Gripen
Presentation för NTVA
2007-02-27
Agenda

- Saab Introduction
  - Saab R&T
- Gripen Background
  - Program
  - Design Goals
  - Tactical requirements
  - System aspects
- Operational Aspects
- Next Generation Gripen
- Questions
A history of high technology

1941
First B17 delivered

1948
Tunnan – first flight

1979
First order for RBS 15

1990
First laser simulator BT46

1993
First Gripen delivered

2002
First contract for NLAW

2003
First delivery for A380

2005
Contract for Neuron

2006
Saab 2000 ERIEYE™ AEW&C

1646
Bofors Järnbruk is founded

1894
Alfred Nobel acquire Bofors

1948
First order for Carl Gustaf

1998
StriC in operation

1950–
Development of fighter radar

1970–
Development of GIRAFFE

1980–
Development of ARTHUR

1990–
Sea Giraffe AMB is launched

1937
Saab is founded

1990
Saab Automobile independent company

2000
Saab acquires Celsius

2005
Saab acquires Grintek

2006
Saab acquires EMW

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## Saab in brief

<table>
<thead>
<tr>
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<th>2006</th>
<th>2005</th>
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<tbody>
<tr>
<td>Sales US$ m</td>
<td>2,854</td>
<td>2,582</td>
</tr>
<tr>
<td>Operating income US$ m</td>
<td>236</td>
<td>221</td>
</tr>
<tr>
<td>Operating margin %</td>
<td>8.3</td>
<td>8.6</td>
</tr>
<tr>
<td>Number of employees</td>
<td>13,577</td>
<td>12,830</td>
</tr>
</tbody>
</table>
International business

Sales: 65%
Order bookings: 72%
Order backlog: 77%

- Sweden
- International
Three segments – 17 business units

Defence and security solutions

- Saab Systems
- Saab Aerotech
- Combitech
- Saab Grintek
- Saab Communication
- Saab Surveillance Systems

Percent of sales 2005:
- 27%

Systems and products

- Saab Bofors Dynamics
- Saab Space
- Saab Avitronics
- Saab Underwater Systems
- Saab Training Systems
- Saab Microwave Systems

Percent of sales 2005:
- 34%

Aeronautics

- Saab Aerosystems
- Saab Aerostructures
- Gripen International
- Saab Aircraft Leasing

Percent of sales 2005:
- 39%
Unique focus on research & development

- The number one R&D company in Sweden

R&D as a percentage of sales

- 2004: 22%
- 2005: 18%
Saab Aeronautics

Focus on 3 market segments:

- Fighter Aircraft Systems
- Unmanned Air Vehicles, UAV
- Supplier to manufacturers of large civil aircraft
Saab R&T

Industry

Research Organisations

Demonstrators

Product Concepts

Key technologies

Aerospace specific basic technologies

Generic technologies
Demonstrators, examples

FILUR (Flying Innovative Low-observable Unmanned Research vehicle)

MERA (More Electric Research Aircraft)

Electromechanical actuator
Product concepts, examples

Gripen future development

TUMAV
Key technologies, examples

Sense and avoid technology

Autonomy and decision support

System Architecture
SAAB Venture Capital Council

Leveraging R&D by bringing competitive technologies to non-core markets in win-win arrangements
Our heritage – close to 70 years of experience
Gripen program in the rear view mirror…

- **1988**
  First flight with JAS 39 Gripen prototype.
- **1992**
  Swedish Parliament decision, followed on June 26 by a contract between FMV and IG JAS, to develop a dual-seater, to purchase a second lot of **110 JAS 39 Gripen** including 14 dual seaters and some additional support systems.
- **1996**
  Parliament decision to purchase lot three consisting of **64 JAS 39 Gripen** including 14 dual seaters and some additional support contract
- **1997**
  Gripen declared operational by CAF Gen Harrskog
- **1999**
  Export starts…
JAS 39/Gripen Program

- Order book 246 aircraft
- ~190 Gripen currently delivered
- Contracted by South Africa December 1999
- Contracted by Hungary December 2001 and February 2003
- Contracted by Czech Republic in June 2004
- UK Empire Test Pilots’ School, ETPS… April 2005
### Single seat – General layout

