



Influence and Role of Technology on Stress: A Mathematical Analysis

Dr. M.S.Saleem Basha¹, Dr. Esam Al Lawati², Mrs. Gargi Bhattacharya³ and Dr. Nasir Ahmed Khan⁴

¹Assistant Professor, Department of Computer Science, Mazoon University College,
Muscat, Sultanate of Oman.

²Assistant Professor, Department of Business, Mazoon University College, Muscat, Sultanate of Oman.

³Assistant Professor, Department of English, Mazoon University College, Muscat, Sultanate of Oman.

⁴Professor, Department of Quality Assurance, Mazoon University College, Muscat, Sultanate of Oman.

Abstract: *This paper reviews the possible reason of stress which is encountered in all the spheres of our lives. Human beings have to combat with stress in their daily situation. We must first analyze the cause of stress, then try to find effective solution for the same. This paper also analyzes the difference between the use of technology in the previous industrial fields and the modern updated computer softwares. The discussions made in the paper are supported with the minmax theorem and its mathematical derivation.*

I. Introduction

Stress has become a part of modern existence. Human beings encounter stress in their family, due to difference of opinion among the family members, in their work place because of the anxiety produced from excessive work load, and also in the social lives when we are confronted with uncertain circumstances. The effect of the stress is multi dimensional. Most of the times the signs and symptoms of the mental stress are evident in the body and physical activities. Stress should be controlled otherwise it can lead to harmful consequences like interrupted sleep, diabetes, high blood pressure and other health problems. When people over use technology, then they lose their capacity to motivate themselves in their surroundings. The balanced use of technology can increase our efficiency. However, techno mania or excessive addiction to technology may have adverse consequences. The idea of the people that machines can replace human skills has become outdated. Modern technology, the multimedia, upgraded computer softwares demand the role of the human brains to complement them. The modern role of technology thus, depends more on the efficient functioning of the human minds to make it a success.

II. Background Work

The demand of the body is expressed through the symptoms of stress. Excitement can be the impact of both positive and negative experiences. The result of stress can be the release of certain harmful chemicals in the blood. Stressed men or women are seen both in family and workplaces. Sometimes the chemicals are considered positive, especially when they give us strength and energy in dangerous situations. Stress can be negative when it is caused by emotional setbacks and psychological problems.

Thus, we can define stress as both a mental and external or physical response to certain changes in our lives. It is a signal to suggest adaptations to the changing and challenging circumstances of our lives. It is a type of stimulus that makes our bodies to react to certain social, psychological or physical events.

The factors that influence our reactions to stress are as follows:

1. The type of stress, whether it can be controlled or predicted.
2. The biological vitals such as age or gender.
3. Recurrence of events and the frequency of similar experience [1].

The effects of stress can be tangible such as deduction from salary. It can be intangible also such as the feeling of anxiety when one gets an invitation from the legal one gets an invitation from the legal court for the first time. We can enumerate the physical effects of stress in the following points:

- a) *Cardiovascular disease (CVD)*: Research has revealed the impact of chronic stress on blood pressure, frequency of heart attacks etc. [2].
- b) *Weight gain*: Stressed people are prone to gain weight faster than the general increased stress optimized the production of cortisol in the blood stream. This results in enhanced hunger and activates the fat storing enzymes [3].
- c) *Diabetes*: Stress must be controlled to prevent the development of diabetes. Anxiety and stress may result into diabetic problems. Uneven sleep, interrupted eating habit etc. endanger a person's life with diabetes [4].
- d) *Effect on the mind and intellectuality*: When the mind is stressed then it loses its capacity to think and act sensibly. On the contrary, the productivity of the mind, the power to focus and concentrate increases when the mind remains stress free. So, indirectly stress effects our career.

e) *Memory and concentration*: The short term memory of the human mind is adversely affected with the production of the key stress hormone known as “cortical”. Cortical leads to the shrinking of the hippocampus, the major memory centre of the brain [5].

f) *Insomnia*: The importance of a sound sleep is often ignored by the people. Sleep refreshes the mind to face new challenges of the life. Sleeping disorders may debilitate the ability of the mind. Without adequate sleep the vitality of the brain cannot be restored. Restricting the sleep may result in attention lapses, reduced recognition power, forgetting things easily etc. The performance is enhanced with proper sleep [6].

