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Technology and its Place In Islamic Civilization

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Knowledge production, science and art have only been offered to the service of humanity by the nations that have magnificent civilization and culture in history. Nations with such a civilization and culture could raise knowledgeable people who contribute to universal humanitarian work. These important people have been recognized and respected as members of all nations, regarded as values for the entire humanity. For, knowledge and systematic data produced by such great persons provide benefits not only to their own communities but also to many different nations and cultures that accept them. Knowledge and scientific concepts have always been present throughout history of man and gradually developed into what they are today. Not every culture and civilization have participated this progressive process. On the other hand, many different nations and cultures have carried these knowledge to their communities and benefit from it greatly. In the course of history, scientific and technological developments never stopped but slowed down and kept on moving forward. The only thing that changed has been the civilizations and cultures that performed these developments. For this reason we can trace the movement of technology in different cultures, in Egypt, Mesopotamia (Babel, Akkad, and Sumerians), and Ancient Greece, Islamic civilization (Arabs, Persians and Turks), Europe (different nations) and American societies. All these cultures have acquired scientific heritage of others and developed further. The same civilization and culture is not always blessed with this precious gift. This is an interesting phenomenon which should be investigated in a detailed manner. Civilizations which have failed to contribute to development of knowledge, science and technology shall start to evaluate their past and to reconsider the elements that prepare the ground

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for the emergence of science and technology. They should also know that the cultures and worldviews of nations play a primary role in this process. Important conclusions can be acquired by looking at production of information, science and technology by societies. Therefore, a nation cannot put its sign to sustainable, fundamental scientific studies without strong moral values, culture, religion and a belief system.[2] People may believe in the illusion that may be generating original knowledge in a society which dresses, behaves and thinks like other societies. Even if someone performs scientific studies with culture and perspective of other societies, s/he cannot truly implement these into her/his own culture. In fact, such a scientist will be forced to use the language of other societies for writing new works, which will cause the history to regard these works as success of other societies.

Having said that, importance of language, culture, tradition, and moral values can be understood, especially in terms of performing scientific studies in a society. Therefore, a country or a society shall look into its own cultural values for inspiration, rather than embracing the values imposed by imperialism, to perform their scientific activities. On the other hand, if a culture has not experienced any production of knowledge, scientific studies or technological progress, then it shall benefit from the sources of knowledge in other civilizations in order to assimilate them creatively by developing important concepts and ideas to implement these works. When history of science is carefully studied one can see that societies need to implement beneficial concepts of science according to their cultural perspective, language, traditions and moral values rather than adjusting their culture and moral values to the societies where scientific enterprise is progressed.[3]

The true aim of science is to discover quantity, features and characteristics of events in nature on every aspect and level as well as to evaluate the relationships between different beings and concepts. This way, science is able to acquire the required knowledge which may be used to predict

2 Zekai Şen. *Philosophy, Logic, Science and Ethics in Engineering* (Istanbul: Su Vakfı Yayınları, 2011). For the second edition see *Philosophical, Logical and Scientific Perspectives in Engineering* (Cham, Heidelberg, New York, Dordrecht, London: Springer International Publishing, 2014).

3 For more information see George Sarton, *Introduction to the History of Science*, 3 vols. (Baltimore: The Williams and Wilkins Company, 1927).

what may happen in the future and how events in the future can be controlled. On the other hand, scientific studies are also performed to satisfy man's need to understand and know the unknown. Today, science has provided advanced technological developments by providing the foundation that is essential for the development of useful tools and devices for people. In fact, the development of tools and equipment called technology began before the phenomenon called science, and it has constantly progressed since the early times. Following the cutting tools of Stone Age; man has continued to create new tools with copper, iron, etc. to satisfy his needs, without having any scientific basis. Invention of the plow to till the field, the discovery of the wheels and the discovery of gunpowder are all technological developments. All of these developments have been created to satisfy a certain need. Hence, today the organized body of knowledge obtained through systematic thought with a specific methodology, called "*science*".

