container as fairly satisfactory and over 2.5×10^5 cfu/ml as unsatisfactory. This implies that count above 2.5×10^5 cfu/ml is a contamination. In case of restaurant no. 3, the TBC count of *E. coli* for knives was 3.3 x s105 and in case of restaurant no. 4 and no. 5, the TBC values for plate and spoon were 4.3×10^5 and 4.7×10^5 respectively. These values were higher than the recommended values. These high bacterial densities in such restaurants suggested that kitchen equipment kept in open basket or trays in the open air are prone to contamination with bacteria. Food-borne disease through contaminated crockery and cutleries are major causes of morbidity throughout the world (WHO, 1984).

Microorganisms that contaminate these equipments damage the caterer's reputation, sometimes beyond repair and eventually ruin his business. It is in view of these findings tourist are advised to utilize restaurants that are hygienic. It is always safer and easier to prevent the contamination of these kitchen equipment. It is more difficult to make the equipments safe again. Infection by food poisoning organisms is a threat requiring constant vigilance unless kitchen equipment that comes in contact with food are adequately cleaned and sanitized; it may still be an important source of contamination of food. Not only may organism persist on kitchen equipment, but they may increase in numbers when treatment has been inadequate.

In conclusion the study has shown that the higher the bacterial densities were found in plates, spoons, drinking cups, forks and cutting instrument used at the dining table, most especially in restaurant D and F were high (shown in Table 3a) compare to the standard set by the USA Public Health Services (Collins and Lyne, 1979). These high bacterial densities in such restaurants suggested that the sources of contamination included water and food sources that were inadequately removed during routine cleaning. Six organisms were identified by their appearance on medium of which three bacteria species were gram negative rods namely; *E. coli, P. vulgaris, and Klebseilla sp*. The gram positive rod identified was *Bacillus sp* while *Staphylococcus aureus* was the only gram positive cocci.

Biochemical tests were carried out to identify the organisms on MacConkey agar. The tests included citrate, coagulase, indole, Catalase, motility and KIA. As a result of these seven (7) organisms were isolated. These tests indicated that the following isolates were present; *S. aureus, Klebseilla* sp, *E. coli, Shigella* sp, *Salmonella typhi, P. vulgaris and Bacillus* sp. The best way to protect public health is to enhance sanitation control. It is also good for chefs and hotels waiters never to use any kitchen equipment without 'sterilizing'. Thelma

Appendix B5 - "A Study on Bacterial Contamination of Cooking Environments of Food Service Operations at University of Seoul": [1]

Table 6. Concentrations of total airborne bacteria in the cooking areas of 20 foodservice operations

Unit: (CFU/m3)

Food Service Operation	Airborne bacteria
A	127.2
B	431.1
C	551.2
D	353.4
E	332.2
F	106.0
G	7.1
H	134.3
I	49.5
J	63.6
K	0.0
L	127.2
M	21.2
N	311.0
O	56.5
P	42.4
Q	14.1
R	332.2
S	148.4
T	7.1
Mean±SD(range)	160.8±164.0(ND-551.2)

Bacteria were detected on knives in a total of 8 restaurants, and more than 3 log CFU/100 cm2 of general bacteria were detected on cutting boards in 2 restaurants out of a total of 20 restaurants. In addition , more than 3 log CFU/100 cm2 of general bacteria were detected on the floor of the cooking area and 6 drains in 10 restaurants , and S. aureus was also found in many restaurants, so hygiene management such as regular cleaning and disinfection is urgently needed. It was

Results: We detected bacterial indicators on knives or chopping boards in eight different food service operations and, three food service operations(I, M, and O) showed more than 3 log colony forming units(CFU)/ 100 cm2 on their knives, significantly higher than others. The levels of bacterial indicators on the floors and drains in the cooking areas were much higher than those on the cooking utensils. S. aureus was detected on 10 floors and 8 drains. Culturable bacteria were identified in 5 drinking water samples, and food service operation B (431.1 CFU/m3) and C(551.2 CFU/m3) showed more than 400 CFU/m3 of total airborne bacteria.