ATILIM UNIVERSITY

Department of Mechatronics Engineering

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Summer Practice II

ASELSAN Elektronik Sanayi ve Ticaret AŞ.

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ABSTRACT

ASELSAN is one of the biggest and leading companies of Turkish Defense Industry. Thanks to ASELSAN, the Defense Industry is highly developed and cooperates with other companies in the sector. During my internship, I worked in the Guidance and Unmanned Systems - Avionics Production Department in ASELSAN's Akyurt Campus. In this department, I observed the production and testing processes of the production of guidance kits, missile defense systems and other unmanned systems. I have created solutions and made researches about the problems encountered during production and failure tests of the devices. During my internship at ASELSAN, I learned about the production, testing and precision points of the devices produced in the Defense Industry. I experienced how to deal with the problems encountered during engineering studies and work ethics.

ÖZ

ASELSAN, Türk Savunma Sanayiinin en büyük ve önde gelen firmalarından biridir. ASELSAN sayesinde Savunma Sanayi oldukça gelişmiştir ve sektördeki diğer firmalar ile büyük bir işbirliği içindedir. Stajım süresince ASELSAN'ın Akyurt yerleşkesinde bulunan Güdüm ve İnsansız sistemler - Aviyonik Üretim Departmanında görev aldım. Bu departmanda üretimi yapılan güdüm kitlerinin, füze savunma sistemlerinin ve diğer insansız sistemlerin üretimini ve test süreçlerini gözlemledim. Üretim yapılırken karşılaşılan sorunlar ve cihazların başarız testleri hakkında çözümler oluşturdum ve araştırmalar yaptım. ASELSAN daki stajım süresince Savunma Sanayiinde üretilen cihazların üretimini, test aşamalarını ve dikkat edilmesi gereken hassas noktaları öğrendim. Mühendislik çalışmaları sırasında karşılaşılan problemler ile nasıl başa çıkılacağını ve iş etiğini tecrübe ettim.

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DESCRIPTION OF THE COMPANY

1.1. Company's History

Turkey has experienced some obstacles in using their defense equipment by the allied countries during the Cyprus crisis experienced in 1964. This situation has shown he should not become dependent on other countries and has revealed the need to produce their own facilities to meet all of Turkey's Defense Equipment. Turkey, the year after it is subjected to an arms embargo in order to meet with national capabilities of the Turkish Armed Forces has established communication needs in 1975 ASELSAN.

1.2. Vision

ASELSAN's vision is to be able to grow continuously in the global market with the values it creates and to be a preferred, trusted, environmentally and humanly sensitive technology company with competitive power by fulfilling its purpose in its establishment.

1.3. Location and Website

1.3.1. ASELSAN Akyurt Facilities

Akyurt Facilities are established on a total area of 231.000 m2, 54.500 m2 of which is closed area. Microelectronic Guidance and Electro-Optics Sector Presidency is located in ASELSAN Akyurt facilities.

Figure 1. ASELSAN Akyurt Facility [1]

1.3.2. Website

ASELSAN presents the company's general structure, news, announcements and job advertisements on https://www.aselsan.com.tr.

1.4. Company's Sector

Since its establishment, ASELSAN has aimed to expand its customer and product range based on advanced technology, and today it has become an integrated electronic industry company that develops, manufactures, installs, markets and carries out after-sales services.

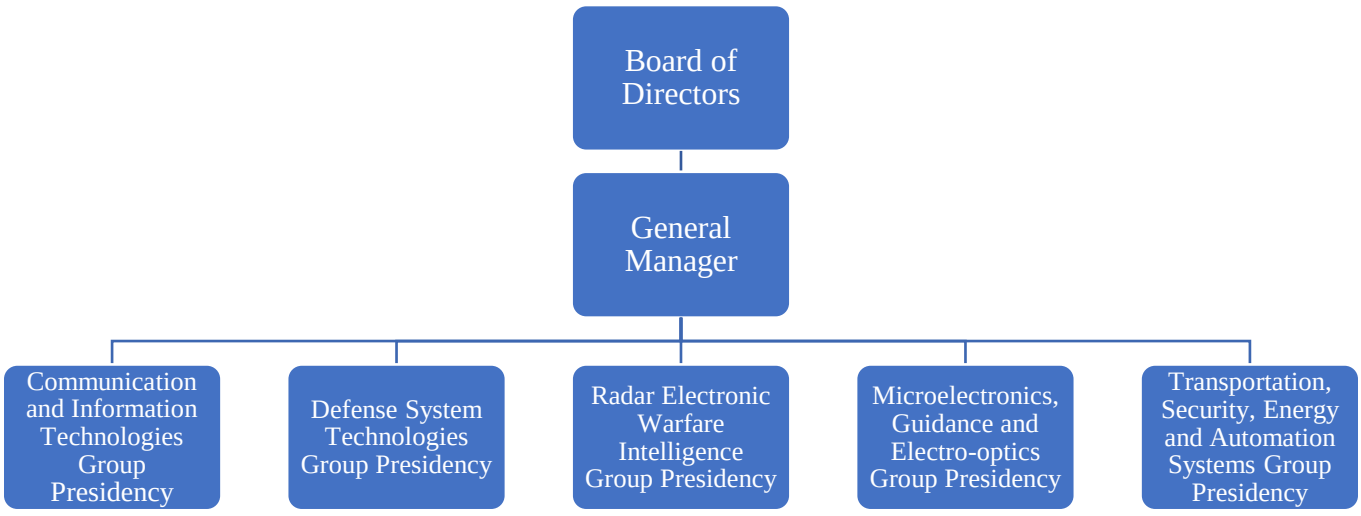
ASELSAN has the following departments:

- Communication and Information Technologies Group Presidency (HBT)
- Defense System Technologies Group Presidency (SST)
- Radar Electronic Warfare Intelligence Group Presidency (REHIS)
- Microelectronics, Guidance and Electro-optics Group Presidency (MGEO)
- Transportation, Security, Energy and Automation Systems Group Presidency (UGES)

With these departments, ASELSAN successfully serves a wide range of sectors.