Activities that we call science today had close relationship with philosophy during the centuries when Islamic civilization had its golden age in scientific advancement. Philosophy may simply be defined as the love for wisdom or acquisition of knowledge with systematic and critical thinking. Knowledge, technology, philosophy and religion have moved from one civilization or culture to another welcoming it; and served humanity perfectly. Middle ages, is the term between the end of West Roman Empire in 476 and invasion of Istanbul by the Ottomans in 1453, marking the end of Byzantine Empire, which has been a successor of Eastern Roman Empire. This period witnessed an immense activity by Islamic civilization in terms of science, philosophy, technology, military, education and social solidarity. At that time, the West was struggling to take a breath of relief from political instability of feudalism, coupled with darkness, filth and absence of human rights. With the order of Pope, the West attacked Eastern Roman civilization to acquire their wealth and heritage, by showing Jerusalem as an excuse and calling these wave of attacks "Crusades". Many of their fellow religious peers were killed; cities, even Istanbul, which was then Constantinople, the center of Orthodox world, were raided and pillaged. Later in 16th century this period in Western history is referred to as the Dark Ages by their historians when ignorance dominated due to the dark, self-centered, inhumane behaviors that the world had witnessed.

This adjective may be very accurate for that age, but not for all civilizations that lived at those times. As it may be suitable for Europe, the term "Dark Ages" was the exact opposite of what Islam was right at that time because, especially when we consider the period between 7th century and 12th century there has not been a single scientist in the West that could be recognized as peers to Turkish - Muslim thinker or scientists of that time.[4] For Middle Ages has been the most beneficial, rich and bright era for Muslims up to date. For this reason, the term of Dark Ages shall not be used especially in education systems of Muslim countries. Unfortunately, Turkish students and general public are deprived of the fundamental knowledge concerning philosophy, science and technology of their ancestors. As a result they apply the term "Dark Ages" referring to this bright age of Islamic civilization due to the modern, western mindset. In some way, education system of Turkey, has been left very weak in terms of its own science and religion. Our younger generations do not know the history of science and technology in their own civilization. Therefore, roots of abundant trees have been cut, only western philosophy and culture have been inoculated. On the other hand, one side of these vaccinated trees can give their own fruits. Our education system ignores Islamic sciences and technologies completely. Our youth has been raised with an inferiority complex, stating that we are not capable of developing such high and mighty products of science. Consequently, we have found ourselves in an inert position, imitating scientific history, scientists, cultures and traditions of others. Especially, history of Islamic science and technology should be known and taught. Mindset and philosophy of the Antique times, which are far darker and older from the aforesaid eras, have dominated the world. On the other hand, even in the West al-Farabi (d. 950) was regarded as the "Second Master" (*al-Ustadh al-Thânî*) after Aristotle. The year 1950 was confirmed and declared by UNESCO as "The Year of Farabi" to commemorate his 1000th birthday as a reputable philosopher and scientist. Even many scientists in our country are still unaware of this fact.

Unfortunately, as a result of forgotten sources, the Islamic intellectuals today claim that they are only doing imitative investigations in

4 See ibid, vol. 1. In fact Sarton thinks that in these centuries it is not worth studying any civilization other than the Muslim world where original scientific works were produced primarily in this part of the world, 1: 543ff.

the direction of the West. The small amount of scientific contribution from these countries as we see today, creates an important contradiction when compared to their past. This should not lead us to say: "we should boast about our past". But, we should not despise it either. Instead of mechanically writing scientific articles in international magazines, we should embrace our past and diffuse the awareness in the minds of the public to change this sad portrait that we face today. Otherwise, the act of looking for solutions in a mechanized and artificial manner, will be permanent. Especially, the idea which claims that "the distance between the West and us in scientific progress is growing further, that is pointless to try catching up with them" confines our minds in narrow gaps. We shall be absolutely positive about the fact that we are at an equal distance, and sometimes, may even be superior to the West, especially when we consider the huge contributions which have been made by Islamic scientists and technology researchers, despite our present inability to contribute right now. Otherwise, we will not accomplish anything by regarding pioneers of today's science, who are worshiped but not respected at all. Especially, the act of despising our own culture, society, history and resources while worshiping and aggrandizing West, which has dominated Anatolia for the past 200 years, has become the most influential element which holds us back in terms of scientific and technological developments. Especially, adoption of such an idea by the pioneering thinkers of our country, has reflected its negative influences onto the public and started deteriorating our wellbeing and self-confidence, preventing us to be happy and continue creating, just like a computer virus. Therefore, our pioneering thinkers shall definitely be aware of our major contributions in the arena of science and technology; and convey this self-confidence to the public, as we are successors of those great Islamic thinkers. The West, has become what it is today, thanks to the heritage of Muslim world. On the other hand, the West has wrongly based these values to Ancient Greece, which had been regarded culturally similar to themselves, and created their own Christian foundation for science and technology while ignoring major contributions of Islamic civilization to science and technology. Western civilization, which had a feeling of inferiority especially in terms prior to 16th century, had inverted this status and started to feel like they are superior to other cultures and socie-

