

# Udvar Hazy Center Training

## SR-71 Overview

June 2010

### DEFINITIONS

- SPYING - a person employed by a Gov to Obtain secret info or intel on another Gov  
Alt - any person who clandestinely seeks info on people or projects for a profit
- ESPIONAGE - a covert act of spying on others often a systematic use of spies by a government to discover Military, Political, Economic secrets
- RECONNAISSANCE - An overt act of reconnaissance in the field... a search made for useful military Information to inspect, observe, or survey for enemy positions, strengths, and intent, ect. No longer just military purposes in this blended Technology Age

### HISTORY

Most earlier history HUMINT, human intelligence, was the primary source of information gathered and acted upon.

### TECHNOLOGY IMPACT - Reconnaissance

#### - CIVIL WAR

-- First use of Hot Air Balloons to observe the battlefield from high ground by Union forces

-- Considered by historians as the First Modern war. Mass transportation, Industrial age production, Rapid telegraph communications, modern weapons, Battlefield photography, etc

## WORLD WAR I

- FIRST MAJOR USE OF AIRCRAFT as observation aircraft with cameras and visual observers. Delayed information to decision maker until film developed and/or report filed
  - Caudron G4, Spad XVI, Hand Held Cameras with Black & White Photography & early radio reporting

## WORLD WAR II

- First 6 British Spitfire aircraft built were recon versions that flew over Germany and discovered build-up prior to WW II. Cameras incorporated into airframe
  - High Altitude Coldness and fogging problems on Window glass and film. Moisture causes film jamming and blurred images
  - Begin use of color film - resolution not as good as black & White but useful for camouflage detection
  - P-38 (F-5 reconnaissance version was excellent recon platform with cameras in the nose)

## COLD WAR

- Heightened SPYING & RECONASSANCE Activities  
How do we get information we need from the closed society of Soviet Union and its satellite system of countries?
  - Early attempts to penetrate IRON CURTAIN using modified fighters and bombers; RF-100As (Slick Chick - Europe), RB-17s, RB-29s, RB-47Hs, RF-86Fs (Haymaker - in Far East), British RB-57s, RB-36s, P-2s etc - With limited success. Most coverage of Eastern Satellite countries - Some Soviet Union Over flights - RB-47Hs Project Home Run - major over flights with multiple A/C over Siberia
  - 14+ Aircraft shot down and 170+ USAF, NAVY & ARMY crewmembers lost in early peripheral recon missions

-- Balloons were launched from German bases with Optical and IR sensors to fly over USSR. Fighters would provide protection until the balloons were high enough to be beyond the altitude reach of Soviet fighters. Randomly these missions were very successful if they happened to drift over fighter or bomber bases.

- U-2 background -

-- First aircraft built specifically to SPY and to be used to over fly Soviet Union & China

-- Kelly Johnson team wins award -Nov 54

--- P-38 (Major design contributor), P-80, F-104, U-2, (30+ aircraft designs) and his greatest developmental and fielding accomplishment - SR-71

--- U-2 built in less than nine months - 1<sup>st</sup> Flight Aug 55 - Test pilot Tony LaVier

--- First operational mission June 1956 flown from Wiesbaden, Germany flew over East Germany, Czechoslovakia, and Poland flown - Pilot Carl Overstreet

--- First Moscow over flight was on 5 July 1956 flown by Carmine Vito - This U-2 is displayed in the NASM on the Washington D.C. Mall

--- Surprised on first and early over flight missions with the U-2's detection by Soviet Radars & U-2 cameras discovered the deployment of advanced Surface to Air Missile systems

--- Knew threat of Surface to Air Missile defense and radar coverage was growing in late fifties and even before the 1 May 60 shoot down of Gary Powers it was known that the aircraft was at risk from advancing USSR defense capabilities

---- Bissell, CIA, initiated Survivability Study in 1957 as directed by President Eisenhower after he briefed the President on the U-2's risk - Key study findings would be that Supersonic speed, High Altitude, and low radar cross section (stealth) contribute most to survivability

---- Kelly Johnson first mentions ARCHANGEL in his diary in April 1958. He briefs

Edwin Land committee on his concept on 21 July 1958. Mach 3 aircraft flying at 90,000 ft.

---- Summer 1958 Bissell commission reports back to President Eisenhower. Space not ready for collection - Corona project still not successful.