The psychosocial causes of stress can be noted in the following way:

This refers to the daily work pressures attributed to our social and physical environments.

a) *Hassles*: The inevitable problems of our life which cause petty annoyances are collectively referred to as hassles. Some common examples are loud music, traffic hazards, paucity of parking areas, excess work load etc. These all trigger our anger and frustrations.

b) *Techno Stress*: This symptom is common with the people who excessively depend on technology. Technomania is prevalent among the modern generation. People in modern age use the technology in all spheres of life from entertainment, casual activities to serious work. However, obsession with technology may lead to distracted driving. Interestingly, the researchers like Michel Weil and Larry Rosen have mentioned about; “Technosis” which is a syndrome where people are so addicted using technology that they can even risk their lives [7].

It is mandatory for the users of technology to set limits and give adequate time to face to face interaction with people. Virtual relationships may have loop holes and cannot foster intimate relationships. It is common in our busy schedules that we don’t answer our phones immediately or postpone our replies to emails. Discussing the problems face to face sometimes help us more than trying to solve them virtually.

c) *Frustrations and Conflicts*: Frustrations occur when the people are unable to achieve their goals as they had decided. Conflicts may be defined as the compulsion to choose among competing desires, instincts and behavior. When the immediate demand of the situation is incompatible with our values or there are contradictions in values among the colleagues, then also conflicts may occur.

III. Proposed Mathematical Model for Stress Influence by Technology:

The current relationship between humans and machines is quite different than what can be assumed to be used before in business and industries, the previous automated technology targeted mainly the replacement of manual skills. Engineers in the factories mechanized the production methods. Some humans were there to attend the operation of the machines. Thus, the role of the humans became subordinate to the machines. The new technology on the contrary, requires diverse human skills without attempting to replace them. Thus, in the modern concept machine and human beings complement each other. The use of modern technologies such as the mobile phones, ATM machines, computers etc. depend on the successful functioning of the human mind rather than the physical labour. So it is not appropriate to think the modern computer aided technology has reduced the mental work load. On the contrary, modern technology has increased the work of the mind while weakening the social support [8].

The major factors influencing the stress due to technology for human kind are:

1. Social interaction on Technology
2. Internal Factors
3. External Factors
4. Lack of Understanding of Technology
5. User Friendliness

The above five factors are the major concerning with the stress on the human kind due to the influence of the stress. Considering the above factors a mathematical model has been proposed in the forth coming section. The above factors are purely a non functional attributes and cannot be quantify the values or cannot be judges but can be empirically derive base on the mathematical model.

The formulation of mathematical model

The proposed mathematical model can be represented in terms of MinMax method. It is a mathematical method for the solution and assignment of decision rules in the non functional parameters and components. In theory, MinMax method can be used to minimize the possible loss in a worst case context. First, it was applied in a small scale while abiding by the rules and regulations of the decision. Later, MinMax method was applied to solve complex decision at the time of uncertainty.

This theorem was established by John von Neumann, who is quoted as saying "As far as I can see, there could be no theory of games ... without that theorem ... I thought there was nothing worth publishing until the Minimax Theorem was proved"[9].

The above stated factors can be formalized in a mathematical model as follows and these are the minmax function of ‘x’, this can be written as:

$$\text{Minmax}(F(x)) = (f(x), f(y)) \quad (1)$$

where,

$f(x)$ is the direct factor influencing the stress.

$f(y)$ is the indirect factor influencing the stress.

$$f(x) = \{IF_1, IF_2, IF_3, IF_4, IF_5\} \quad (2)$$

where,

IF is the Influencing Factor.