ties. We start our lives by accepting superiority of the West, even without needing them to state this expressly. In the Middle Ages, Islam has not acquired anything from the West. Without the past products of Muslim contributions and movements, the West would have been in a far more backward condition today. We can eliminate this feeling of inferiority only if we start to imitate, so to speak, the Western ideas only in certain areas. For example, they have created their own world views and moral values without sacrificing much from their traditions, cultures and religious beliefs. The only opposition came from the authoritarian pressure of the Church. Similarly, we should base our scientific and technological future on our own traditions, beliefs, language and culture. None of the cultures, which has strong influences in the history of science and technology, has made a sacrifice from their culture, language or religion, but successfully blended the new knowledge they developed or even borrowed from others with their own culture. While it is an apparent fact that doing otherwise will not be a wise choice in the future, changing our culture, traditions and beliefs to imitate the West seems preposterous. Historical realities show us that we do not need to subject ourselves to Christianity, change of language or cultural erosion to become successful. Just like Muslims, who have acknowledged and blended the products of Greek, Indian and other scientific traditions without sacrificing their language, religion or culture, European civilizations also preserved their values while they acquired the intellectual products of Islamic civilization. Nobody has changed his/her clothing, language or belief. On the other hand, they have succeeded in advancing to even higher level of development.

Which scientists and engineers do you think created the first drafts for automation systems and robotics industry that are admired and thought to be performing many hard tasks for mankind? Most of us would probably think that they were from the West or at least, we would not think that such a person was possibly a Muslim scientist. Similarly, most of the Muslims who live in the "modern" "information society" of our time most probably thinks that these ideas have come to life in Ancient Greece, developed in Middle Ages for a thousand years, and finalized to be what they are today following the Renaissance movement in Europe. On the other hand, we must see that this is not the case when we refer to Western books which in-

terestingly approach this issue objectively. But unfortunately, in the modern age of today when we cannot even trust our own resources; we insist on acquiring our scientific and cultural heritage from the west, and keep on ignoring these fundamental facts of history with a skeptical mindset. Even people who refer to these resources, refuse to adopt, acknowledge and embrace these information, therefore resulting in our inability to develop our own resources. The first lesson that we learn from all these are the facts that the scientists of our own cultural heritage, have the right to be embraced and taught at the same level with thinkers of Ancient Greece. This is not only their right but also has a rightful need of our young students, who will be thinkers, scientists and technologists of the future, as they may inspire greatly from their own culture, lose this pointless sense of inferiority and even succeed in eliminating this feeling. For many people who do not know their history, their past, their family learnt from the history with bitter experience that it is not possible to advance without the light illuminate their way from their past. While important works of Islamic thinkers have been translated into Latin, the mostly accepted language of science in Europe, different nations have translated these resources again to their respective languages, enabling them to benefit from these works, creating their own resources by planting their own, adapted seeds.

Especially the wave of terror which has been created in Islamic countries and societies, make everyone think that knowledge, science, technology and even human rights are only products of ancient Greece and today's West. Civilizations that have lost their touch with their histories and repelled their own historical values, have become blind followers of the West. These societies have even ignored and despised all scientific and technological ideas and developments in their own country and accepted ideas and movements from other cultures with blind imitation. This is such a pitiful state and a miserable position to be in. History tells us the fact that societies may only acquire the age of enlightenment by creating their own sources of knowledge with their own cultural resources. Today, all societies and particularly Muslim nations, struggle to maintain their origin in an environment which has been invaded harshly by foreign and western approaches.