**Dimensions**

- Wing span incl. launchers: 8.4 m
- Length excl. pitot tube: 14.1 m
- Height overall: 4.5 m
- Wheel track: 2.4 m
- Wheel base: 5.2 m
- Empty weight: 6.8 tonnes
- Max Take-off weight: 14 tonnes
Dual seat – General layout

Dimensions

- Wing span incl. launchers: 8.4 m
- Length excl. pitot tube: 14.8 m
- Height overall: 4.5 m
- Wheel track: 2.4 m
- Wheel base: 5.9 m
- Empty weight: 7.1 tonnes
- Max Take-off weight: 14 tonnes
Gripen baseline features

Gripen Inherent Features – Baseline A/B

- Worlds most advanced Data Link System
- Swing Role Capacity
- Advanced multi-mode radar
- Fly-By-Wire
- High agility, speed & autonomous
- Auxiliary Power Unit (APU)
- Low radar and visual signature
- Advanced cockpit layout
- Embedded training
- Rapid reaction & turn around time
- Advanced Built In Test system
- Fully Integrated Avionics System
- Designed for a low cost of ownership
Design Goals
Design goals

Break the cost increase curve
Replace all versions of Viggen
Reduce empty weight by half with maintained stores capability
Able to operate from Swedish AF dispersed road base system
Easy and quick turn-around, performed by conscripts
Minimized requirement for ground support equipment
Small footprint to the base-system
Built in growth potential
Low LCC
Design goals

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Design Goals. New materials

Composites

- Carbon-Fiber Composite (CFRP)
- Glass-Fiber Composite (GFRP)
- Aramid-Fiber Composite (AFRP)
Design Goals. Material by weight

- CFRP: 59%
- Titanium: 8%
- Aluminium: 20%
- Steel: 5%
- Other: 8%
Design goals

• Break the cost increase curve
• Replace all versions of Viggen
  ▪ Reduce empty weight by half with maintained stores capability
• Able to operate from Swedish AF dispersed road base system
• Easy and quick turn-around, performed by conscripts
• Minimized requirement for ground support equipment
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Brake system

- Brakes on all wheels
- Anti skid protection
- Touchdown protection
- Spin down control
- Brake energy control (Nose wheel)
- Pulse mode, emergency
- Isolation of supply during flight (gear up)
- Fault Monitoring
Design goals

- Break the cost increase curve
- Replace all versions of Viggen
- Reduce empty weight by half with maintained stores capability
- Able to operate from Swedish AF dispersed road base system
- Easy and quick turn-around, performed by conscripts
  A-to-A 10 min, A-To-G 20 min
- Minimized requirement for ground support equipment
- Small footprint to the base-system
- Built in growth potential
- Low LCC
Gripen – Easy and quick turnaround

Survivability & Flexibility for Autonomous Operations

- Typical runway (45 x 2,400 m)
- Swedish Road Base (17 x 800 m)

- Dispersed operations
  - Short take-off/landing
  - Side mounted engine intakes
  - APU
  - Minimum GSE and crew

- Rapid turnaround
  - Air-to-Air < 10 min
  - Air-to-Sea/Ground < 20 min

- Scramble
  - Airborne < 1 min
Gripen – Easy and quick turnaround

Survivability & Flexibility for Autonomous Operations

Typical runway (45 x 2,400 m)

Swedish Road Base (17 x 800 m)
Gripen requires (9 x 600 m)
Gripen – Easy and quick turnaround

Survivability & Flexibility for Autonomous Operations
Design goals

- Break the cost increase curve
- Replace all versions of Viggen
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- Able to operate from Swedish AF dispersed road base system
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Secondary power system

Allows start of aircraft without external power.
The built in APU provides power to:

Auxiliary gearbox (Hydraulic/Electrical)
ECS, when engine bleed air not available
Air Turbine Starter, for engine start

As backup thermal batteries for hydraulic and electrical power.
Design goals

- Break the cost increase curve
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Built In Test Functions

Pilot

- Main Power on
- Take off
- FM, Recording
- SC failed
- Engine shut down. Quick Report
- Main Power off

Ground Crew

- SC failed
- SC
- FI + Recommended procedure

FC

- FM-alarm
- FRPT + Recommended procedure
Test status summary after Safety Check.