SPACE SATELLITES - not yet mature or successful

- CORONA

- 12 failures before first successful flight
- 13<sup>th</sup> Flight successful - carried no film Jun 60
- 14<sup>th</sup> Flight on 8 August 1960 flew over Moscow as Gary Powers was on trial and in one pass filmed more area of the Soviet Union than all the U-2 flights up to that date. 40ft resolution initially and by Oct 67 6ft resolution or Oct 69 9ft resolution

MANNED REPLACEMENT REQUIRED with three advanced characteristics: Mach 3 flight(2,000+mph), flying above 80,000 ft, and America's first stealthy aircraft. Need for manned over flight with lower political risk solutions - To meet President Eisenhower's concerns & prospective

This compared with the U-2 that flew around 70,000ft at about 450mph and was not at all stealthy even after radar reduction efforts

President Eisenhower gives go ahead for study competition in December 1958 - Competitors are Convair & Lockheed

- September 1958 Skunk Works studying various configurations starting with Archangel-1, Archangel-2 which eventually are just called A-1, A-2, Etc

- President Eisenhower approves U-2 replacements go ahead in July 1959

- 29 August 1959 CIA accepts Lockheed A-12 design

- Kelly Johnson Skunk Works team  
-- Leading edge technologies as this was all new performance grounds. Kelly was looking to design an aircraft that would fly at Mach 3+ and at 90,000ft A-1 design starts in 1958 with evolving design iterations that leads to

-- A-11 Archangel Program grows into:

-- TWO PROGRAMS

--- A-12 - single seat - Code Name Oxcart

- First Flight 26 April 1962 - Pilot Lou Schalk
- 13 built/ 5 lost
- 2 Built used for D-21 Drone launcher/1 lost
- Primarily Imagery - some SIGINT
- Only known combat hit - Minor SAM nick

-- SR-71 two-seat Strategic Air Command requirement - Code Name Senior Crown

-- Larger A/C for Multi-Intelligence collection capabilities and greater payload

-- Trade-offs longer range, heavier payload - 4K, lower altitude and has higher Max takeoff weight of 140,000+ vice 117,000 for A-12

-- Lockheed SR-71 Contract - Feb 1963

-- Pres Johnson announces SR-71 program 25 Jul 64

-- First flight 22 Dec 1964 - Bob Gilliland

-- USAF first delivery 10 May 1966

-- 32 built/ 29 SR-71As -11 lost, Trainers: 2 SR-71Bs -1 lost, & 1 SR-71C

-- First combat 21 March 1968 - Replaced Blackshield, CIAs A-12s force at Kadena Okinawa AB, Japan - Maj Jerry O'Malley & Maj Ed Payne (absolutely first class Operational/Maintenance facilities at Kadena AB, Okinawa Japan funded by CIA)

-- SR Operational Flights end - 1 Oct 1989

-- SR decommissioned 26 Jan 1990

-- 972 arrives Dulles after speed runs 6 Mar 1990 (LA to Dulles Airport 64 minutes)

#### AIRCRAFT CHARACTERISTICS

- Last major A/C designed using Slide Rule. Blue prints were reference documents during life of program
  - Big aircraft 107 ft long 55 ft wide and 18 ft high
- First low RCS aircraft - About 1 sq meter
  - America's first stealthy aircraft
    - Lockheed Team that tried to reduce U-2 radar signature worked in baseline of SR-71 design
    - Sloped tails, curved sides A/C fuselage, Graphite materials in leading edges and pie shaped panels, ferrite particles in paint to further defuse radar energy
- Aircraft Speed - Mach 3.3, 2200 mph, 36 miles/minute, 3200fps, over ½ mile/second
- Tremendous heat stress environment generated on aircraft drives requirement for Titanium as aluminum can't endure the heat and steel alloys were too heavy
  - 93%+ titanium - Russia Source of Sponge
  - Heat picture Aver Temp near 600 temp range 400- 1200F+ degrees
    - Pilots pie window 620F+ and side window 550F, Wing leading wing area 500F+ to core of engines - 3400F+ degrees
    - Aircraft grows 3-4 inches length & 1-2 inches in width & Engines expanded with heating
    - Expansion joints loose fit handles length growth and corrugation handles most of width growth
    - Landing Gear largest Titanium forging ever tried
- Tires - B. F. Goodrich 22 ply filled with N2 to 425 psi - Impregnated with Aluminum powder to reduce tire heat by reflecting airframe heating
  - One of the more sensitive parts of the aircraft for operational considerations