One definite example which may even serve as an accurate illustration of today's world of science and technology is Bediuzzaman Abu'l-'Iz

al-Jazari's technological automation researches. 800 years ago, and before capitalist and imperialist so-called technological and scientific products were presented to humanity for the purpose of material gain, a Muslim scientist have produced the same kind of technical devices solely for serving humanity, making us feel the need to start reconsidering our heritage. This scientist engineer is al-Jazari, whose complete name is Abū'l-ʿIzz ibn Ismāʿīl ibn al-Razzāz al-Jazarī, who has been the only and most influential thinker throughout history. Abū'l-ʿIzz al-Jazarī developed highly admired ideas of "cybernetics", "automation" and "robotics" which are held highly important today. His "engineering" and "innovation" capabilities have been so unique that only a few scientists showed to have this kind of expertise throughout the following history of man. Also, he has based his technological ideas on objective concepts rather than speculative, abstract ideas as it was in ancient Greece, nor did he expressed his ideas with symbols.

In the rest of this article because of his importance in the field, I would like to highlight the works of Abu'l-'Iz al-Jazari and contribution in the field of technology and its significance for the technology-value relationship. This way I hope to spread awareness about his rich capabilities as a Muslim Scholar. The main aim of this article is to provide a brief perspective towards works of mechanical devices and automation concepts which have been created by Muslim scientists between 9th and 13th centuries as well as evaluate works of Abu'l-'Iz al-Jazari. He is indeed one of the most notable and progressive Muslim scientists working in this area. The work of al-Jazari has inspired from the works of previous researchers before 12th century and thus created important exemplary works which have acted as a basis for conical threads, suction and force pumps and even steam machines. Unfortunately, even imitations of these works, which have been products of Muslim scholars that have been blended with their own culture and resources, could not be made in the following centuries, resulting in the lack of ability to acquire further developments in this area. Moreover, another objective of this article is to embrace this important examples of mechanics and automation by Muslim scholars due to their historical importance. Particularly, contributions of Muslims to automation, have been the most ignored efforts of this unique society, which are unfortunately overlooked and almost forgotten completely.

I. A Brief History

During the time of Abbasid caliphates in Baghdad, many works of antique Greek have been translated into Arabic. The intention was to enable scholars who are competent in Arabic to benefit from previous studies. Among these translations, the most notable ones were works of Byzantine Philon's works on pneumatic (air powered) devices in 2nd century B.C. as well as mechanical works of Egyptian scholar, Heron, which have been performed in Alexandria in 60 A.C. Also, works of Archimedes on water counters were also translated into Arabic. Particularly, works of Archimedes has been noted in studies of Abu'l-'Iz al-Jazari's whose works also took into consideration previous studies of Archimedes, Philon as well as Arabic scholars, more particularly Banu Musa brothers. Involvement of Muslims in the field of mechanics start with the works of Banu Musa brothers in 850, and reached the peak level thanks to the works of al-Jazari in 1206, who was an Artuk Turk and has lived in Diyarbakır.

One branch of Turkish tribes has started to head west, as Sultan Alparslan has stepped in Anatolia in 1071. Artuk Tribe, being one of these Turkish tribes, has established a state near Diyarbakır. Abu'l-'Iz al-Jazari, who lived in the time of this state, has caught the attention of state authorities thanks to his knowledge and capabilities; and has been able to continue his studies in a confident and relaxed manner thanks to this direct support from the ruling class. At this time he wrote a book on robotics and automation devices.[5] By also applying his drafted works on real machines, he has received admiration of the public. The title of this scholar is Badīʿ al-Zaman (we shall spell it as it is pronounced in Arabic as "Bediuzzaman") which means "the prodigy of his time." By only taking his pictures and drawings into consideration and comparing these to machines and robots of our time; we can easily see that his works were spread to other centuries. Additionally, as we can clearly see that the idea of "cybernetics" has been created by western scholars in 19th century by evaluating his books and drawings; the influence of al-Jazari can be better understood. First information about our robotist can be found in the foreword of his book.

5 Abu'l-'Iz al-Jazarî. *The Book of Knowledge of Ingenious Mechanical Devices* (*Kitāb fī Ma'rifat al-Hiyal al-Handasiyya*), translated and annotated by Donald R. Hill (Dordrecht, Holland: D. Reidel Publishing Company, 1974).