$f(x)$ can be visualized in two folds namely summation and product properties

1. Summation Properties

$$f(x) = \sum_{i=1}^k (IF_i) \quad (3)$$

where,

n is the form factor for the each IF's

k is the total number of IF's

$$\min f(x) = \min \sum_{i=1}^k (IF_i) \quad (4)$$

$$\min. f(x) = \min \sum_{i=1}^k d(IF_i, IF_{(i+1)}) \quad (5)$$

where,

d is the min term constant

2. Product Properties

$$f(y) = \prod_{i=1}^k n(IF_i) \quad (5)$$

$$\max f(y) = \max \prod_{i=1}^k n(IF_i) \quad (6)$$

$$\max f(y) = \max \prod_{i=1}^k r(IF_i, IF_{i+1}) \quad (7)$$

where,

r is the max term constant

3. Relating r and d

By using Cauchy's mean theorem, the product of five IF's of constant sum attains the maximum value at

$$d = \sqrt[5]{IF_1 * IF_2 * IF_3 * IF_4 * IF_5} \leq \frac{IF_1 + IF_2 + IF_3 + IF_4 + IF_5}{5} \quad (8)$$

Similarly, by Cauchy's mean theorem the sum of 5 IF's of constant product attains the minimum value at

$$r = \sqrt[5]{IF_1 * IF_2 * IF_3 * IF_4 * IF_5} \leq \frac{IF_1 + IF_2 + IF_3 + IF_4 + IF_5}{5} \quad (9)$$

Therefore,

$$\frac{IF_1 + IF_2 + IF_3 + IF_4 + IF_5}{5} \geq r \quad (10)$$

$IF_1 + IF_2 + IF_3 + IF_4 + IF_5$ is always at least five times of r and equals to five times of r only when $IF_1 = IF_2 = IF_3 = IF_4 = IF_5 = r$.

Equating and relating 'd' and 'r' of equation (8) and (9),

If $C \in (d, r)$ also if f is continuous on (d, r) and differentiating (d, r) will yield

$$f'(C) = \frac{f(r) - f(d)}{r - d} \quad (11)$$

IV. Analysis

All the implementations are done using MATLAB 7.13 (2011). The instances that have been chosen for experimentation are collected from individual experience and have been assigned the value empirically for the analysis purpose. A stress matrix is generated for every instance with maximum utilization of the technology which the individual has.

Sl. No.	Parameter	Value / Method
1.	Number of individuals	150
2.	Task Given to the individuals	40
3.	Termination condition	Based on the saturation of the individuals.

Saturation for the individuals:

The individual is given with a task to complete within the specified time. During this task completion process, to predict the saturation point for the individual due to stress is obtained by the problem solving and repeated questionnaires to the individual. The Individual is asked by simple arithmetic calculations, the individual have to answer to the arithmetic within 5 seconds also answer to the simple and general questions. The individual can able to answer to those questions quickly if their mental stress in under control and takes more time to answer if the level of stress increases. Once the time taken to answer is increased, which means that the person is on stress. For the analysis purpose the time was extended upto 5 times. Beyond it is concluded that the individual is saturated. Further the number of task to be completed is increased gradually until 40 tasks, and correspondingly the time period also increased to complete the task. All the task is related to computing with technology. For example to format a word file, searching for a particular mail in the spam or inbox. If the individual was fluent in the technology and computing facility then he can complete the task soon than those who are not familiar with those facilities and may be searching for the options and buttons to complete the task. This opens the room for stress in their work.