1.5. Structure of the Company

1.5.1. Organization



Block Diagram 1. Organization Chart

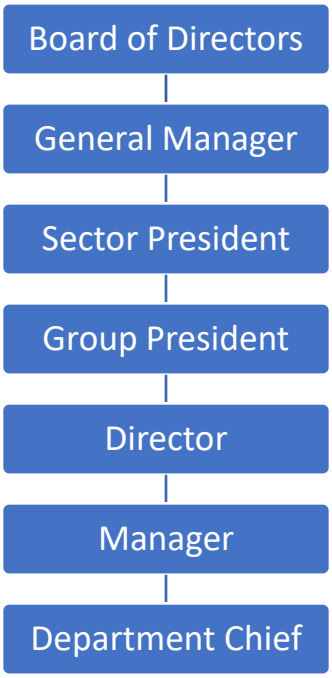
1.5.2. Size

ASELSAN produces with the latest technology and talented personnel are needed. The organization employs engineers and technicians and ensures that the staff is well trained.

According to 2017 data, 5440 employees work at ASELSAN.

Company employees: 59% (3209) engineers, 29% (1577) technicians, 7% (380) administrative staff, 3% (163) office staff, 2% (108) took part in the records as workers.

1.5.3. Hierarchy



Block Diagram 2. Hierarchy Chart

With this hierarchical structure, ASELSAN aims to manage the company in a bureaucratic manner, to organize the duties and powers according to a hierarchy within the framework of subordinate-parent relationship and to ensure a harmonious functioning by following orders.

2. INTRODUCTION

Avionics Production Department manufactures, assembles, tests and quality controls of various manufactured devices such as guided missiles, night vision systems, target recognition systems, unmanned vehicles. If there are design and software problems of the products in the department, they are redesigned by going back to the Design departments. In the same way, if there is a problem, the subcontractor manufacturers are contacted and necessary corrections are made. These transactions are then delivered to the customer. When producing these products, it is very important to make sure that the devices can work under any desired conditions. In addition, the shelf-life and service life of these devices are of particular importance. Failure to comply with these criteria is extremely critical as it can pose a risk to life for customers and users.

Interns do not have a critical role in ASELSAN. The interns are not liable for any damages in any problem and act accordingly. In ASELSAN, interns are expected to fully understand the work done and be willing to learn. Interns follow the production and design process of a project and observe how the engineers approach the problems encountered during this process.

It is very important that a trainee in ASELSAN has full engineering knowledge. In the Production and Design department, Mechanical Design, Material Knowledge and Instrumentation are required to have knowledge and analytical thinking is required to solve possible problems. During the internship I had enough knowledge about these issues and I was able to overcome the problems we faced.

During my summer internship at ASELSAN, I gained valuable experiences. While working in the Defense Industry and manufacturing military equipment, I learned what processes went through, how tests were performed, how to correct faulty devices, how problems were solved, and quality controls were delivered to the customer.

2.1 Problem Statement

We experienced some problems in the leak test we conducted under the Infrared Seeker Project. The leak test is carried out to ensure that there are no problems in transferring the cooling gas required for operation of the device to the device, and to ensure that the gas concentration, pressure is correct and does not leak from anywhere in the device. During a certain period of my internship, I contributed to the solution of the problem we encountered in the sealing test. In the solution phase of the problem, I presented new ideas from a different point of view. I assisted Senior Engineers and Technicians for the efficient implementation of the test. I created new techniques by analyzing the problem with different software.

This test is carried out with the device called NEPS1000 and increases the concentration by transferring the gas from the nitrogen line to the device with pressure.

Figure 2. NEPS1000 Leak Test Device [3]

2.2 Tools and Techniques Used

2.2.1 Programming Languages

Since the testing device has its own embedded software, no specific programming language was used during this test.

2.2.2 Software

During this test, different software was used in addition to the system of the test device in order to find alternative solutions to the problems. As an example, the cooling graph of the infrared seeker head was drawn with Matlab, dew point and cooling time were determined.

2.2.3 Hardware

NEPS1000 was used as hardware during this test. I had some difficulties using this device. I was unfamiliar with the device's interface and had to do research on the internet and get help from engineers to learn. Also, because the tube of the NEPS1000 was long, the nitrogen gas pumped into the device could not be withdrawn. The non-renewable gas remained mixed with air. Therefore, the nitrogen concentration did not reach the desired level and the temperature did not decrease. As a solution, the pipe was shortened and the fittings were assembled.

2.2.4 Techniques and Algorithms

Different techniques were used to solve the problems encountered during the test. Since the tester had a ring at the valve connection point, the nuts could not be tightened and lowered sufficiently, and the valve system could not engage and apply sufficient pressure. As a solution, the ring at the port was removed. As a installation problem, gas was escaping from a screw above the device. The problem is solved when you tighten the screw but the outer body of the device is too tight and distorts the structure. Permanent solution required material exchange.