Based on this information we know that he served to the ruling family, especially Nasreddin himself, his father and his brothers for a total term of 25 years during the time of Artuk Turks. This reign continued during the rule of Melik Shah, the sultan of Anatolian Seljuks in the 11th century. Then they were divided into two branches as Ilghaz and Sukman Artuklus. Especially in the 12th century, the Artuk Turks established a state in Diyarbakir during the time of the Seljuks who were stronger than themselves, Byzantines and the Crusaders who also came occasionally to their regions.

II. Islamic Technology and Al-Jazari

The title of this section is taken from the first book of al-Jazari that have been translated into English by Hill.[6] In some way, works of al-Jazari are regarded as "Islam technology". Especially, among works of all Muslim scholars in the Middle Age which have served as a basis for scientific and technological developments in following centuries, works of al-Jazari have been the only one which has included practical and objective examples. Sarton has accepted the fact that, works of al-Jazari can very well be considered as the peak works which had been performed by Music scholars up to that date.[7] Unfortunately, number of books which include works of Muslims in fields of technology and science is rather low. Among these, information and technological developments that have been provided by Nasr serve as an important resource.[8] Especially, the works of Wiedemann and Hauser and engineer Fritz Hauser have been the most important examples of studies involving al-Jazari in Western world.[9] Widemann was a physicist who knew Arabic. Therefore, study of his works by physicists and engineers, instead of a historians, social scientists and lectures shows us the fact that, works of al-Jazari have important economic, practical and up-to-date benefit which may be used in terms of engineering designs with correct physics principles. It has been known that, drawings and explana-

6 See Sarton, op. cit.

7 See Ibid.

8 Seyyed Hossein Nasr. *Three Muslim Sages* (Cambridge, Mass.: Harvard University Press, 1964).

9 E. Wiedemann and F. Hauser. "Über die Uhren in Bereich der Islamischen Kultur", *Nova Acto Academiae Caesarae Leopoldino*, 100 (1915), 167-272.

tions in al-Jazari's book involves an important plausible information for practical development in terms of their design and technical applicability.

Other thinkers and scientists which has contributed to Islamic technology before al-Jazari was Banu Musa (The Musa Family) heritage, Khwarizmi and Rıdvan. In the Musa Family, there has been three notable scientists including Abu Ja'far Muhammad, Abu Qasim and Hasan. These thinkers have been raised under the rule of Caliph al-Ma'mun, following the death of their father. Three brothers seem to have influenced al-Jazari in his works. Works of these brothers include 100 different devices. These involve seven different designs of fountains, four automatic shaving (chipping) machines, one automatic music instrument, one gas mask for working on a dirty well, and one mechanical containment device for excavation in wells. The rest of their works mainly includes different mechanisms with water depots. Designs of these scholars were influenced by some ancient Greek thinkers such as Philon and Heron, who had similar concepts in their works. Therefore, Muslims of those times have also used the principle of referencing, which is still a respected rule of scientific practice. Works of Musa family are more systematic and automation works as technological devices.

Al-Jazari has used the idea of water counter, which had been set forth by Archimedes. As also explained by Drachmann,[10] insufficient features of Archimedes' design have been modified, adapted and corrected by Muslims who have also invented first working water counter in the world. Another example of mechanical device parts developed by Muslim scientists for the first time in history and could not be found in prior ages is conical valves. This mechanical part is used in different parts of al-Jazari's book. According to Western sources, the idea for the conical valve, has started flourishing in 8th century, and developed fundamentally in 9th century.[11]

Moreover, the book of Abû Abdillâh Muhammad ibn Ahmad ibn Yûsuf al-Kâtib, known for short as "al-Khwârizmî" (d. 997), entitled *The Key of Sciences* (*Mafatih al-'Ulum*), included important technological information which is used by Muslim scholars. The section which catches

10 A. G. Drachmann. "Ktesibios's Waterclock and Heron's Adjustable Siphon", *Centaurus*, 20, 1 (1976), 1-10.

11 See Hill, op. cit.

our attention in Khwarizmi's book is called "*hiyal*" (Inventions) involves an in-depth knowledge of different mechanism. Fundamental definitions which have been used by al-Jazari are also included clearly in this book.