Only failed tests are shown.

Display in order of Fault Isolation Priority.

<table>
<thead>
<tr>
<th>TEST MODE: FI</th>
<th>SUMMARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 HYD F</td>
<td></td>
</tr>
<tr>
<td>5 FUEL F</td>
<td></td>
</tr>
<tr>
<td>4 ECS F</td>
<td></td>
</tr>
<tr>
<td>18 RDR M</td>
<td></td>
</tr>
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</table>

U/S:
- Radar Ground Ranging
- SC Flight Safety Fail
- SC Mission Fail
- SC Rear Seat Started

SC degradation info will provide information to the pilot about what causes a degradation of the aircraft in terms of mission capabilities.

Information to ground crew.

Fault in the ECS. Indication that the auxiliary power unit (APU) and the ground support equipment (GSE) supply air at the same time, or none of them supplies air.

SC degradation info will provide information to the pilot about what causes a degradation of the aircraft in terms of mission capabilities. (Even at FMAN-page.)
Central or Right Display
Manual selection of Warning presentation.

Flight manual display
Shows
- Failure
- Recommended pilot actions
- Information about degradations

A 193 CABIN PRESS LO

1. ALT < 20 000FT
2. IF ALSO OXY PROBLEM: ALT < 10 000FT
3. ABORT MISSION

INFO:
OXY MASK PRESSURE INCREASES ANTI-G SUIT PRESSURE FLUCTUATES
Tactical requirements

- Possible for a pilot to fly all types of missions
- Autonomous operations, shared information, superior situational awareness
- Able to change mission type during flight
- Quick response time
- System for mission planning, evaluation and training
- Tools for enhancements to the electronic map and EWS-system library
Mission Support System

Data Support
- Map info
- Com. Libraries
- EW Libraries

Planning
- Stores
- Navigation
- Communication
- Weapon
- EW
- Sensors

Rehearsal
- Scenario Simulation
- 3D View

Intelligence Updates
- Order Intelligence Weather
- TAC

Mission Report

Preparation Data
- EW Libraries
- Waypoints
- Weapon data
- Settings
- EW selection queries

Recorded Data
- Flight Path
- Radar Events
- EW Events
- Recce Events
- EDS & Panels
- Audio & Video

Evaluation
- Mission Replay including
  - Flight path
  - Events
  - Cockpit
  - Audio/Video

DTU-P

DTU-P MMC

Orders
- Intelligence
- Weather

Mission Support System

Evaluation
- EW Analysis
- Weapon Analysis
- Radar Analysis

EDA & Panels

Audio & Video
Aerodynamic layout and design

- Requirements asked for:
  - Good turn performance
  - Excellent handling qualities
  - Low buffeting level, gust alleviation (low level operations)
  - Supersonic speed at all levels
  - Good acceleration performance
  - High external stores capability
  - Long range performance
  - Short field operations
  - Stable weapons platform
Aerodynamic layout and design

Requirements resulted in:

- Modified delta wing with canard
- Relaxed static stability in pitch
- Fly-by-wire flight control system
- Feathered canards resulted in stable aircraft, gave time for safe ejection
Why an Electronic Flight Control System, EFCS?

- Improved performance
- Advantage in installation (space and weight)
- Easy to create redundancy, battle damage resistance
- Possible to make advanced calculations (load factor limits, auto recovery etc.)
- Reduced pilot workload
- Easy to monitor
- Flexibility with potential to enhance software
- Low-cost mass produced components
FCS Handling qualities

Flying qualities optimized depending on:
- External stores, altitude, speed
- Op. mode: Taxi, Ground roll, Lift off, Combat, PAL, Aiming

Drag minimized through trimmed lift between canard and main wing
- Cuts through the air