3. ANALYSIS OF PRODUCTION

3.1. Analysis of Manufacturing Techniques and Production Line

ASELSAN is engaged in the production process in line with the needs of the defense industry sector. There are 3 kinds of production types: mass production, batch type production and production according to order. The production policy does not produce a large number of different types of devices. According to the orders and requests from companies to make the desired number of productions. The production of very sensitive equipment is carried out in special departments called clean rooms. The cleanroom is the place where conditions suitable for extremely sterile and precise production are provided. Since the devices produced here are very sensitive and will be affected by any air flow, temperature change and dust particles, production is done by controlling the factors such as heat and humidity in clean rooms. The production system designed to realize a single large-scale production is called project type production. In addition, several jobs can be carried out at the same time. Each project is independent, meaning it has different features. Distinguishing features of project type production can be listed as follows; It is a production method consisting of large-scale one-off jobs, depending on special demand. Project Type Production The activities will be complex according to the planned work. Project type production is very different from batch and continuous production. This feature of project type production; completely different techniques are used for planning, management and supervision of project activities.

3.2. Overview of The Mechatronics Engineering Related Projects and Advantages of Mechatronics Engineering

Mechatronics engineers are experts in the fields of machinery, electronics and software. Therefore, during my internship, I observed that mechatronics engineers could be more dominant in avionics production and guidance and unmanned systems projects. During my internship at ASELSAN, I found the opportunity to work in various projects related to mechatronics engineering. These projects are bomb destruction robots, human detection and surveillance drones, missile launch systems and guidance kits. The disciplines of mechatronics engineering are used extensively in these projects. In all these projects, electronics, software and mechanics are prominent. Mechatronics engineers

use their technical knowledge in these 3 areas to solve problems encountered in projects and they are very successful in carrying out projects more efficiently.

In particular, job descriptions of Test Engineers working at ASELSAN conform to the job descriptions of Mechatronics Engineers. A Mechatronics engineer stands out in the test department with his knowledge and experience compared to other engineering branches. The task of the test engineer working in our project coincides with the working area of mechatronics engineering. The test engineer checks the hardware of the test devices with computer software such as Matlab-Simulink and performs the test. Mechatronics engineers are able to carry out highly productive studies by transferring their theoretical knowledge in software, mechanics and electronics fields to their work during the test.

3.3. The Standards Followed by The Company

ASELSAN adopts Occupational Health and Safety & Environmental Policies in the field of electronic technology and system integration.

ASELSAN's occupational health and safety policy aims to achieve successful performance beyond the standards for continuous improvement by meeting the legal and other requirements of occupational health and safety. It aims to identify, prevent, reduce and eliminate hazards that may cause occupational accidents and occupational diseases. Through training and other activities, employees have a good occupational health and safety awareness and adoption as a joint responsibility by all personnel, taking risks and opportunities into consideration, it raises the awareness of occupational health and safety to the highest level. It undertakes to create a strong occupational health and safety culture that contributes to the implementation and development of all employees by taking into account the needs and expectations of the relevant parties, and to ensure the continuity of the management system performance with the leadership of senior management and the participation of employees in line with the occupational health and safety objectives.

It aims to comply with legal and other requirements in identifying and managing environmental risks, taking into account the environmental aspects and impacts of ASELSAN's environmental policy activities, products and services. It aims to comply with the objectives and context of the

organization, monitor and transparently report greenhouse gas emissions to mitigate the impacts of global climate change, ensure efficient use of natural resources and reduce waste. To follow the sustainability programs developed nationally and internationally and to create the sustainability added value at the highest level, to create a strong environmental awareness in which all employees contribute to the implementation and development of the environment by considering the needs and expectations of the related parties, to see the environment as a trust to be transferred to future generations, under the leadership of management, focusing on protecting our natural environment and preventing pollution, undertakes to continuously improve and improve environmental performance with the contribution of employees at all levels.

These standards enabled the employees of the organization to become more conscious and to create better and more efficient working conditions.

3.4. Assessment of Future Plans of the Company

Turkey's Defense Industry in developing their own weapons systems, indigenization and nationalization, ASELSAN, which has an important place in goal to eliminate dependence on foreign, about weapon systems is not only domestic, it aims to take part in the overseas market. ASELSAN's fields of activity are; smart ammunition, anti-drone, exoskeleton and electromagnetic ejection system. Products such as the National Processor and High-Performance Computing are aimed at both mastering critical technologies and independence from hidden or open embargoes. ASELSAN aims to become an integrated company to the market, sensitive to the environment and human, by integrating the quality of the service it offers with its honest and reliable company image and its sustainable growth. In order to develop qualified manpower for the Defense Industry, ASELSAN aims to train qualified technicians and candidate engineers in secondary education.

4. INTERNSHIP PROJECT

4.1. Bomb Destruction Robot

4.1.1 Ertuğrul Bomb Destruction Robot

Ertuğrul is a unique product developed by ASELSAN. Designed to deactivate handmade explosives under tough conditions, from a safe distance. This robot, which can move in 6 axes, is controlled by a portable control console. With its waterproof vehicle platform and flipper system, it can easily perform duty on snowy and muddy roads, stairs and tough environmental conditions and provides a comfortable use. Advanced surveillance system with 30x optical zoom. The sighting and clamping cameras allow the user to monitor suspicious objects in high resolution and in real time from the control console and allow them to be recorded for later inspection. 3D robot image on the control console all movements of the robot can be monitored even when they are not in the field of view.