--- Of the 12 aircraft lost - 3 had tire failure as main cause & 1 as significant contributor

- Elevons Mixer Assembly - Blend pitch and roll inputs to back surfaces - built by Boliva Watch

- Stability Augmentation System(SAS) - Aircraft Unstable in Pitch & Yaw axes. SAS gives constant automatic small flight control inputs

-- Pitch and yaw sensors on Pitot static system on nose y-stem fed constant information to SAS

- Special fuel JP-7 Normal flash point for JP-4 is -40 & JP-7 is about 335F 12,000+ gallons spread mostly in center of aircraft, Tanks inerted with N2 gas as fuel is burned.

-- One of the operational limits on aircraft is availability of Nitrogen gas - two 55-liter LN2 dewars plus smaller one for longer missions

-- Fuel used as heat sink to cool critical parts of aircraft - crew, sensors, hydraulic & engine oil and also used as hydraulic fluid in engine nozzle controls (Russians always wanted to understand how this cooling worked)

-- Triethylborane(TEB) used to start engines and with each afterburner light. A pyrophoric burns at about 3000 degrees with contact with air when ejected inside the engine. Counter on each throttle quadrant - 16 guaranteed ignition shots for Initial start & Afterburner lites

-- Special fleet of dedicated tankers KC-135Q, & later KC-10s were also used to refuel SR-71 fleet worldwide

-- Oil solid at 32F deg, Jell-O at 40deg, honey at 60deg, Pre heat engines before every start to 12 C(70F) Temp to insure adequate lubrication

-- Glass - Quartz Laminated 2.0 inches thick temp on pilots pie windows 620F+ temp

-- Graphite Composites on Chines mainly on edge and pie shaped to defeat radar energy

-- Blue Black paint - Gives some cover against black upper atmosphere sky, but its greatest

service was radiating heat away from the a/c into the cold air, -55C standard( -80F), outside temp varies from -40 to -85c. Paint reduces overall skin temp by up to 50 F degrees at Mach 3.2.

-- Hydraulics Special fluid -normal operating pressure about 3200psi

- Astro-inertial Navigation System

-- Based on canceled British Sky bolt program

-- Each hangar surveyed by US Geological Survey team for exact earth location and geodetic marker placed in each hangar for aircraft navigation alignment reference

-- Computer/inertial alignment about 1 hour + 45 minutes prior to engine start

-- Astro-tracker behind RSO would normally have a three star lock-on within 30 seconds after clearing the hangar on a clear sunny day

-- Guaranteed President 300 ft anywhere in world traveling at 2200mph+

- Radios on Aircraft

-- UHF 1 & 2 COMNAV-50 - antennas Left forward and right aft under chine near wing root

-- Secure communications with range and bearing information for tanker rendezvous beyond 300 nm when automatically combined with the ARA-48

-- VHF - ARC-186 antenna left rear under chine

-- ADF ARA-48 - Direction finder radio

--HF ARC-190 antenna in nose & pitot boom

- MRS - Mission Recorder System

-- Records specific flight and sensor activity - including voice

-- 650+ data points recorded at set intervals for maintenance, checkrides, and film processing

-- Key to keeping aircraft operational success rate in the 95%+ range

- Aerodynamic Characteristics:

-- Double Delta design creates forward body lifting body effect- America's first lifting body

--- Contributes 35% lift at 3.2 Mach



- Able to fly higher and make higher bank turns - More maneuverable - 45 Deg bank turns
- Aircraft cruises with nose up - engines mounted about 2 degrees low to maintain level air inflow during cruise at 5 degrees Angle of Attack
- Aircraft rides the air the same as a boat rides in the water to provide the additional lift
- Sonic Boom with Flight - distinctive double boom like Shuttle sound barrier noise
- Referred to as the "Sound of Freedom"