Leading edge flaps to reduce buffeting level and drag

Automatic gust alleviation

Precise response easy to fly formation, land and handle on ground

Very small effect of external stores

Outer loop functions can easily be developed
FCS-Performance Groups

- Flight Control Software (FCS) in ‘performance groups’

Carefree maneuvering

- Each configuration assigned to a ‘performance group’ PG

Increasing ‘g’

Increasing AoA / Roll rate

Group A

Group B

Group C

Group D

Group E

Group F

Light Fighter

Heavy Fighter

Light Attack

Heavy Attack

Heavy asymmetric

Performance continuum

Gripen International | 2007-02-13, 45
Manoeuvre performance (AoA, loadfactor, rollrate)

Releases

PG A
PG B
PG C
PG D
PG E
PG F
We picked the Best!
Gripen export features

Gripen Enhanced Features – Export & C/D

- Multi-national/NATO interoperability
- Fully integrated electronic warfare system
- Additional weapons clearances
- Helmet Mounted Display
- Higher payload & increased MTOW
- Recce Pod
- Advanced Mission Support Equipment
- 3 Colour MFD (8” by 6”)
- English language displays and publications
- World-wide climate clearance
- Air-to-Air Refuelling
- OBOGS
Day and Night HMI Adaptation
Gripen Architecture – Major Functionality

Centralized system built around:
- Five MIL-STD-1553B data buses
- SC (Systems Computer), acts as bus controller
- AIU (Aircraft Interface Unit), as backup bus controller

High grade of functional Integration within Core System:
- SC (Systems Computer)
- AIU (Aircraft Interface Unit)
- GECU (General Systems Control Unit)
- SMU (Stores Management Unit)
Data-links

**User Controlled Encrypted Datalink**

- Tactical info
- Positions
- A/c to a/c
- A/c to ground
- Ground to a/c
- Image transfer
- Auto messages
- Etc

**Link 16**

- Optional level of integration
“Generic Third generation fighter”

Head-down display

Radar detection: 2 targets at medium range.

SA-Display

Radar-display
Tactical scenario, example
The Gripen ‘Cobra’ HMD system is the latest version of the ‘Striker’ family
- Includes Night Vision Cameras and day camera on the helmet
- Electro Optical trackers

In 2004 centrifuge tests were carried out in UK and Sweden.

In May 2004 the ‘Cobra’ HMD System was flown for the first time in the Gripen - This was the first flight with a modern binocular HMD system in the –3g to +9g envelope.

In service date planned for 2008.
Multimodal Display Techniques
Perspective Displays

Experience Perspective Displays

- Synthetic Terrain Head-up
- 2,5D- and 3D- presentations.
Multimodal Display Techniques
Tactile Indications

Experience Tactile Indications

- Evaluated the use of tactile indications as navigational aid in a ground based scenario
- Tested with, and without, 3D-audio as a complement.
- Preliminary results are very promising regarding spatial awareness and the ability to discriminate the indications.
Direct Voice Input has been tested and evaluated during different kind of scenarios.

Advantages were found regarding High Level Commands, in other words: One voice command replaced a chain of ordinary keyboard and marker selections.
Operational Aspects
Experience gained…

- First SwAF sqn operational 1997
- Logged some 85,000 flt. hours
- Proven logistics concept
- Participation International Exercises
  - Battle Griffin
  - Nordic Air Meet
  - Frisian Flag
  - NOAM (Nordic Air Meet)
  - COOP Jaguar
  - Joint Winter
  - Red Flag Alaska
  - …
- Successful dissimilar ACM training
  - F16, F18, MIG 21, MIG 29, Tornado F3, L39, Mirage III…
Gripen on a spiral development path!

**Gripen A/B**
- Digital Fighter Link
- Swing-role fighter
- Rapid reaction & turn around time
- Advanced BIT
- Designed for low cost of ownership
- Glass cockpit
- AMRAAM
- Fly by wire
- APU
- 
- NATO interoperability/LINK 16
- Air to Air refueling
- Increased MTOW
- OBOGS
- Color displays
- Fully integrated EWS
- HMD
- World Wide Climate Clearance
- Increased survivability/lethality
- NATO-pylons
- ...