Figure 3. Bomb Destruction Robot Ertuğrul [4]

Some of the bomb destruction robots that ASELSAN previously delivered were returned for maintenance and failure reasons, and during this time I had the opportunity to inspect the devices. One of the devices I was examining was unable to move along the clamp axis and was warning in the control console.

The reason for this failure was that the motor of the clamp axis draws excessive current and the device restricts the movement by protecting itself. Since the wiring between the clamp motor and the contactor lost its permeability for any reason, the motor was drawing too much current and causing a malfunction. In ASELSAN, parts are not repaired in order to eliminate the factors that cause problems in the repair process of the products, parts are replaced with new ones. In this device, the malfunctions occurred in the axis motor and cabling, and since these parts cannot be repaired, they were replaced with new ones.

After the defective parts of the device have been replaced, tests such as functional, sealing and environmental conditions are performed in order to device is fully operational. Following these tests, if there is no problem with any function of the device, it is delivered to the customer.

4.2. Guidance Kits

4.2.1 Precision Guidance Kit

Precision Guidance Kits (HGK) are high accuracy, target lockable unmanned weapons. HGK are guiding kits that turn penetrating bombs into smart weapons. HGK is designed to work in all weather conditions. It can re-target during flight, is resistant to target confusion and can be used in missions with low secondary damage. Requires fewer bombs, staff and logistics per mission. HGK has the ability to hit targets at 12 nautical miles when dropped from mid-altitude and 15 nautical miles when dropped from high altitude with increased range capability. With the shot angle from 10° to 90°, HGK can hit various targets with lethal precision. HGK provides the operational flexibility required to adapt to sudden changing conditions, thanks to the ability to target and update tasks during flight using the acceleration sensor and GPS on board. The HGK is compatible with the universal weapon interface and can be integrated into the F-35 aircraft.

Figure 4. Precision Guidance Kit [5]

During my internship, I observed the installation and testing of the precision guidance kits. The assembly of the other parts of HGK except for the explosive part is carried out in the avionics production department of ASELSAN. Inspection is made at every stage of the assembly to verify that there are no problems. These installation and inspection stages are recorded in ASELSAN's SAP system.

Various tests are performed during the production phase of HGK. These tests are carried out to ensure that the device can operate under all conditions. The tests I have had the opportunity to examine are vibration test, hot-cold test, Coordinate Measurement Metrology (CMM) test and acceptance test. Vibration is applied to the device in 3 different axes as shown in the figure. After the test, it is checked whether there is any deformation on the device and the functionality of the device is checked.

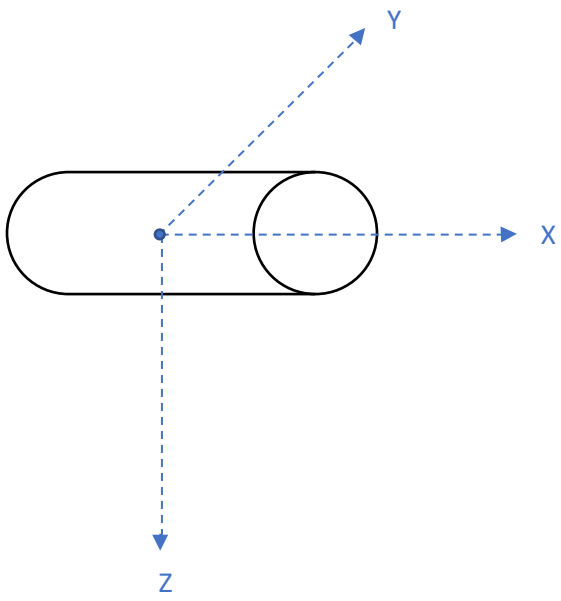


Figure 5. Representation in 3-Axis Coordinate Plane

4.2.2 Laser Guidance Kit

The Laser Guidance Kit (LGK) is a laser guidance kit that converts MK-82 and MK-84 bombs into highly reliable intelligent ammunition. LGK provides higher impact sensitivity to fixed and moving targets, increased firing envelope, lower secondary damage and ability to change target after shooting. The LGK semi-active seeker consists of a hood, a guiding section, a thermal battery, a wing drive system and a rear tail. The ammunition is directed to the reflected laser energy from the target, the seeker detects the reflected laser light from the target, the fins direct the bomb to the target marked by the laser. LGK has advanced features. It has a range of 12km and can be shot at 40,000ft altitude. It has 10m accuracy and can accurately hit the target. It also has a viewing angle of 15 degrees and the desired targets can be selected at high altitude.

Figure 6. Laser Guidance Kit

During my internship, I had the opportunity to examine the assembly and testing phases of LGK. LGK has a similar structure to HGK. Unlike HGK, it has a laser hood, which makes it possible to lock the targets. Likewise, LGK is produced in ASELSAN except for the explosive section. It is applied to HGK in the same way for tests such as Vibration and Hot-Cold. In addition to these tests, since the LGK has a Laser head, the target tracking test is also performed.

During LGK's tests, I had the opportunity to examine the CMM test. In ASELSAN, CMM tests are performed in special sections called dark rooms. CMM tests are very important for the final inspection of the parts produced in production technologies. CMM devices perform their measurements by working on X, Y, Z coordinate axes, matching part dimensions with these coordinates, in other words, comparing them. The most important feature is with the measurement information obtained, the whole solid model of a measured part can be extracted and checked with the required measurement values. Before we started the CMM test, we started the test by wearing spectacles that protected from ultraviolet rays in the dark room. During the test, we placed the body in the fixture on the x-y-z axes, respectively, and took the measurements with ASELSAN's own test software and recorded them. Thanks to the software, we were able to see if there were any errors on the body and we proceeded accordingly.