Another important work, which influenced al-Jazari belongs to Fakhr al-Din Ridwan ibn Muhammad al-Sa'atî (d. between 1220-1229) who was a scholar and mechanical engineer, author of the book *'Ilm al-S*ā'āt wa'*l-'Amal bihā*[12] in which he described the public clock set in Damascus by his father. Being a doctor, Ridwan set forth important opinions in different areas such as rhetoric, logic and philosophy. On the other hand, the insufficiencies in his drawings show his lack of competence in these areas. Nevertheless, even insufficient drawings of Ridwan have played an important role in development of Islamic technology. Ridwan does not have a technical background, but his works include even the minute details, unlike al-Jazari.[13]

Lack of importance given to automatic devices which were also designed and explained widely by Banu Musa brothers and later by al-Jazari and other Muslims in the following centuries, have led to the loss of the light of Middle Age Muslim Science. Unfortunately, this has been also felt by al-Jazari as he pointed out these matters in the foreword of his book; and stated: "I have put in so much effort to this work and I am deeply worried that my works will be lost with the blowing wind, and erased like the night does to the day." As Muslims have not paid the required level of attention to works of al-Jazari, especially to his book called *Kitab al-Hiyal* (The Book of Inventions), despite the fact that he provided important explanations in this book. This fundamental issue may be set forth as an important reason which neutered the development of automation science in Muslim societies, which held indeed a potential to make an important revolution. Many scientists, who were influenced by this book have made science and technology what they are today. Al-Jazari not only developed important device mechanisms that pioneered technology but also provided many influential concepts and ideas that have later been contributed to sci-

12 For the sake of practical reading for the layman we did not follow the Arabic transliteration very meticulously. Only in certain cases we followed the general convention to make sure the correct reading of the words.

13 For more information see also Donald R. Hill, *Arabic Water Clocks* (Aleppo: Institute for the History of Arabic Science, University of Aleppo, 1981).

ence, philosophy and engineering. This can also be understood from the foreword of al-Jazari's book. Because of its importance I would like to list these as follow:[14]

1. The inventor starts his book with the "basmala" (saying "in the Name of God, most merciful most beneficent"), and continues, stating that the real secret and power of everything on the land and in the sky, belongs to the Allah, the most high.
2. He asks more of these scientific discoveries from Allah, and respects his powerful ruling and decision. Such a request can be also found similar to the desire of Einstein; to know how God wanted to create the earth and what was the divine design behind the creation.
3. It has been also noted that al-Jazari has researched all the works in world literature before him. Therefore, al-Jazari provides us with an excellent example of Muslim's indebtedness to other works which were written prior to them by showing references, in the history of science. Such a behavior is expected morally by the scientific community.
4. Foreword of al-Jazari's book also tell us that he has researched works on how objects can be used to move other objects as well as other articles which prove different laws involving the sky and earth; and decided to focus on his energy on the field of robotics. This means, works which had been made prior to him has given him the will to perform his own studies. Here, we also understand that al-Jazari was also interested in physics, the philosophy of nature.
5. Reading the previous works without criticism is good for only transmitting the knowledge acquired in this way and that is why he wanted to free himself from

14 See Zekai Şen, "Robot ve Otomasyon Biliminin Öncüsü Ebu-l 'Iz al-Jazari" (Robotic and Automation Science Pioneer Abu-l 'Iz al-Jazari) presented (in Turkish) in the *Osmanlı Su Medeniyeti Sempozyumu*, Feshane, İstanbul, 2000.

being a simple transmitter. This way he was able to keep himself from just repeating what others have done, and return to his problems to investigate with his own insight. Thus, to continue the work independently to produce original works and do research freely.

6. He also stated that he had to pass through subtle and difficult ways during his studies and felt himself in distress from time to time, but he continued to work for years. Al-Jazari is so determined and stated: "I have awakened my ideas of drowsiness by extraordinary effort to stimulate my determination." In this, he has done all he can in order to make every effort to do more research. At the end of this, he has become a scientist who excelled in the society he lived in.
7. Despite all his successes, competence and achievements, he could not help to save himself from skepticism, just like Rene Descartes, a thinker of 16th century 400 years after his time, who states his famous methodical skepticism.
8. Another sentence in the foreword of al-Jazari's book, which is so well-thought that can still enlighten the world of industry and science today, states that "a technique (technology) will be left stranded between right and wrong if not realized and brought to application. With these words, he has expressed his desire for all researches to be realized and transformed into machines and mechanism that may be used to serve humanity.
9. Another important fact which has been given in the foreword of his book is his success in creating basic elements of science by gathering previously acquired dispersed sources of knowledge and then organizing them systematically. He highlights the fact that difficulties will arise in all fields of work, while these can be eliminated by means of systematic working and

organization of findings during the course of scientific studies.