**Gripen C/D**
- 
- Increased range
- Increased MTOW
- Added weapons stores
- Increased thrust
- AESA
- Enhanced EWS
- Advanced rear cockpit
- Enhanced NCW
- Full capability HMD
- GCAS
- Satellite Comms
- Jammer Pod Integration
- Improved LCC
- Overall increased basic performance
- ...

**Gripen N**
Example - Structural

New fuel tank 6, in existing landing gear compartment

New main landing gear, repositioned
## Gripen Next Generation

<table>
<thead>
<tr>
<th>Basic data</th>
<th>Gripen C</th>
<th>Gripen N</th>
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<tbody>
<tr>
<td>Length excl. pitot tube</td>
<td>14.1 m</td>
<td>14.1 m</td>
</tr>
<tr>
<td>Wing span incl. launchers</td>
<td>8.4 m</td>
<td>8.4 m</td>
</tr>
<tr>
<td>Number of Stations</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Empty weight</td>
<td>6 800 kg</td>
<td>7 100 kg</td>
</tr>
<tr>
<td>Internal Fuel</td>
<td>100%</td>
<td>138%</td>
</tr>
<tr>
<td>Engine Thrust</td>
<td>18 000 Lbs</td>
<td>&gt; 22 000 Lbs</td>
</tr>
<tr>
<td>Max Take-off weight</td>
<td>14 000 kg</td>
<td>16 000 kg</td>
</tr>
<tr>
<td>Payload</td>
<td>5 000 kg</td>
<td>6 000 kg</td>
</tr>
</tbody>
</table>
New/Upgraded Avionic Structure

- Increase overall capability:
  - Better computer and bus performance
  - Reduce time to integrate new systems and functions (hours rather than months)
  - More efficient distributed development

- Increase mission availability
- Meet new (unknown) operational requirements
- Easy Start-Up
- Common avionic development for all flying Saab products
- ....
Existing Saab industrial network in Norway:

Nordtro A.S
Natech NSV A/S
ASTI
Capro AS
Trelleborg Viking A.S
Capinor A/S
Nammo Raufoss A.S
Nortek AS
Eltek Energy AS
L3 Communications Navigation AS
Det Norske Veritas AS
Vikato Consulting A/S
Park Air Systems AS
Simrad Optronics A/S
Syberg A/S
THALES Norway AS
Visma Services
Vinghog A/S
Keytouch A.S
Hydro Polymers A/S
Engelsrud Fyrverkerifabrikk A/S
Heli-One Norway AS
Kitron Arendal A.S
Hydal A/S
Jakob Hatteland Display A.S
Corena Norge AS
Kongsberg Defence & Aerospace AS
Seaprof Solutions AS
Aanderaa Instruments A/S
Ingeniør Harald Benestad A.S
West Mekan Produksjon A/S
Sörkjosen
Narvik
Selbu
Melhus
Mjøndalen
Gjøvik
Raufoss
Rud
Drammen
Hövik
Slemmested
Oslo
Oslo
Oslo
Tonsberg
Horten
Porsgrunn
Sarpsborg
Stavanger Lufthavn
Staubö
Kopervik
Nedre Vats
Kongsberg
Kongsberg
Bergen
Bergen
Lierskogen
Nordfjordeid
New partners and suppliers:

Applica AS
Datarespons Norge AS
DYNO Nobel ASA
Flextronics International Norway AS
Josab International AS
Karotek AS
Keytos AS
Mesanin AS
Motec AS
NCE Systems Engineering Kongsberg
Norsk Hydro ASA
OPRA
SCALI AS
SH Produkter AS
T&G ELEKTRO
TECHNI AS
TINEX AS
UMOE AS
VMETRO ASA
Jotne/EPM Consultants
PRESENS AS
EIDEL Eidsvoll Electronics
Kongsberg Devotek

N-Tec
Tisics
Aktiv Styrning
Heli-One
Teleplan
Ergo Group
Nordisk Mobiltelefon AS, NMAS
Saab Microwave, Halden
Volvo Aero Norge
Fjord International
Semcon

..and many more to come...
QUESTIONS ?