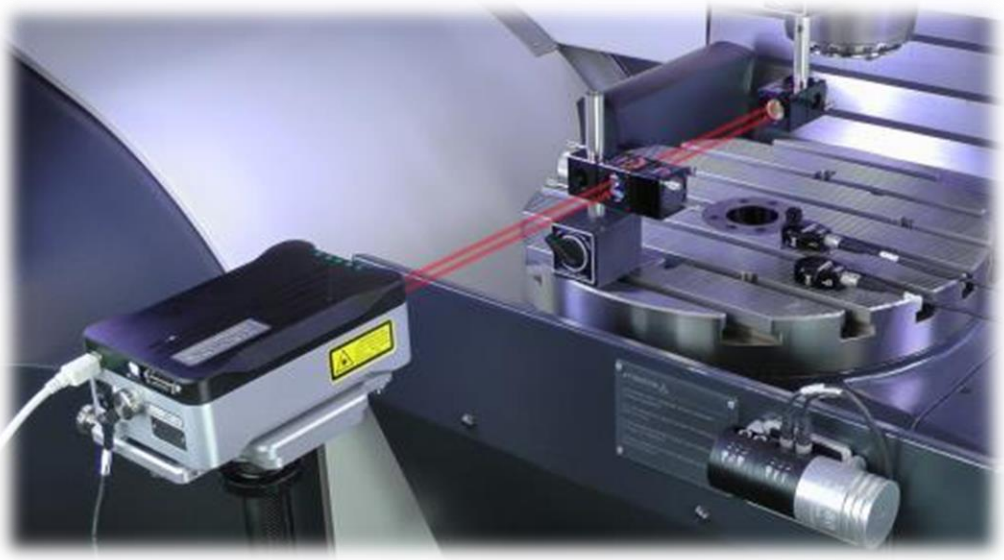


Figure 7. CMM Test Device

4.3. Missile Launcher System Infrared Seeker Head

4.3.1 UMTAS

UMTAS; It is a long-range anti-tank weapon system that can be integrated to various platforms such as helicopter, UAV, land vehicle, fixed platform, light attack aircraft, naval platform and effective against all armored systems. UMTAS is designed as an anti-tank missile system of the National Attack Helicopter (T-129). Within the scope of the project, it is aimed to nationalize critical technology areas such as seeker technologies, low smoke / smokeless high energy solid fuel technologies, insensitive engine technologies, insensitive warhead technologies, insensitive igniter technologies, safety building unit technologies, inertial measurement unit technologies, tandem hollow warhead technologies. The system developed by ROKETSAN A.Ş can work day and night and in all weather conditions. With a range of 8 km, UMTAS has been developed against armored targets for use from air to ground or from ground to ground with the choice of infrared seeker hood or laser seeker hood. UMTAS, which has two usage features named "fire-forget" and "fire-update", provides the opportunity to update behind the defilade, to the targets hidden behind the defilade, to set the precise hit point and to evaluate the efficiency of the strokes. can be used against targets.

Figure 8. Long Range Anti-Tank Weapon [6]