- ENGINE/INLET MAGIC

- P & W J58 Engine - Originally designed for Navy classified project - subsequently canceled
  - Engine weighs 6,000 lbs
  - 34,000lbs thrust- Afterburner @ sea level
  - Continuous afterburner - climb & cruise
  - Engine core temperature - 3400F degrees
  - Rocknite ceramic coating in A/B section
  - 6 Engine by-pass tubes facilitate RAM effect at higher Machs - Total thrust components contribution
    - At 2.2 Mach thrust produced by engine 73%, (inlet 13% & ejectors 14%) - 27% Ram effect
    - At 3.2 Mach 83% thrust is created by RAM thrust(inlet 54% & ejectors 29%)& engine 17%
- Inlet
  - Bypass doors
    - Forward - automatic modulating to keep even pressure/flow on face of engine compressor
    - Aft doors- manually set positions to relieve pressure on compressor face
- INLET Configuration
  - Adjust airflow to maintain subsonic airflow at the face of the engine
  - Ambient pressure 14.7 psi at sea level & .4 psi at 80,000ft with outside temp -55C(-70F)
  - 14-16 psi at 3.2 Mach at compressor face

--- 1.6 mach - spike starts moving aft at 1 & 5/8 inch/per 10<sup>th</sup> of mach increase - total 26 inches aft at 3.2 mach

--- Spike aft movement opens inlet entry area by 112% and closes down inlet throat to 54% of Mach 1.6 position by 3.2 mach

--- UNSTARTS - Inlet Aerodynamic Disturbance

---- Mostly in climbs & turns

---- Could be extremely violent & threaten Aircraft controllability

---- All but disappeared with digital automatic flight & Inlet control upgrade - DAFICS

- Pilot functions in front - no stick in back

-- Standard steam flight instruments - Round dial - with a few special gauges, Triple Display Indicator(TDI)

-- Aircraft Commander & Flies the aircraft

-- Controls air refueling

-- Engine/bypass controls

-- Fuel controls

-- Periscope view - Rudder adjust & A/B monitoring at night, Plus Contrail monitoring

-- Special attitude system - Peripheral Vision Display (PVD) Laser cockpit reference system to help with Pilot's night flight situational awareness

- Reconnaissance Systems Officer (RSO) - NAVIGATOR

-- Aircraft Navigation

-- Sensor controls

-- Tanker Rendezvous

-- Defensive systems,

-- Handles most of the radio calls

-- Aircrew checklist executer

- Crewmembers 30-35 years old

-- 7 years flying experience

-- Physically fit - modified astronaut physical

--- Pilot must have 20/20 vision, no glasses allowed - Unstart's violence required no glasses that could be knocked loose during recovery

- Exceptional aircrew skills
- Volunteers for special assignment
- Demanding life of temporary duty about 150 days a year overseas in typically 42 day increments

- SELECTION PROCESS

- Submit volunteer program application
- SR-71 wing reviews Records- Flight & Personnel
- Seeking Excellent recommendations & interviews
- Modified astronaut physical
- T-38 flight evaluations for pilot
- SR-71 Simulator evaluation on individuals learning ability

- TRAINING

- One year from beginning until operational mission - 100 hours in the aircraft
- 3 months academics
- Lots of outstanding Computer Flight Simulator Training time
  - First simulator I had ever flown that flew just like the aircraft
- Two seat Trainers SR-71B and SR-71C for pilots
  - Milestones - 1<sup>st</sup> flight, 1<sup>st</sup> Mach 3 Flight, 1<sup>st</sup> CREW FLIGHT, 3.2 high mach, 45 deg high bank turns, and finally night flights
- CONTINUING TRAINING at Beale AFB, California
  - Home - monthly goal 3 SR-71 flights and 1 Simulator plus 8 T-38 companion trainer flights
  - Overseas - SR-71 flights as required by operations & maintenance

- TYPICAL DAY & SORTIE

- Certified formed crews flew ALL OPERATIONAL SORTIES
  - Monitored life style
  - Mission planning day before - computer plan generated by dedicated mission planning staff
  - Check mission for route plan, sensor schedule, divert bases, high bank turns, predicted fuel use, any unusual operations & special mission rules
  - Physical on arrival - 2 ½ hours before takeoff
  - High protein/ low residue meal- Steak & eggs
  - Put on cotton long johns to absorb perspiration
  - 1:15 hour before takeoff - SUIT-UP

- PRESSURE SUITS:

- Required for any USAF flight above 50,000 ft as above 63,000 ft with total cabin pressure loss creates instant death
- Started with modified Gemini Space suits
  - A White Suit & Chocolate Brown suit
  - Suit life about 12 years
  - 1030 Suit created by David Clark Co. came in during 1977
    - Suit weighs about 45 lbs & cost about \$250,000 in the late 1970s. Suit cost included suit, helmet, harness for parachute, oxygen regulator, and suit pressure controller
    - Much better shoulder movement, more Velcro attachments for checklists, and better ventilation
    - Each crewmember had two suits and two helmets
    - Four layers to suits\_ - Inner Nylon comfort layer, rubber bladder liner, adjustable fish net to keep the suit's shape, and the outer layer fire resistant material, Fipro - good to about 800 degrees

--- Suit starts to automatically inflate when the cabin pressure exceeds 32,000 ft

--- UCD Urine Collection Device - looks like condom with hose to tank in lower pocket

--- Harness hooked to larger main chute to compensate for heavier weight in Pressure suit

---- Life preserver built into harness - automatically inflates with water contact

---- Survival kit in seat pack you were sitting on. Manually deployed by pilot/RSO

--- Boots - Had stir-ups on heels connected to cable to retract feet against the seat upon ejection sequence to prevent losing legs on cockpit rail during the rocket propelled ejection

-- Helmet

--- 10 lbs

--- Critical flawless Glass faceplate for pilot, plexi-glass faceplate for RSO

--- Fine Gold mess face heater to prevent fogging on faceplate glass/plexi-glass

--- All 100% Oxygen environment

--- Access portal on right side for water and food

---- Food was in toothpaste like tube filled by Gerber's Junior foods - 6 food types

--- Mike in front near mouth

This suit would later be used in the Space Shuttle test program until they developed their own quick donning space suits that shuttle crewmembers use today

-- EJECTION SEAT - Rocket seat - excellent from sitting still on the ground, to takeoff roll, to the full speed and altitude of the aircraft

-- USAF crewmembers never had a fatality with this Lockheed ejection seat during aircraft ejection

- Driven in van and "installed" in Aircraft  
30 minutes prior to takeoff start engines

--Faceplates down breathing 100% oxygen

- Start cart - pair of Buick wildcat engines with drive shaft into engine from below
  - 1000 rpm start ignition with throttle movement
  - 3200+ rpm accelerating engine - start cart disengages automatically (Idle RPM 3975)
  - Flight control/leak checks
- End Runway checks

Tankers already airborne

- Check tires carefully for cuts/or inflation problems
- Final leak and flight control check

#### - TAKE-OFF & CLIMB

- Mobile aircrew checks runway for foreign objects to prevent engine ingestion and/or tire damage
  - Brake release - select Afterburners (A/Bs)
  - A/Bs always come in separately
  - Start rotation at 180 knots - (205 mph)
    - Without rotation it becomes world's fastest tricycle
  - Lift off at 210 knots(240 mph) after about 20+ second roll using about 4,500 ft of runway
  - TO PROTECT TIRES AND FLIGHT CONTROL LOSS-OF CONTROL ZONE (Below about 275-290 knots or 315-335mph) - Most common fuel load was 40,000lbs on takeoff with refueling shortly after airborne
    - 2 minutes from brake release thru 20,000ft
    - Climb to 25,000ft and head out to tanker
    - Rendezvous with Tanker - On load normally about 60,000 lbs (10,000 gallons)
    - Accel and climb starting with dipsey doodle
      - To minimize high drag zone - Climb subsonically to about 33,000ft
      - Start shallow descent and select full afterburners for quick acceleration thru about 1.10 mach
    - About 17 minutes to altitude around 75,000ft+ & distance 360 nm+

- Burn 1/3 of fuel in climb & acceleration
- Manually turn off Rotating beacons at about 2.0 Mach & they would retract flush into the aircraft
- Using pilot's periscope check for contrails to start in the 50,000 ft range and normally stopping in the high 60,000 ft range during climb & acceleration. Contrails have occurred above 80,000 ft in very cold air.

- CRUISE in a climbing mode

- Engine temp control, inlet controls, outside temp big factor on performance
- Hostile areas - be above 75,000 ft and Mach 3.15+ before entering enemy airspace with DEFENSIVE systems operating
- Defense Systems - Highly advanced Electronics to counter Surface to Air Missiles and Fighters with Air-to-Air missiles
  - 100s missiles fired at aircraft during operational missions - none close - most common and widely deployed threat was the 3.5 Mach SAM-2 Air Defense system. SAM-5 long range missiles were deployed which had 4+ Mach capabilities and would come down from above. No SAM-5s were ever fired at a SR-71
  - Attempted fighter intercepts on many missions which included MIG-25s, MIG-23s and MIG-21s
- High Bank turns & 2.8 Mach for tight boundaries - Baltic Sea -and inside West Germany
  - Must manage your energy carefully to execute high bank turns
  - Visibility at altitude about 350+ miles in forward half = 9 - 3 O'clock position
  - Inside of pressure suit flying at Mach 3 with most of the sound behind you it was for the most part a rather smooth quiet flight
  - Intense concentration to insure aircraft does exactly what it is supposed to do.