Table 1: Analysis of Stress with the Effect of Technology

Instance	Optimal Solution	Computation Time	Quality of the Solution			Convergence Rate (%)			Error Rate (%)			Convergence Diversity
			Best	Worst	Average	Best	Worst	Average	Best	Worst	Average	
2	2.24	4.86	5.34	9.12	7.23	-38.39	-207.14	-122.77	138.39	307.14	222.77	-168.75
	2.62		5.42	9.18	7.3	-6.87	-150.38	-78.63	106.87	250.38	178.63	-143.51
4	3.72	7.63	7.12	10.1	8.61	8.6	-71.51	-31.45	91.4	171.51	131.45	-80.11
	3.91		7.29	10.29	8.79	13.55	-63.17	-24.81	86.45	163.17	124.81	-76.72
6	4.52	9.07	8.66	11.33	10	8.41	-50.66	-21.24	91.59	150.66	121.24	-59.07
	4.55		8.86	11.48	10.17	5.27	-52.31	-23.52	94.73	152.31	123.52	-57.58
8	5.63	11.59	9.71	12.29	11	27.53	-18.29	4.62	72.47	118.29	95.38	-45.82
	5.96		9.82	12.31	11.07	35.23	-6.54	14.26	64.77	106.54	85.74	-41.77
10	7.68	15.97	10.59	13.27	11.93	62.11	27.21	44.66	37.89	72.79	55.34	-34.9
	8.29		10.93	13.28	12.11	68.15	39.81	53.92	31.85	60.19	46.08	-28.34
12	9.01	18.04	11.72	14.19	12.96	69.92	42.51	56.16	30.08	57.49	43.84	-27.41
	9.03		11.73	14.21	12.97	70.1	42.64	56.37	29.9	57.36	43.63	-27.46
14	9.96	20.05	12.67	15.55	14.11	72.79	43.88	58.33	27.21	56.12	41.67	-28.91
	10.09		12.93	15.67	14.3	71.85	44.7	58.28	28.15	55.3	41.72	-27.15
16	10.99	22.15	13.84	16.56	15.2	74.07	49.32	61.69	25.93	50.68	38.31	-24.75
	11.16		13.92	16.61	15.27	75.27	51.16	63.17	24.73	48.84	36.83	-24.11
18	12.01	24.1	15.11	17.89	16.5	74.19	51.04	62.61	25.81	48.96	37.39	-23.15
	12.09		15.12	17.93	16.53	74.94	51.7	63.28	25.06	48.3	36.72	-23.24
20	13.07	26.22	16.05	18.47	17.26	77.2	58.68	67.94	22.8	41.32	32.06	-18.52
	13.15		16.05	18.83	17.44	77.95	56.81	67.38	22.05	43.19	32.62	-21.14
22	14.02	28.05	17.25	20.1	18.68	76.96	56.63	66.76	23.04	43.37	33.24	-20.33
	14.03		17.28	20.7	18.99	76.84	52.46	64.65	23.16	47.54	35.35	-24.38
24	15.16	30.45	18.05	22.16	20.11	80.94	53.83	67.35	19.06	46.17	32.65	-27.11
	15.29		18.06	22.38	20.22	81.88	53.63	67.76	18.12	46.37	32.24	-28.25
26	16.26	32.74	19.19	23.58	21.39	81.98	54.98	68.45	18.02	45.02	31.55	-27
	16.48		19.49	23.65	21.57	81.74	56.49	69.11	18.26	43.51	30.89	-25.25

28	17.51	35.34	21.27	24.15	22.71	78.53	62.08	70.3	21.47	37.92	29.7	-16.45
	17.83		21.58	24.25	22.92	78.97	63.99	71.45	21.03	36.01	28.55	-14.98
30	18.28	36.63	22.93	25.47	24.2	74.56	60.67	67.61	25.44	39.33	32.39	-13.89
	18.35		23.19	26.06	24.63	73.62	57.98	65.78	26.38	42.02	34.22	-15.64
32	19.7	39.64	23.83	29.16	26.5	79.04	51.98	65.48	20.96	48.02	34.52	-27.06
	19.94		23.96	30.38	27.17	79.84	47.64	63.74	20.16	52.36	36.26	-32.2
34	23.25	46.6	24.83	31.58	28.21	93.2	64.17	78.67	6.8	35.83	21.33	-29.03
	23.35		25	34.65	29.83	92.93	51.61	72.25	7.07	48.39	27.75	-41.32
36	23.97	48.04	26.46	35.15	30.81	89.61	53.36	71.46	10.39	46.64	28.54	-36.25
	24.07		27.34	39.25	33.3	86.41	36.93	61.65	13.59	63.07	38.35	-49.48
38	25.08	50.23	29.46	43.47	36.47	82.54	26.67	54.59	17.46	73.33	45.41	-55.87
	25.15		32.34	47.06	39.7	71.41	12.88	42.15	28.59	87.12	57.85	-58.53
40	26.56	53.4	35.99	53.97	44.98	64.5	-3.2	30.65	35.5	103.2	69.35	-67.7
	26.84		36.1	55.54	45.82	65.5	-6.93	29.28	34.5	106.93	70.72	-72.43