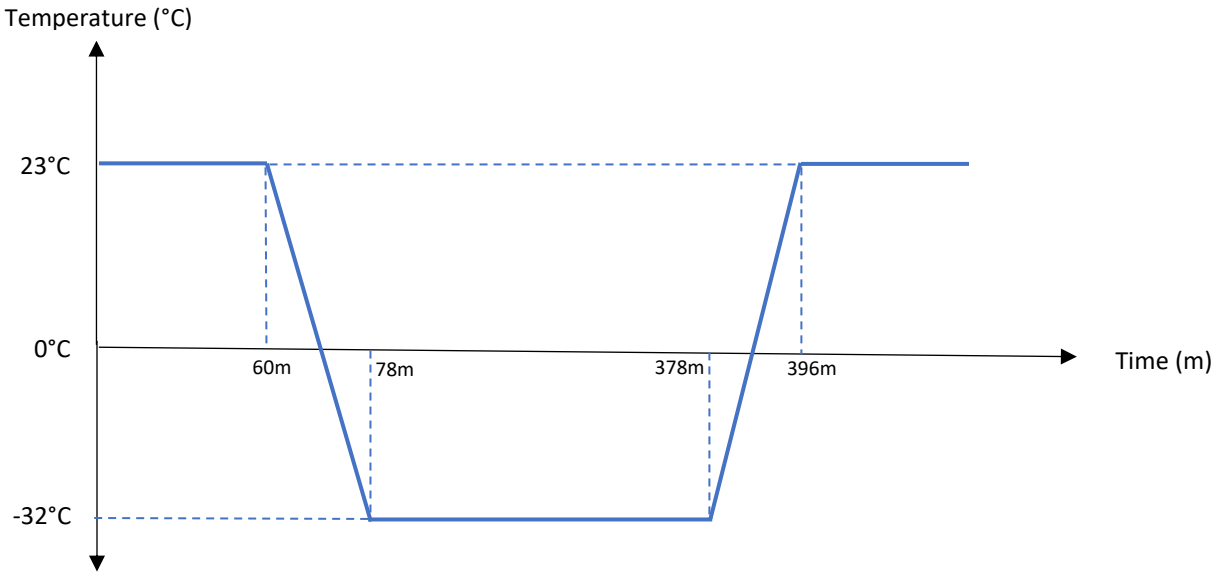
4.3.2 HISAR

HISAR Missile Launch System performs the mission of air defense against fixed / mobile units and critical facilities, War Planes, Helicopters, Unmanned Aerial Vehicles, Navigation Missiles, Air to Land Missiles. HISAR Missile Launch System is a multi-purpose system that uses low and medium altitude missiles. HISAR Missile Launch System with the most advanced technology in the future needs and features can be added to the structure has an open architecture. Some features of HISAR System are: Low altitude or mid altitude missile firing control, Multiple engagement and sequential firing, Intermediate phase guidance with data link, Ability to work during day, night and bad weather, Positioning and direction finding, Remote command, Tactical field mobility, Short deployment time, Automatic leveling system, Effective logistic support and maintenance. In addition, the Hisar system has a 25km system prevention range and 6 ready-to-fire missiles, which can reach a speed of 65km / h and move 60% steep and 30% sideways.

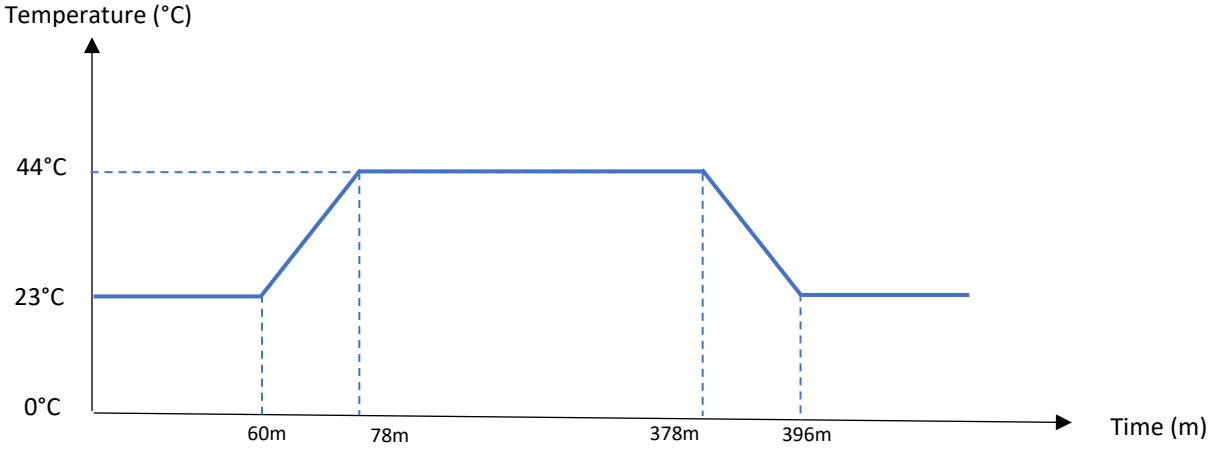
ASELSAN produces the Infrared Seeker Head of the HISAR project and I have gained experience during my internship. Features of this Infrared Seeker Head are: High Speed, Acceleration and Vibration Levels, High Dome Temperatures, Long Range Target Detection, High Processing Power Assisted Target Tracking Algorithms, Continuous Focus Optical Design (Athermalized), Wide Perspective (FOV), Wide Total Field of View (FOR), High Resolution Refrigerated Infrared Detector, Short Opening Time, High Sensitivity, High Reliability and Low Life Cycle Cost, Modular Design.

Figure 9. HISAR Infrared Seeker Head

I was involved in the application of hot-cold tests to check the operability of the infrared seeker head of the HISAR project in all weather conditions. The device is brought to high and low temperatures in a test device that can simulate ambient conditions, as shown in the graph 1 and graph 2 below. When the temperature graph peaks, the device is tested with the artificial target generated by the collimator for 60 seconds. This ensures that the target can be tracked even in the most demanding conditions and is not disturbed afterwards.



Graph 1. Cold Test Temperature Graph



Graph 2. Hot Test Temperature Graph

Specific parameters are used in the comprehensive target tracking test of the seeker head. Target tracking is performed by using artificial targets created with portable collimators. After adjusting the values that can be seen in the table below, we perform the test. These values simulate targets of different types and conditions. The temperature value in the table indicates the value of the rays emitted by the target and the mRad value indicates the width of these rays.

Number of Target	Temperatures (°C)	Width (mRad)
1	34	0.40
2	36	0.45
3	44	0.39
4	50	0.39
5	140	0.34

Table 1. Test Parameters of Collimators

4.5. Cost Analysis

The sum of the expenditures made for a product or service obtained or to be obtained is called cost. Payments made against inputs used in the production of goods or services must be reflected in the cost of manufactured goods or services. All cost elements are converted to sales expense as incurred.

ASELSAN uses two methods to create costs:

Work Order Cost Calculation System: Work order product works on the basis of sub-tools and the labor and material used in the production process are recorded in this work order. Thus, depending on the production operations, the cost of the part to which the work order belongs.

Activity Based Cost Calculation System: Processes of production and related services (planning, maintenance, repair, etc.) are handled gradually and cost calculations are calculated and cost is calculated according to the operation.

There is no large number of differences between the calculations of these two systems. In general, very similar figures emerge and the sales price of the product is calculated and the cost values generated by these two systems are taken into consideration.

4.5.1. Classification of Expenses

4.5.1.a. Classification of Expenses by Business Functions

Another criterion in the classification of expenses is their relevance to the business functions and their places. The following functions must be performed.

- Supply (Purchase) Expenses

  Expenses incurred for the purchase of assets and services purchased for sale or use in operating activities are included in this group.

