

# Contents

<b>Foreword</b> . . . . .	ix
<b>Author's preface</b> . . . . .	xi
<b>Acknowledgments</b> . . . . .	xv
<b>Acronyms</b> . . . . .	xvii
<b>1. A brain and mind for the Orbiter: the avionics system</b> . . . . .	1
Shuttle data processing system: familiarization . . . . .	1
Redundancy . . . . .	13
Backup flight software . . . . .	23
Crew operations . . . . .	26
C/W and on board system management . . . . .	28
<b>2. A skeleton for the Orbiter: structure and mechanisms</b> . . . . .	35
Designing the Orbiter structure . . . . .	35
Shuttle Orbiter structure: fuselage . . . . .	39
Orbiter active vent system . . . . .	48
Payload bay doors . . . . .	51
Orbiter wing . . . . .	61
Body flap . . . . .	66
Vertical tail . . . . .	66
Robotic manipulator arm . . . . .	67
Orbiter structural maintenance . . . . .	79
<b>3. Power to orbit: the main engines</b> . . . . .	81
Introduction . . . . .	81
Main propulsion system . . . . .	81
SSME propellant flow . . . . .	83
SSME main components . . . . .	91
SSME development . . . . .	107
SSME evolution . . . . .	110
SSME operations . . . . .	114

<b>4. Power to orbit: solid rocket boosters</b>	125
The rocket equation	125
The search for a booster	127
SRB structure	129
Thermal protection	137
Recovery system	138
Propellant	140
SRB thrust vector control	144
SRB recovery and refurbishment	147
<b>5. Shuttle propulsion: the external tank</b>	157
Introduction	157
Ground processing	167
Launch pad operations	171
Thermal protection system	172
<b>6. Maneuvering in space: the orbital maneuvering system and reaction control system</b>	179
Introduction	179
Development	180
OMS and RCS configuration	183
Propellant storage and gauging	191
Orbital maneuvering system engine	196
Reaction control system thrusters	201
<b>7. Heart and lung of the Orbiter: the environmental control life support system and electrical control system</b>	207
Environmental control life support system	207
Waster collector system	221
Fire detection and suppression system	225
Electrical power system	226
Extended duration Orbiter kit	234
<b>8. The Orbiter's skin: the thermal protection system</b>	237
Introduction	237
Reusable surface insulation tiles	239
Flexible reusable insulation	249
Reinforced carbon-carbon	250
Orbiter TPS configurations	252
The flight experience	263
On-orbit TPS repair techniques	273
TPS ground maintenance	288
TPS flight testing	290

<b>9. Auxiliary power unit and hydraulic system . . . . .</b>	<b>291</b>
Introduction . . . . .	291
APU system description . . . . .	292
Hydraulic system . . . . .	297
<b>10. Fundamentals of the Shuttle GNC . . . . .</b>	<b>299</b>
Guidance, Navigation & control . . . . .	299
Coordinate systems . . . . .	300
Shuttle navigation hardware . . . . .	303
Shuttle flight control system hardware . . . . .	313
State vector propagation . . . . .	314
The Orbiter flight deck . . . . .	320
Digital autopilot . . . . .	332
<b>11. The art of reaching orbit . . . . .</b>	<b>339</b>
Nominal ascent: first stage . . . . .	339
Nominal ascent: second stage . . . . .	352
Nominal ascent: displays . . . . .	356
Control stick steering . . . . .	359
Intact ascent abort modes . . . . .	360
Contingency aborts . . . . .	382
<b>12. Orbital dancing . . . . .</b>	<b>389</b>
Maneuvering the Shuttle . . . . .	389
Orbital rendezvous maneuvers: development . . . . .	397
Orbital rendezvous maneuvers: operations . . . . .	417
Orbital flight rules . . . . .	445
<b>13. Returning home . . . . .</b>	<b>447</b>
Falling from orbit . . . . .	447
Atmospheric entry . . . . .	454
Terminal area energy management . . . . .	465
Approach and landing . . . . .	473
<b>Glossary . . . . .</b>	<b>495</b>
<b>Bibliography . . . . .</b>	<b>497</b>
<b>Index . . . . .</b>	<b>499</b>

To Orbit and Back Again

How the Space Shuttle Flew in Space

Sivolella, D.

2014, XXII, 502 p. 245 illus., 95 illus. in color., Softcover

ISBN: 978-1-4614-0982-3