The figure 1 and figure 2, shows that, initially for two task the convergence diversity is high negative value. It means that the individual is mentally relaxed and stress is negative. Once if the given task increases the stress also increases. This increase in stress is clearly shown in the graph, the point moves from high negative towards the positive. If we increase the task the stress also increases, this increase can be noticed in that graph that the point keep on moving towards the positive number. At certain point of time stress, the individual will be saturated and stress will be at maximum. In the figure 1, stress attains the maximum at 30 task and the stress value is -13.89. After attaining maximum stress the individual get saturated and fails to concentrate to finish the task and loses the interest. Then, of course the stress keeps reducing.

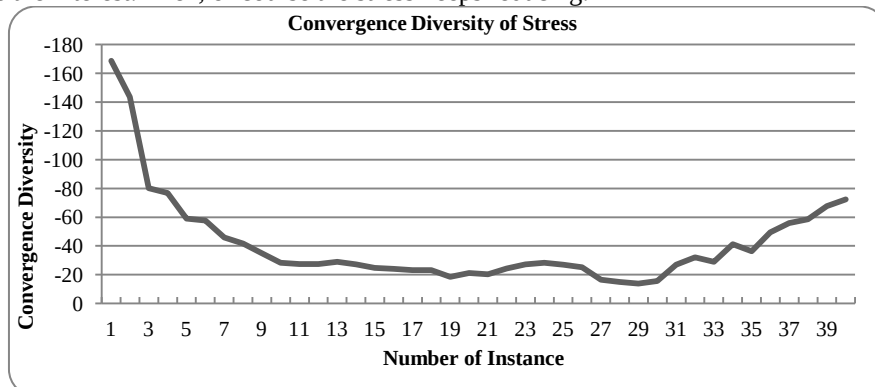


Figure 1: Graph Between Number of Instance And Convergence Diversity

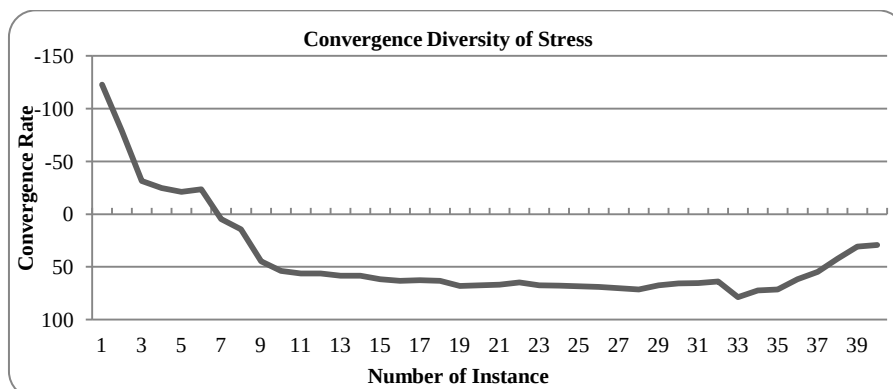


Figure 2: Graph between Number of Instance and Convergence Rate

V. Conclusion

The advent and sophistication of the technology is to brighten the human life and to minimize the man-hour effort. The goal of each and every technology is also the same as said earlier. Unless until the intended user have not trained or educated how to use the technology, the goal of such technology may not be achieved. The ease of

use of technology without any stress will be got by the fluency of such technology to be used. Instead, proposed analysis shows that the cause for the stress is mainly depends on the illiteracy about the technology.

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