- Production Expenses

Expenses included in the formation of production costs are included in this group. Production expenses are the monetary amount of the assets consumed in order to produce the goods and services that constitute the main activity of the enterprise. Production costs; direct raw material and material expenses, direct labor expenses and general production expenses.

- Research and Development Expenses

Reducing the costs of the products that continue to be produced, increasing sales, ensuring the development of new products, researching new production methods, improving existing products and so on. expenses.

- Marketing, Sales and Distribution Expenses

It covers the expenses incurred from the moment the products are delivered to the warehouse and the service is completed until the delivery of the goods and services to the buyers. For example; advertising expenses, warehouse and sales staff fees, sales shop expenses.

- General Management Expenses

All expenses that are necessary for the maintenance of the business activities and which are not included in other functional expenses are collected in this group. For example; management functions of the enterprise, determination of business policy, organization and staff organization, office services, general management, security, legal affairs, financial affairs including credit and collection, accounting service expenses are collected in this group.

- Financing Expenses

Interest arising from the provision of foreign resources consists of expenses such as commission and bank expenses. Financing expenses are generally shown outside the production and operating expenses. These expenses are considered as operating expenses.

4.5.1.b. Classification of Expenses According to Loading of Products

It is a classification made according to whether the expenses incurred in the production process are directly loaded to the products or not. In other words, the relationship of expenses to manufactured articles may be direct or indirect.

- Direct Expenses

They are expenses that can be charged directly to the production cost of a particular good or service without using any distribution key. For example; direct raw materials and materials, direct labor costs.

- Indirect Expenses

They are expenses that cannot be directly attributed to the production cost of a particular good or service and are loaded with the help of a number of distribution measures. Some expenses are also considered as indirect expenses due to the difficulties in qualifications and calculations. For example, all expenses incurred for the service are considered as indirect expenses. In addition, although it has a direct relationship with the main production expense; expenses are considered to be indirect due to qualification or calculation difficulties (such as annual leave fees, bonuses, operating materials).

These expenses, which can be charged directly to the cost center costs without the need for any distribution measure, are indirect expenses since they require a distribution measure in the cost of the product, although they are direct in terms of cost center. For example, the depreciation expense of a machine used at the production site is direct for that expense but is indirect when it is loaded on the manufactured products.

The main idea of separating expenses directly and indirectly is the ability of the expense to be directly attributable to the cost of the product or service produced. Here we can draw the following conclusion. Even if it is directly in terms of an expense, it is considered as an indirect expense if it is not calculated separately for the units produced. Expense types; outputting raw material and material expenses, direct raw material and material expenses and production-

related works; workers' wages and expenses are directly related to labor, overtime and production premiums; all other expenses are indirect expenses.

4.5.1.c. Classification of Expenses According to Production Volume

These expenses can be grouped as fixed, variable and mixed expenses depending on whether they change with production amount.

- Fixed Expenses

Fixed costs are the ones that do not increase and decrease in the amount of production within a certain period of time. Initial establishment expenses, depreciation shares of buildings, machinery and fixtures are fixed expenses. Some labor costs are also fixed in character.

- Variable Expenses

Variable expenses are expenses that vary due to changes in production volume. Examples of variable costs are direct raw material and direct labor costs.

- Mixed Expenses

Mixed costs are neither literally fixed nor variable. Some expenses continue even though production is the same but may increase if production discards.

4.5.1.d. Classification of Expenses by Type

Expenses in this group are classified as follows according to their natural names which determine their types:

- First Substance and Material Expenses

It covers all kinds of direct materials, indirect materials and works related to production that are consumed in order to ensure the production of goods and services and the continuity of business activities. For example, the first material used in the production of timber is the material; polish, paint, nails, glue materials such as indirect material.

- Workers' Wages and Expenses

Covers all amounts accrued for workers employed in accordance with the Labor Law to carry out business activities and perform production and services.

- Officer Fees and Expenses

It covers all amounts accrued for all salaried personnel employed to carry out business activities and perform production and services.

- External Benefits and Services

Covers expenses for external benefits and services in order to carry out business activities and to perform production and services.

- Various Expenses

Other than the above-mentioned expenses, it covers the expenses to be incurred in order to continue operating activities. Travel expenses, advertising expenses, notary public, lawsuits, execution expenses, dues paid to professional organizations and other expenses are included in this group.

- Taxes, Duties and Fees

It covers the taxes, duties and charges accrued in accordance with the legislation.

- Depreciation and Depreciation Shares

It includes depreciation expense and depreciation expense for tangible and intangible assets and assets subject to special depletion.

- Financing Expenses

Interest, commission, etc. arising from the use of foreign resources of the enterprise. speak bank expenses bank expenses.

4.5.1.e. Cost Calculations According to Expense Types

When calculating product costs, expenses can be classified according to their types as follows.

Production Costs

- Expenditure of raw materials and materials
- Labor costs
- General production expenses

Term Costs

- Research and development costs
- Sales and marketing expenses
- Management expenses

Expenses related to production activities of companies and expenses made for other activities are monitored separately. Production costs are transferred to product costs and period costs are transferred to the operating expenses. Follow-up of material expenses compared to other expenses and reflecting costs to products are processes requiring information. In order to prevent confusion, separate units have been set up to monitor materials, and to reflect payments to costs.