Emergencies come fast & furious with limited time to input corrections/recovery

- MISSIONS

-- Most 2.5-4.5 hours - 1 or 2 refuelings  
-- Longest program missions 11 hours & 22 minutes - into Middle East from U.S. East coast & back round trip

-Over flights - political risk assumed by President - you are over their sovereign airspace

-- Sound of Freedom from the supersonic shock waves to make political statement during overflight. Shock wave was always present supersonically which dictated where we would climb, cruise, and descend over the United States to avoid sonic booms and possible sonic boom damage- generally manifested in broken windows

-Peripheral missions - Toughest - right along border of country of interest traveling at speed.

-- With an Emergency NOT authorized to violate Objective country's sovereign airspace to make a safe recovery

-High Frequency(HF) radio listening monitor for threat advisory and/or recall

- DESCENT

-- About two hours between refuelings & 2800nm (3200 Statue miles)

--- Tight descent profile -start 220 nm back and takes 10 minutes to descend to 25,000ft

--- Critical RSO function

--- Slowing & critical aircraft cooling

--- Tight descent profile to prevent engine compressor stalls & flameouts

--- Navigating to tanker at 25,000 ft

--- Silent rendezvous



- TANKERS - CRITICAL PARTNER

-- Essential partner of SR-71 System that made the system intercontinental plus so flexible, responsive and effective

-- Normally two or more tankers involved with each overseas refueling location

-- Often demanding remote refueling locations - Inside Artic circle

-- Special rendezvous radios give secure range and bearing at over 300 miles - CommNav-50 UHF radio for range & automatically ARA-48 for bearing

-- Refueling normally 12-15 minutes

(6,000lbs/minute transfer rate- 1000 gals/min)

-- Normal Hot refuel (coming from altitude)

80,000lbs or cold refuel 60,000lbs on loads

(shortly after takeoff)

-- Radio silent - interphone talk with tanker crew thru refueling boom to relay information

-- Director lights on belly of tanker give pilot visual guidance to go forward or aft and up or down

-- Aircraft weight often required the use of an afterburner during last 5-10,000lbs of fuel transfer.

--- One of Most demanding training items for pilots - Light an A/B while still in contact with tanker receiving fuel - stabilized

-- End Air refueling track with fuel tanks full & on time were critical to mission success

-- Over 26,000 refueling during program - an almost every flight occurrence

-- Russia scenario 5 refuelings 10.4 flight hours from California to North Coast of Russia and back involving 5 refueling rendezvous with 15 tankers and total of 72,000 gallons of fuel transferred. Second tankers out of Goose Bay Labrador, landed refueled and launched again to be our 5<sup>th</sup> set of tankers that day. Flew over 15,000 miles.

- ACCEL - Repeat profile

- LANDING

- No Flaps high-speed approach
- 175 knots (200mph) plus fuel (Typically less than 10,000lb of fuel but not less than 5,000)
- Land at 155 knots (170+mph) plus fuel
- Drag chute required because of brake/tire stress - landing roll about 4-5,000ft
- Radar landing pattern 3,000lb fuel consumed & 1,000lbs for closed visual pattern

- HANGAR

- Dollies ready to download sensors for immediate processing, film and recorders
- De-suit and immediate Intel Debrief
- Maintenance session on aircraft performance and possible write-ups which was attended by military personnel and Industry Technical Representatives
- Later maybe view film take - Early rules stated you were not allowed to view the film

- SENSORS

- OBC (Optical Bar Camera) in Nose - countries camera - 100,000 square miles per hour
  - Picture image 72 miles wide - High resolution film roll was 10,500ft long & 5 inches wide
  - Critical preflight camera preheating for 12+ hours for mirror stability
  - Manually actuated camera with turn on and turn off points along a route of flight
  