10. Al-Jazari not only wanted to satisfy his curiosity but also wanted to teach his findings to others. He has stated this as follows: "I wanted to leave a decent work behind me which will convey what I wanted to teach and enable others to write what I have accomplished in my works." Therefore, he also took into consideration the connection with other generations after him. On the other hand, he decided not to follow this decision as he explains this in the following way: "But I gave up on this idea because I was afraid that an influential critic would find my mistakes."
11. Later on, the adherents of the people of benevolence appealed to al-Jazari to discover various aspects of his beautiful wisdom. He has expressed his feelings by stating "I have received such an interest and assistance of rulers and thinkers of my time that I was able to see the products of my work." Ruler of Diyarbakır, Abu'l-Fath Mahmun bin Muhammad ibn Qaraaslan, who was aware of his studies told him once: "You have created unique plans, realized these from as if absence into existence. Do not waste all this effort and the foundation you have created. I want you to create a book for the projects you made and drawings you drew." Therefore, the book of al-Jazari, *Kitab-ul Hiyal* has been flourished with state support and encouragement, and was thus transmitted up to date. Unfortunately we do not see any such work after that until today.
12. Another message that we can receive from the foreword in this book is the fact that, humans should be wise when deciding upon something; and everyone has been created with the competence required to perform a task easily. Everyone is also required to share what

he/she has. He thus said: "I am sharing what was given to me. Nobody would keep useful information to himself and nobody would be obliged to perform something beyond his/her ability." He points out here that information can spread towards society easily.

13. Another message of al-Jazari in his book is his engineering concept. He explains, these concepts with drawings and annotations he provides. As engineering has just started to be acknowledged as an "applied science", al-Jazari's flowmeter is an important example with fine details.

Focus of al-Jazari's works have been "brilliant" technological devices called "hiyals" (inventions). At his time, these devices were using water and air pressure, as there were no valuable resources of energy to empower devices. His empirical knowledge is also based on the sources of that date, as he produced such operating systems and devices. Especially, copper depots, pipes, pontoons and wheels were his creations with these materials. He used syphons, nozzles, orifices, taps and valves to control the movement of water. All kinds of wheels were manufactured from wood or iron, and settled on shafts.

While al-Jazari had a wide knowledge of numbers, Banu Musa brothers had used letters to represent figures. Even though mathematical relations were not known very well, experiences up to that date were used during studies. Even though Banu Musa brothers did not know the concept of pressure difference, they have successfully designed devices based on hydraulics and air pressure.

III. Automation, Robots And Comparison With Today's Technology

Works of other scholars and scientists prior to al-Jazari were not recorded in a written manner but successfully conveyed from one generation to another verbally. Usage of these transmitted technical knowhow by al-Jazari and Banu Musa brothers have resulted in creation of many brilliant technological devices. Al-Jazari's efforts in accumulating these technical knowhow and organizing them in a book subsequently enabled engineers after him to produce works of technical devices. Mathematics, space geom-

etry and other different measurement systems have been used in creating of these devices. Also, Abu Abdullah al-Khwarizmi's book called *Mafatih al-'Ulum* which was written in 991, managed to enlighten the path of future studies as a science and manual of technology. This book also included etymological data about meanings of different parts used in those brilliant inventions. An important feature of this book is the fact that it involves the common terminology, used by Muslim engineers up to end of that century. 200 years after this incident, in the year 1203, al-Sa'ati provided an important source, indicated above, concerning mechanical operations and performances of technical devices, which was intended to be used as a guidebook for repairing clocks. Besides these works, different books of Muslim engineers and scientists of nature also included certain sections on engineering, technical devices and mechanics. An organized and careful research should be carried out to collect all these works and present them for scholarly use. Notable works among Muslim philosophers, scientists and thinkers belong to al-Biruni, al-Hazini, Ibn al-Haytham and Jabir ibn Hayyan.