For example, let's calculate the unit cost of a product A:

The unit cost (with non-real values) is calculated as follows:

Annual Capacity: $ 100 000

Annual Direct Labor Cost: $ 200 000

Annual Total Production Cost: $ 400 000

Raw Material Cost: $ 100

Transport and Other Costs: $ 10

General Management Expense: 10%

Marketing and Sales Expense: 5%

Production Time: 2 Hours

Accordingly, the cost of a product:

Costs per hour:

Direct Labor Cost (DLC) = 200 000/100 000 = $ 2 / hour

Overall Production Cost (OPC) = 400 000/100 000 = $ 4 / hour

Raw Material Cost = Transport Cost + Purchase Cost = 100 + 10 = $ 110

According to Total Production Time:

Overall Production Cost = 4 * 2 = $ 8

Direct Labor Cost = 2 * 2 = $ 4

General Administrative Cost (GAC)= (OPC + DLC) * 0.1 = 12 * 0.1 = 1.2 $

Marketing / Sales expenses = (OPC + DLC + RAW + GAC) * 0.05

= (8 + 4 + 110 + 1.2) * 0.05 = 66.1 $

Product cost = (Market / Sales + OPC + DLC + GAC + RAW) = 66.1 + 132.2 = 198.3 $

Profit = 0.1 * 198.3 = 19.83 $ A profit margin (10%) is determined by the management.

Sales price = Profit + Product cost = 19.83 + 198.3 = $ 218.13

Distribution Expenses in May							
Types of Expenses	**Sum**	**Workshop A**	**Workshop B**	**Assistant Production Expenses Place**	**Assistant Services Production Expenses Place**	**Inventory Tracking**	**Packing**
Indirect Material	10.918	3.600	4.100	923	1.365	520	410
Direct Labor Cost	13.330	7.840	5.490	-	-	-	-
Indirect Labor Cost	20.660	8.940	10.560	620	540	-	-
Depreciation Expenses	44.283	10.200	16.870	423	590	6.400	9.800
Total Expense Places	89.191	30.540	37.020	1.966	2495	6.920	10.210

Table 2. Distribution Expenses

General Production Expenses

Indirect Material	10.918
Indirect Labor Expenses	20.660
Officer Fees and Expenses	5.400
Outside Benefits and Services	3.500
Miscellaneous Expenses	9.680
Taxes, Duties and Fees	5.400
Depreciation and Extinction Shares +	1.060
	56 618

Expenses from Distribution

Auxiliary Production Expenses	1.966
Service Expenses	+ 2.495
Total Expense from Distribution	4.461

Total Production Expenses = 56.618 + 4.461 = 61.079

Suppose 120 hours product A is produced in workshop A, 80 hours B is produced in workshop B, and there are a total of 200 DLT (Direct Labor Time) for July. Ratio of General Production Expenses to Products = 61.079 / 200 = 305,395 TL / DLT

Product A = 305,395 x 120 = 36,647.4

Product B = 305,395 x 80 = 24,431.6

Manufacturing Expenses	A	B	Sum
Direct Labor Cost	3,600	5,200	8,800
General Production Expenses	36,647.4	24,431.6	61,079
Total Production Expenses	41,447	32,031.6	73,479
Production Amount	500 pieces	300 pieces	800 pieces
Unit Cost	82,895	106,772	189,667

Table 3. Manufacturing Expenses

Unit costs are calculated by dividing the total costs of each product by the production quantity:

Unit Production Cost for Product A = 41.447.4 / 500 Pieces = 82,895 TL

Unit Production Cost for Product B = 32,031,6 / 300 Pieces = 106,772 TL

Estimated values and cost calculations were made for confidentiality reasons.

5. CONCLUSION

ASELSAN Electronic Industry and Trade Inc. During my 20-day summer internship in Istanbul, I saw the organization order in the business field. I learned the practical applications of engineering knowledge gained during learning. I had the opportunity to examine the systems and equipment used in unmanned systems and avionics production. I met with engineers, senior engineers, technicians and managers working at ASELSAN and got information about the plant layout and operation. During my internship, I had the opportunity to reinforce the theoretical knowledge I learned at school during practical applications. I learned how to take advantage of my theoretical knowledge in finding solutions to problems. I observed the competencies that a mechatronics engineer would have to have at work. I communicated with the engineering team to discuss methods to improve process and performance. Me and engineering team collaborated with multidisciplinary specialists to research and develop solutions to address issues. I have done detailed research on the projects of ASELSAN which serves in defense industry. I had the opportunity to personally observe the projects in the 'internship projects' section of my report. I have strengthened my knowledge by using the design programs and software languages that I am currently learning in the field. I observed the production methods and production process on the spot. I didn't encounter any problems during my internship period I have seen the opportunities and opportunities they provide to their employees and trainees quite sufficient. I observed that ASELSAN is an institution with discipline and principles and I had the opportunity to observe all its subtleties. It changed the way I look at programming and the applications I didn't know made me learn. He made me see what his working life was like. I was able to put into practice what I learned in technical and engineering terms. The machine elements and robot vision classes I took at school helped me a lot during my internship. Through these lessons I had an early idea of what to consider in the manufacturing process of the devices and the critical points. Thanks to my robotic vision lesson, I was able to provide a good idea of how to follow possible problems and test methods, as I know the principles and how the guidance and unmanned systems work and how they operate. I had a very efficient summer internship in ASELSAN which will be very effective in deciding the job site I want to work in the future. In addition to my technical, theoretical, practical and administrative achievements, I think it has added a lot to me about human relations. I think that the work experiences I gained and the new perspectives I have gained will help me in my professional life. I have seen many positive aspects of internship at ASELSAN.

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