- SAR (Synthetic Aperture Radar) nose - great improvements: Either side 12-inch resolution - spot imagery at 25-85nm range & swaths at 20-100 nm range -10 nm wide at 10ft resolution
  - Mt Saint Helens and other special applications- Hangars and sub pens

- Computer controlled with multiple modes
    - Spot imagery
    - Area coverage in strips
  - TEOC (Technical Objective Camera)
    - Cameras programmed for flight & controlled by computer
    - Common to have 100s of objective targets
    - Sub 12-inch resolution - up to 20nm out on side of aircraft with camera. Imagining further out possible when taken in a turn with the upside camera
    - Film was very high resolution 1,500 feet long & 9.5 inches wide
- Infrared System never really worked

-EMR Electromagnetic Reconnaissance System

- World class ELINT system
- Speed and ground distance change makes for best in its time collector for accuracy on short duration signals
- Deep view of emitters - electronic horizon over 600+ miles
- Coordinated Missions most effective involving multiple types of platforms & sensors to include space, airborne, ships, and land sites for collaborative collections
- SR-71 always viewed as a most effective stimulator of enemy defense radars and command and control functions

- POST SCRIPT

- No SR-71 is flying today as they have all been transferred to museums
- Major Cold War assessments:
  - Flew for almost 25 years unchallenged technologically
  - 11,000 operational hours / 20 % of total hours flown 54,000 hours
  - 3500 + operational sorties around the world

- Over 26,000 refuelings
- Critical provider of information to 6 Presidents & the major image provider during Arab-Israeli War in 1973 flying round robin from the East Coast of the United States - Some of the SR-71's longest and most successful missions
- SR-71 was not retired because it was no longer capable as it was without an aeronautical equal and the 1980s had seen significant upgrades to the aircraft systems

#### Reason for retirement

- "Cold War over" Perceived Reduced threat
- Expensive \$85,000 per hour to fly
- Lack of Data link to support changed Commander requirements - Today's world requires information to decision maker in minutes not hours or even days. Today the metric is revisit times and persistence looking for critical time sensitive target discovery, identification, and their changes

#### - Personal vignettes

- I flew over 60 operational sorties - including taking 972 into Middle East from England
- Survived over 100 unstarts - one nose rise off China coast almost caused consideration for ejection
- Coordinated sortie out of Kadena - terrible weather with airfield closed. Harrowing departure and recovery after aborting for no A/B on one side after refueling. Cleared to land only to break out at about 200ft in the weather and see a DC-10 on runway - circled to land under weather with Attitude/Navigation instruments now gone and the radar controller no longer able to talk with us- he was relieved of duty
- Landing at night from mission on closed Mildenhall AB, airfield in England - Weather below minimums at air base & all over England

--Tremendous joy of flying this aircraft and being part of an absolutely superb selfless team from planners, maintenance, Physiological Support, Tankers, and Intelligence and our Bases focused on serving this nation daily - wherever that service required us to go and whatever to do

-- Privilege to have been able to dialog with Kelly Johnson on a number of occasions and bore witness to one of America's greatest aircraft designers/innovators. No Challenge was too great nor detail too small not to be dealt with

-- Wonderful sense of accomplishment from these missions flown knowing you were helping the cause of Freedom during the Cold War. But because of the nature of this activity you could only share the details with a very close and cleared few

-- 972 was one of our finest aircraft. Not only did it set numerous speed records but also it was an aircraft one could depend on during day-to-day operations

#### RECOMMENDED BOOKS TO READ:

Blackbird Rising - Birth of an Aviation Legend,  
Donn Byrnes, Sage Mesa Publications, 1999

Lockheed Blackbird Beyond The Secret Missions,  
Paul Crickmore, Osprey Press Revised 2004

SR-71 Revealed The Inside Story, Col Rich Graham,  
Zenith Press, 1996

SR-71 Blackbird - Stories, Tales, and Legends, Col  
Rich Graham, MBI Publishing Co.2002

Flying the SR-71 Blackbird In the cockpit on a  
Secret Operational Mission, Col Rich Graham, Zenith  
Press, 2008

50 Years of the U-2, Chris Pocock, Schiffer  
Military History Book, 2005

BUZ CARPENTER - UHC DOCENT  
Former SR-71 Instructor Pilot  
Any Questions, Email [Acarpenter4@cox.net](mailto:Acarpenter4@cox.net)  
Tele home 703-385-4862, Off 703-236-7413  
Cell 703-408-2971