Of course the only book which has directly influenced modern engineering is the book of al-Jazari because his book included drawings and information about materials, methods, and simple explanations that anyone can easily understand. By considering his works with today's technology, the most notable invention is most probably the mechanical device which involves moving pistons placed in cylinders. This machine involves a wheel with scoops, which is used as a source of movement. This movement is controlled with a gearing system to harmonize the movement of a slot shaft. The movement of the slot shaft is transferred to horizontal movement to move the cylinders on sides, for the purpose of pulling water continuously according to open/close status of valves. This device involves three important characteristics which is still used in the water pumps as we use today. The first is presence of bidirectional pistons; the second is conversion of the rotation, the harmonic movement, to horizontal forward and backwards movement, and the third is its exemplary features for a water pump today. For all these reasons, al-Jazari's double water pump system, has provided an important mechanism for drafting the vapor machines in 19th century. In fact, many mechanical device models of al-Jazari has served as a basis for modern mechanical engineering.

Another element that has been used by al-Razzaz al-Jazari is conical valves. Although there is a claim that these valves were used by Leonardo Da Vinci for the first time in 16th century it has now been proved that al-Jazari's first book of drawings did actually include conic threads which means that this valve has been invented by al-Jazari in 12th century.

Drop-type buckets are also one of many robotic mechanic devices which have still been used today. Drop-type buckets are essential elements of rain meters we use today. This bucket drops with certain intervals and prepares itself for the next fill. Also, al-Jazari has successfully discovered the correct orifice diameter to use by expanding the diameter slowly until he reached the correct level, despite his lack of knowledge about orifice formulas. In other words, empirical manual works have been performed rather than theoretical studies. This also shows the fact that al-Jazari has been the first to perform empirical studies which have flourished in Islamic cultures. He has also used rules of geometric similarities, by creating paper models of his invention designs before. He is also the first engineer who invented usage of oil dipped wooden shafts to prevent from scraping. One of his water rising devices involved transfer of power by means of a crank shaft. This can be acknowledged as one of the first examples for today's modern crank shafts used widely in different machines. Crank had been known before him but had been used manually before him.

Conclusion

Technology, especially in early ages, have been developed independently from philosophy and scientific theories. First humans were struggling to satisfy their most basic needs such as shelter, protection from the outside world, and finding food. China, India, Mesopotamia, Egypt, ancient Greece, Islamic civilization and today's Western culture have all contributed to the development of technology throughout the history. Information about technology in early ages could only be acquired from excavations. Also, different cultures have written records involving development of technological literature. As these technological developments could easily be written with Arabic alphabet, rapidly, many scripts successfully conveyed these information to us. Particularly, primitive technol-

ogies of ancient Greece and other civilizations have been carried to their prime condition by the help of Islamic civilization and other centers of interest (namely Andalusia); before being successfully carried to Western societies devoid of this kind of knowledge then, Africa, Andalusia (Spain), and Islamic nations of Middle East. This influential development wave has sparked Europe, and enabled it to become what it is today. Although Islamic civilization is the most influential spark of Western science and technology, this truth is not known even by most Muslims today. Many convoluted ideas flood these nations, asserting that technology has always been created by Western civilization.

This article has given a brief information about the history of technology in different civilizations and provided information about Islamic technology, especially before, during and after reputable al-Jazari. This Muslim thinker, inventor and scientist, who created prime examples of technology before Renaissance, has enlightened the path of future studies. The Article also tried to highlight these important contributions of al-Jazari with brief examples. Also, examples of first pistons, cylinders, crank shafts and water pumps in Islam society throughout 1200's have been explained to support the idea that; Islam societies have also been pioneers in benefiting from human, animal, water and wind power. Unfortunately, today's Muslims turn their backs to great contributions of Islamic civilization to science and technology, and turn their face towards the Western civilization as they regard it the only way of development. This mindset is surely confined and sterile, as the history has not witnessed a single civilization which managed to provide innovative and developed products of high science and technology without preserving its own traditions and cultural heritage. In the future, this issue shall be taken into consideration and our nation shall first start to embrace its own values and features while remembering contribution of our successors to the world of science and technology.

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